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Water: Policy and Performance for Sustainable Development

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Water: Policy and Performance for Sustainable Development

Infrastructure Development Finance Company

OXFORD
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Oxford University Press is a department of the University of Oxford.
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Published in India by
Oxford University Press
YMCA Library Building, 1 Jai Singh Road, New Delhi 110001, India

First Edition published in 2011

ISBN-13: 978-0-19-807885-2
ISBN-10: 0-19-807885-4

Typeset in 11/13 in Adobe Garamond Pro
by Excellent Laser Typesetters, Pitampura, Delhi 110 034
Printed in India at Rakmo Press Pvt. Ltd., New Delhi 110 020

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Foreword

It may well be true that the most bitter conflicts in the next fifty years will not be over oil but water. Already, almost a billion people in the world live without access to clean water. The sustainability of human development is being threatened by the growing scarcity of water. Climate change is likely to worsen the situation. Water will increasingly dominate national and international politics and power. It is this thirst for water that may become critical for ensuring political, social, and economic stability. How we manage this valuable resource is, therefore, crucial for our future.

An effective and just policy would need to address several questions. How much is available, and to whom? Who pays, and at what price? How accessible are the formal, regulated water supply systems to the poor? At present, a perverse practice operates in the water market: the poorer you are, the less you get and the more you pay. What is equitable? What is economically viable, and socially as well as legally acceptable? Answers to these questions are complex. John F. Kennedy once said, 'Anyone who can solve the problems of water will be worthy of two Nobel prizes—one for peace and one for science.'

India, which accounts for one-sixth of the world's population, already faces water stress that is likely to exacerbate in future. Unsustainable agricultural practices, industrial pollution, and poor civic planning have further decreased the per capita availability of utilizable water. Water shortages will not only severely restrain the nation's ability to sustain its economic growth but also lead to food shortages and more conflicts, with negative social and political consequences.

Urgent action is required to manage our water resources in a coherent way. The *India Infrastructure Report (IIR) 2011* focuses on the theme of 'Water—Policy and Performance for Sustainable Development'. The *Report* evaluates a range of institutional, legal, and regulatory frameworks that operate in the sector, at the international, national, state, and local levels. This *Report* seeks to evolve an appropriate policy framework from the perspective of rights, entitlements, and conflict resolution mechanisms. It proposes a major reorientation of public irrigation management, more emphasis on localized water resource development, better coordination among institutions in the planning and delivery of water services, and greater use of market mechanisms in the management of water use. Demand management needs more attention which, coupled with technological solutions, offers immense possibilities in improving efficiency in water use, in recycling wastewater, and in its conservation.

It is clear that there needs to be a radical change in our approach to water. I hope the issues and suggestions in this *Report*—the tenth in the series of *IIR*—will be considered in the current preparation of a comprehensive new framework for the delivery of sustainable water services. I also hope that it will create greater awareness of the looming water crisis, and prompt actions to address it at all levels of society. I would like to thank the authors, the editors, and all those who have contributed to the production of this *Report*.

October 2011 | Rajiv B. Lall

Acknowledgements

Water scarcity is among the main problems that the world faces today. India is no exception, as it grapples with the problem of water shortage in many of its regions. In fact, in another twenty years, half of our demand for water could remain unmet if the present pattern of demand and supply continues. Recent catastrophes, such as the floods in Odisha that inundated over a thousand villages and the earthquake in Sikkim that raised critical questions about the prudence of large hydel projects in fragile ecological regions, have highlighted the crucial nature of water resource management.

After having focused on 'land' and 'infrastructure development in the low carbon economy' in the previous two *India Infrastructure Report*s, 'water' was the most appropriate theme for the *India Infrastructure Report (IIR) 2011*. We are grateful to Ritu Anand for proposing this theme and also spending hours with us conceptualizing the framework for this *Report*. Water resource management is a theme that evokes multiple views from policymakers, environmentalists, non-governmental organizations, technocrats, hydrologists, and multilateral institutions. Our challenge was to weave together these multiple perspectives in a theme which would not only distinguish this *Report* from the plethora of other existing reports but would also provide a platform to debate and assimilate them. Initial discussions with Subodh Wagle provided critical inputs for the theme, which was set as 'Water—Policy and Performance for Sustainable Development'.

We would like to thank all those who responded to our 'call for papers' and submitted them for inclusion in the *IIR 2011*. We would also like to express our gratitude to all authors who presented their papers during the Writers' Workshop held at Mumbai on 17–18 February 2011. The deliberations at the workshop helped in shaping the final report. Special thanks are due to Abhay Kantak, Ramakrishna Nallathiga, Gopal Krishna Sarangi, Sunder Subramanian, Thilak Babu Gottipati, Anupam Rastogi, K. Sreelakshmi, Srinivas Chary, Ritu Anand, Kaushik Deb, Kunal Katara, and Sambit Basu for their comments and invaluable inputs during the workshop. We would also like to thank Navroz K. Dubash for his invaluable comments on one of the papers.

This *Report* would not have been possible but for various authors, who have made major contributions by not only preparing their own papers but also by helping with peer reviews of other papers. Our sincere gratitude to all the authors who have responded patiently to various editorial requests time and again.

We would like to thank Rajiv B. Lall, Managing Director and CEO, IDFC Ltd, for his unstinted support and encouragement to the publication of *IIR 2011*.

The Policy Group at IDFC provided the much needed organizational support. The untiring efforts of Kaushik Deb, Pritika Hingorani, Sambit Basu, and Ranesh Nair helped us in bringing out the *Report*.

We would also like to acknowledge the assistance that we received from Bharati Sawant who tirelessly, and with precision, coordinated with the authors and Oxford University Press on a variety of issues, and undertook a host of other tasks as an executive assistant as well as project assistant for ensuring the smooth progress of the project.

The immense support that we received from the editorial team at Oxford University Press helped us in the timely completion of the *Report*. We sincerely thank them for their support, and also for accommodating the sometimes exacting demands made of them.

We would like to thank all our colleagues at IDFC who provided organizational and administrative support.

Piyush Tiwari and Ajay Pandey

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Abbreviations

AAI	Airports Authority of India
ACUACAR	Aguas de Cartagena
ADB	Asian Development Bank
AERA	Airports Economic Regulatory Authority
AP	Andhra Pradesh
ARWSP	Accelerated Rural Water Supply Programme
ASP	Activated Sludge Process
AT&C	Aggregate Technical and Commercial
AWCO	Alexandria Water Company
AWDO	Asian Water Development Outlook
BCM	Billion Cubic Metre
BFA	Beneficiary Farmers' Association
BIS	Bureau of Indian Standards
BOD	Biochemical Oxygen Demand
BOOT	Build-Own-Operate-Transfer
BOT	Build-Operate-Transfer
BPO	Business Process Outsourcing
BSNL	Bharat Sanchar Nigam Limited
BUET	Bangladesh University of Engineering and Technology
BWSSB	Bangalore Water Supply and Sewerage Board
CAD	Command Area Development Authorities
CADA	Command Area Development Agency
CAEAC	Civil Aviation Economic Advisory Council
CAG	Comptroller and Auditor General
CAZRI	Central Arid Zone Research Institute
CBI	Central Bureau of Investigation
CCRCP	Chennai City River Conservation Project
CDP	City Development Plan
CEA	Central Electricity Authority
CEPT	Center for Environmental Planning and Technology
CETP	Common Effluent Treatment Plant
CGWA	Central Ground Water Authority
CGWB	Central Ground Water Board

CLINZI	Climate's Long-Term Impact on New Zealand Infrastructure
CMC	Chandrapur Municipal Council
CMW	Chennai Metrowater
CMWSSB	Chennai Metro Water Supply and Sewerage Board
COD	Chemical Oxygen Demand
CPCB	Central Pollution Control Board
CPD	Centre for Policy Dialogue
CPR	Centre for Policy Research
CRIDA	Central Research Institute for Dryland Agriculture
CSE	Centre for Science and Environment
CSIDC	Chhattisgarh State Industrial Development Corporation
CVM	Contingent Valuation Method
CWB	City Water Boards
CWC	Central Water Commission
DALY	Disability Adjusted Life Years
DBFO	Design-Build-Finance-Operate
DC	Distributory Committee
DDP	Desert Development Programme
DDWS	Department of Drinking Water Supply
DERC	Delhi Electricity Regulatory Commission
DfiD	Department for International Development—UK
DHBVN	Dakshin Haryana Bijli Vitran Nigam
DJB	Delhi Jal Board
DM	Demineralization
DO	Dissolved Oxygen
DoT	Department of Telecommunications
DPAP	Drought Prone Areas Programme
DPC	District Planning Committees
DPR	Detailed Project Report
EAC	Expert Appraisal Committee
EAI	Expressway Authority of India
ECB	External Commercial Borrowings
ED	Enforcement Directorate
EESL	Energy Efficiency Services Ltd
EFCs	Environmental and Forest Clearances
EIA	Environmental Impact Assessment
EMU	Electrical Multiple Unit
EPA	Environment Protection Act
EPC	Engineering, Procurement, and Construction
EPD	Empreses Publicas Distritales
ESCerts	Energy Savings Certificates
ETP	Effluent Treatment Plant
FAO	Food and Agriculture Organization
FBR	Aerobic Fluidized Bed Reactors
FMIS	Farmer Managed Irrigation Systems
FPR	Flood Prone Rivers
FRL	Full Reservoir Level

FYP	Five Year Plan
GAC	Granulated Activated Carbon
GAP	Ganga Action Plan
GBM	General Body Meeting
GBM	The Ganges, the Brahmaputra, and the Meghna
GBWSSB	Greater Bangalore Water Supply and Sewerage Board
GCM	General Circulation Model
GDA	Ganges Dependent Area
GDP	Gross Domestic Product
GECIS	GE Capital International Services
GEMS	Global Environment Monitoring System
GHMC	Greater Hyderabad Municipal Corporation
GIZ	Gesellschaft für Internationale Zusammenarbeit–Germany
GLOF	Glacier Lake Outburst Floods
GoB	Government of Bihar
GoI	Government of India
GoM	Government of Maharashtra
GPS	Global Positioning System
GRP	Glass Reinforced Plastic
GSLDC	Gujarat State Land Development Corporation
GWDT	Godavari Water Disputes Tribunal
GWIDC	Gujarat Water Infrastructure Development Company
GWP	Global Water Partnership
GWRDC	Gujarat Water Resource Development Corporation
HMWSSB	Hyderabad Metropolitan Water Supply and Sanitation Board
HPEC	High Powered Expert Committee
HRT	Hydraulic Retention Time
HUA	Hyderabad Urban Agglomeration
HUDA	Haryana Urban Development Authority
ICOLD	International Commission on Large Dams
ID	Irrigation Department
IDF	Intensity-Duration-Frequency
IDWA	Index of Drinking Water Adequacy
IEB	Institution of Engineers Bangladesh
IFC	Infrastructure Finance Companies
IFI	International and Bilateral Financial Institutions
IKPP	PT Indah Kiat Pulp and Paper
IMD	India Meteorological Department
IMT	Irrigation Management Transfer
I–O	Input–Output
IPCC	Intergovernmental Panel on Climate Change
IRA	Independent Regulatory Authority
ISB	Indian School of Business
ISESCO	Islamic Educational, Scientific and Cultural Organization
ISM	Irrigation Service Market
ISP	Irrigation Service Providers
IT	Information Technology

IT/ITES	Information Technology/IT Enabled Services
IWDP	Integrated Wastelands Development Programme
IWK	Indah Water Konsortium
IWMI	International Water Management Institute
IWMP	Integrated Watershed Management Programme
IWRM	Integrated Water Resource Management
JET	Joint Expert Team
JICA	Japanese International Cooperation Agency
JMP	Joint Monitoring Programme
JNNURM	Jawaharlal Nehru National Urban Renewal Mission
JPC	Joint Parliamentary Committee
JRC	Joint River Commission
JSTC	Joint Standing Technical Committee
JUSCO	Jamshedpur Utilities and Services Company
KL	Kilolitre
KPO	Knowledge Process Outsourcing
KT	Kolhapur Type
KUIDFC	Karnataka Urban Infrastructure Development Finance Company
KUWSDB	Karnataka Urban Water Supply and Drainage Board
KWA	Kerala Water Authority
LBP	Lower Bhavani Project
LIDAR	Light Detection and Ranging
LPCD	Litres Per Capita Per Day
LRMC	Long Run Marginal Cost
LUS	Land Use Survey
MBI	Market Based Instrument
MBR	Membrane Bioreactor
MC/MPLAD	Municipal Councillor/Member of Parliament Local Area Development
MCH	Municipal Corporation of Hyderabad
MCM	Million Cubic Metre
MDG	Millenium Development Goals
MDPE	Medium Density Polyethylene
MFL	Madras Fertilizers Limited
MGNREGA	Mahatma Gandhi National Rural Employment Guarantee Act
MINARS	Monitoring of Indian National Aquatic Resources
MINAS	Minimal National Standards
MJP	Maharashtra Jeevan Pradhikaran
MLD	Million Litres Per Day
MNP	Mobile Number Portability
MoA	Memoranda of Agreement
MoCA	Ministry of Civil Aviation
MoCI	Ministry of Commerce & Industry
MoEF	Ministry of Environment and Forests
MoR	Ministry of Railways
MoRD	Ministry of Rural Development
MoU	Memorandum of Understanding
MoUD	Ministry of Urban Development

MoWR	Ministry of Water Resources
MPRA	Major Port Regulatory Authority
MRO	Maintenance, Repair and Overhaul
MSP	Multi-Stakeholder Platform
MTNL	Mahanagar Telephone Nigam Limited
MWA	Metropolitan Waterworks Authority
MWRRA	Maharashtra Water Resources Regulatory Authority
NABARD	National Bank for Agriculture and Rural Development
NAC	National Academy of Construction
NAPCC	National Action Plan on Climate Change
NBWL	National Board for Wildlife
NCAER	National Council of Applied Economic Research
NCIWRD	National Commission on Integrated Water Resources Development
NDA	National Democratic Alliance
NDMA	National Disaster Management Authority
NDRC	National Development and Reform Commission
NEAA	National Environmental Appellate Authority
NEAMA	National Environmental Appraisal and Monitoring Authority
NEEPCO	North-eastern Electrical Power Corporation Ltd
NESL	Nagpur Environmental Services Ltd
NESRC	North-eastern Social Science Research Centre
NEWRA	North-east Water Resources Authority
NGO	Non-government Organization
NH	National Highway
NHAI	National Highways Authority of India
NHDP	National Highway Development Programme
NIJNNURM	New Improved Jawaharlal Nehru National Urban Renewal Mission
NMEEE	National Mission for Enhanced Energy Efficiency
NMMC	Navi Mumbai Municipal Corporation
NPA	Non-Performing Assets
NRAA	National Rain-fed Area Authority
NRDWP	National Rural Drinking Water Programme
NRLP	National River Linking Project
NRW	Non-Revenue Water
NSM	National Solar Mission
NSSO	National Sample Survey Organization
NTADCL	New Tiruppur Area Development Corporation Limited
NTPC	National Thermal Power Corporation
NWDA	National Water Development Agency
NWDPRA	National Watershed Project for Rain-fed Areas
NWP	National Water Policy
NWSC	National Water and Sanitation Corporation
O&M	Operation and Maintenance
OFD	On-farm Development
OFWAT	Office of Water Services
OMC	One Man Committee
PAP	Parambikulam Aliyar Project

PAPs	Project-Affected Persons
PAs	Protected Areas
PAT	Perform, Achieve and Trade
PC	Planning Commission
PC	Project Committee
PCA	Pollution Control Agency
PE	Private Equity
PHED	Public Health and Engineering Departments
PIL	Public Interest Litigation
PIM	Participatory Irrigation Management
PLUS	Performance Led Urban Services
PPA	Power Purchase Agreements
PPCL	Pragati Power Corporation Limited
PPPs	Public–Private Partnerships
PPWSA	Phnom Penh Water Supply Authority
PRI	Panchayati Raj Institutions
PROOF	Public Record of Operations and Finance
PSP	Private Sector Participation
PUB	Public Utilities Board
PURA	Provision of Urban Amenities in Rural Areas
R&R	Resettlement and Rehabilitation
RBC	Rotating Biological Contactor
RBI	Reserve Bank of India
RBO	River Basin Organization
RCF	Rashtriya Chemicals and Fertilizers Limited
RCOM	Reliance Communications
RECs	Renewable Energy Certificates
RGNDWM	Rajiv Gandhi National Drinking Water Mission
RO	Reverse Osmosis
RoR	Run-of-the-river
RTI	Right to Information
SANDRP	South Asia Network on Dams, Rivers & People
SBR	Sequential Batch Reactor
SCARP	Salinity Control and Reclamation Programme
SEB	State Electricity Board
SEC	Specific Energy Consumption
SES	Socio-Ecological Systems
SEZ	Special Economic Zone
SLB	Service Level Benchmarking
SPCB	State Pollution Control Board
SPV	Special Purpose Vehicle
SRMC	Short Run Marginal Cost
SRSP	Sriram Sagar Project
SRT	Solid Retention Time
SS	Suspended Solid
SSNNL	Sardar Sarovar Narmada Nigam Limited
STP	Sewage Treatment Plant

STW	Treated Sewage Water
SWC	Siza Water Company
SZWRB	Shenzhen Water Resource Bureau
TAMP	Tariff Authority for Major Ports
TERI	The Energy and Resource Institute
TFC	Thirteenth Finance Commission
TNUDF	Tamil Nadu Urban Development Fund
ToR	Terms of Reference
TRAI	Telecom Regulatory Authority of India
TSS	Total Suspended Solids
TTSL	Tata Teleservices Limited
TUFIDCO	Tamil Nadu Urban Finance and Infrastructure Development Corporation
UA	Urban Agglomeration
UAS	Unified Access Services
UASB	Up-flow Anaerobic Sludge Blanket
UFW	Unaccounted For Water
UGD	Underground Drainage
UIDSSMT	Urban Infrastructure Development Scheme for Small and Medium Towns
UIP	Ultimate Irrigation Potential
ULB	Urban Local Body
UMPPs	Ultra Mega Power projects
UN	United Nations
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific, and Cultural Organization
UP	Uttar Pradesh
UPJN	Uttar Pradesh Jal Nigam
UPWMRC	Uttar Pradesh Water Management and Regulatory Commission
USAID	United States Agency for International Development
UT	Union Territories
UWSS	Urban Water Supply Sector
VGF	Viability Gap Fund
VLR	Visitor Location Register
VWSC	Village Water Supply Committee
WA	Water Authority
WAPCOS	Water and Power Consultancy Services
WARPO	Water Resources Planning Organization
WCD	World Commission of Dams
WDR	World Development Report
WEF	World Economic Forum
WHO	World Health Organization
WRIS	Water Resources Information System
WRS	Water Resources Strategy
WSD	Watershed Development
WSP	Water and Sanitation Program
WSP	Waste Stabilization Ponds
WSPF	Water and Sanitation Pooled Finance
WSS	Water Supply and Sanitation

WSSB	Water Supply and Sanitation Board
WSTR	Wastewater Storage and Treatment Reservoirs
WUA	Water Users Association
WWAP	World Water Assessment Programme
YAP	Yamuna Action Plan

Overview

Piyush Tiwari and Ajay Pandey

Introduction

India's water future is in danger if current trends in its use continue. The total annual surface water availability in the country is estimated to be 1,869 billion cubic metre (bcm). Due to spatial-temporal variations, an estimated 690 bcm of surface water is utilizable. Add to this 432 bcm of replenishable groundwater, and the total utilizable water in the country is 1,122 bcm, which appears to be just about sufficient to meet our present needs. Since the total available water is more or less constant, rising demands due to population and economic growth will strain the demand-supply balance. The Water Resources Group estimates that if the current pattern of demand continues, about half of the demand for water will be unmet by 2030 (WRG 2009).

Even the present situation is tenuous. Although at the macro level, demand and supply of water seem to balance, there are stark differences at the basin levels. Of the 20 major river basins in India, 14 are already water-stressed (Chapter 1). Nearly three-fourth of India's population lives in water-stressed regions (where per capita availability is less than 2,000 cubic metres per year) of which one-third of the region is in water, scarce areas (where per capita water availability is less than 1,000 cubic metres per year). Climate change will further aggravate the problem by causing erratic weather patterns. More extreme rates of precipitation and evapo-transpiration will cause more instances of droughts and floods, with disparate and complex effects at the sub-basin level.

In terms of usage of water, agriculture was the largest consumer, accounting for almost 85 per cent of the total water consumption, followed by industry and energy (9 per cent), and domestic users (6 per cent) in 2010 (Chapter 1). Agriculture is also a highly inefficient consumer of water. For instance, the water productivity of rice in India is 0.2–0.26 kg per cubic metre of water; which is half that of China. Water productivity for other cereals is 0.32–0.42 kg per cubic metre of water, just one-third of China (Cai and Rosegrant 2003). Other consumers of water, industry and energy, also use water inefficiently. Moreover, untreated waste water discharge from industry is a major cause of pollution in rivers and other water bodies, which reduces availability of clean water. The situation is further aggravated by the disposal of untreated municipal sewage into these water bodies.

In short, inefficiency in water use and irresponsibility in the management of water resources pose a serious threat to our water security and sustainability. Going forward, the availability of water could pose significant challenges for economic growth. Illustratively, after accounting for drinking and irrigation, which are priority needs, the residual utilizable water for industry and energy would reduce from 492 bcm in 2010 to 197 bcm in 2025, assuming that the total utilizable water remains the same (Chapter 1).

Of course, irrigation water needs could be brought down. The Water Resources Group has evaluated various techno-economic options for supply and water productivity that are available to close the 'water gap' in India by 2030 (WRG 2009). The 'least cost' set of options largely comprise agricultural measures which can reduce much of the projected water shortfall (Chapter 1). Indeed, improvements in water use efficiency, changes in cropping patterns where possible, better irrigation techniques, water-saving innovations, such as a system of rice intensification (SRI), and improving the productivity of 'rainfed' agriculture are some of the practical options to reduce water consumption in agriculture (Chapter 7; Iyer 2011).

It is clear then that demand needs to be restrained, and water use efficiency and conservation increased, since even greater storage and harnessing of water cannot meet an endlessly growing demand. However, till now government response to the growing demand has primarily been to undertake large projects for augmentation of irrigation and water supply systems. Many of these projects remain incomplete. Those which are built do not have sufficient financial resources for operations and maintenance (O&M). As a result this has led to a 'build-neglect-rebuild' syndrome (Chapter 6). A major critique, therefore, is that the government has focused on supply-side initiatives in constructing infrastructure without paying attention to its maintenance. Moreover, it has not exploited demand-side options as much due to weak incentive and regulatory systems.

Thus, going forward, there needs to be a two-pronged approach. First, is the simpler part, which is to extend means of harnessing, retaining, and re-using water. This includes infrastructure for augmenting storage capacity for surface water, groundwater recharge structures, rainwater harvesting structures, increasing wastewater treatment capacity, and upgradation of water supply systems to minimize losses in the transportation of water. The design of these water management systems will also need to take into account the implications of climate change as the design parameters will undergo change due to changes in the pattern of droughts and floods (Chapter 2).

Second, and more importantly, is developing and generating awareness of a completely new approach to water. It will take years to change ingrained habits, but all the systems, institutions, regulations, and practices must work in the same consistent direction of conserving and reducing water use where possible. Underlying the new approach, it should be recognized that water is a resource for the whole community, to be shared equitably by present and future generations.

Presently, competing claims for water use and unclear entitlements lead to conflicts at various levels: rural versus urban, industry versus environmentalists, minorities living off natural resources and entrepreneurs seeking to 'commodify' the resource base. Issues on sharing water resources also lead to intra-state, inter-state, and international conflicts.

Against this background, this IIR attempts to answer the following questions:

- How clear is the strategic vision for water resource management and sustainable development?
- How effective and equitable is the legal framework?
- Given that only the supply-side approach will not help in meeting future demand, what legal, regulatory, institutional, and pricing mechanisms will be necessary to efficiently manage and restrain demand?

Strategic vision for The Water Sector: National Water Policy

The National Water Policy, which was adopted by the National Water Resources Council in 1987, sets out principles and objectives to guide programmes for water resource development and management. The Policy was revised in 2002 (MoWR 2002) and about half of the states have adopted state water policies. The revised National Water Policy, which recognized the importance of water for life, for maintaining an ecological balance, and for economic development, did very little in terms of setting the principles and objectives which could lead to sustainable and equitable use of this resource. There are two major problems with the policy, which are now discussed.

Water Resource Planning and Development

The approach adopted by the policy in the past was to attempt to make more water available in order to meet demand. Water resource planning and development focused on bringing all available water resources within the category of utilizable resources (MoWR 2002). This approach towards water resource development has implicitly encouraged an unabated rise in demand and inefficient use of water by various users. Inaccurate demand projections (which were based on assumptions that did not address inefficiency in use) formed the basis for water resource development projects, which were mainly 'supply augmentation' projects. The policy suggested that projects, such as inter-linking of rivers, desalination of brackish water, and artificial recharge of groundwater should be undertaken, some of which not only have an adverse ecological impact but are also expensive. Consequently, these projects, barring one or two, have not taken off.

Empowerment of Local Institutions and Citizens

Another criticism of the policy is that it seems to 'centralize' the governance of the water sector as evidenced from its emphasis on planning, development, and management of this resource from the national perspective (Chapter 22). This, together with similar state government leanings, tends to disempower citizens and other stakeholders by denying them an opportunity to participate and influence key decisions (ibid.). Warghade and Wagle (Chapter 22) and Iyer (2011) propose an institutional structure that is bottom-up starting from the village and the micro-watershed to the state level as a set of nested institutions up to the basin level, involving all categories of water users. For such a structure to be effective, states will have to cooperate with each other as well as play an important role in the empowerment of local institutions.

The policy has not been able to promote optimal water resource management. It suggests that water resource management will have to be at the level of a hydrological unit and appropriate river basin organizations (RBOs) should be established by the basin states. These organizations will be responsible for preparing comprehensive plans taking into account the needs of various users and existing agreements on award of water tribunals (MoWR 2002). However, in the absence of well-defined water rights for various uses across states and numerous conflicts that have arisen, it has been difficult for basin states to agree on setting up RBOs. Very few RBOs have been established in the country and they are not effective as they do not have the necessary support from states (Chapter 1).

A new National Water Policy (NWP) is now being prepared. An alternative, radically different approach for a NWP has been proposed by Iyer (2011), which sets forth a broad national perspective on 'responsible, harmonious, just and wise use of water'. The crux of this approach is that the availability of fresh water is finite and we need to manage our needs within that availability. It emphasizes the ecological and social justice perspectives as overarching, indeed as a moral responsibility. Just as it eschews supply responses to meet projections of demand, it proposes a shift from large, centralized water resource development projects to small, decentralized, local, community-led watershed development programmes, as well as to severely restrain the exploitation of groundwater.

A Sound Legal Framework

Water within the 'Property Rights' Framework

The basis for an effective water policy design is a clear understanding of rights associated with this resource. There are two critical aspects here. First, water must be recognized as a common pool resource (as against state or private property). Second, water is fundamental to meet the basic requirement of life. Both these indisputable points have implications for policy.

Though not explicitly stated in the Constitution, by judicial pronouncement, water is held in public trust by the state for the community. Expanding this view implies that (i) economic or commercial use of water by some must not adversely affect the lives and livelihood of the community, and (ii) the public trust doctrine applies to all forms of water, including groundwater (which conflicts with its current legal status).

The 'right to water' relates to basic water requirements for life, which is a fundamental right and is non-negotiable. The state has a responsibility to ensure that this right is not denied. This right is distinguishable from 'water rights', which are rights assigned to individuals or groups for various economic uses of water (Chapter 5).

Water Laws within the 'Rights' Based Perspective

Laws are required (i) to create conditions so that the institutions deliver on the 'right to water', (ii) to ensure that the distribution is equitable, and (iii) so that nobody's actions infringe upon others' rights to water. Laws are also required to protect the water resource from being degraded and exploited in a manner that threatens its sustainability. How do existing water laws fare on a 'rights' based perspective? Are water laws able to prevent deterioration or unsustainable exploitation of our water resources? Are the laws being enforced?

The right to safe drinking water is not explicit under the Constitution but various court rulings have declared it to be a fundamental right, interpreting it as a part of 'right to life' which is guaranteed under the Constitution. However, for it to be an effective right, a 'minimum core obligation' (say, defined in terms of litres per capita per day of water of a certain quality standard) of the state needs to be specified below which the right to water can be said to be denied. The state (or its water supply agencies) must provide the basic minimum, even if it means diverting financial resources from other uses for this fundamental purpose. Thus, an explicitly recognized well-defined right to water should be stated in the Constitution, with appropriate legislation defining the minimum quantity and quality parameters.

In order to ensure that water is equitably distributed, some states have enacted legislation to set up water resource regulatory authorities. Three states (Maharashtra, Andhra Pradesh, and Uttar Pradesh) have set up independent regulatory authorities (IRAs) to oversee the issuance and distribution of water entitlements by designated river basin agencies and to fix the criteria for trading of water entitlements or quotas. Once again, the problem is that a system has been created where entitlements exist without corresponding obligations to meet them (Chapter 5). In addition, lack of adequate mechanisms for transparency, public participation, and accountability in the proceedings of IRAs leads to lack of influence of citizens and water users in determining and ensuring that their entitlements are granted (Chapter 22). Moreover, equitable criteria for entitlements are not clearly defined. Currently, for example, water entitlements are based on the size of the landholding, thereby reinforcing inequities (ibid.).

There are various laws that deal with different aspects of infringement of water rights, in particular, relating to the withdrawal of groundwater and controlling pollution. The excessive pumping of groundwater by some farmers has led to an alarming lowering of water tables in some regions and consequent inaccessibility of groundwater resources by others. Several states have introduced legislation to regulate groundwater use but the laws are limited in purpose and area, largely focusing on aspects such as (i) restriction on depth of wells, and (ii) declaration of groundwater conservation and protection zones. These laws have also had limited success in implementation. Moreover, all these laws avoid the most important question about the legal status of groundwater itself. Currently, groundwater is considered an easement connected to the land with the landowner having an unrestricted right to its use. Although recent court rulings have expressed that 'deep underground water' is the property of the state under the doctrine of 'public trust' and the holder of land only has a user right, this needs to be encoded as legislation rather than left for the courts to interpret (Chapters 5 and 7).

Another set of laws deals with pollution control. However, the existing legislations are not comprehensive, nor are they efficient. First of all, these acts do not cover the regulation of water pollution originating from households or agriculture (Chapter 19). Second, legislations specified by pollution control boards, which are empowered to prevent, control, and abate water pollution, require all polluters to meet the same discharge standards, which makes these legislations inefficient.

Recently, a new law called the National Green Tribunal Act 2010 has been enacted which, for the first time, recognizes the right of the victims of environmental damage and pollution, including water pollution, to claim damages and compensation (Chapter 5). This law is a significant departure from the existing legislation where apart from closing down a polluting industry, cutting its water and power supply, and criminal punishment for those responsible for running it, there were no rights available to the victims of water pollution (ibid.).

Environmental impact assessments (EIA) are supposed to address unsustainable exploitation of water resources. They are particularly important to assess large projects, such as multi-purpose hydro projects, which can have a lasting impact on the ecology of a river basin. Many hydro projects have been planned or approved in the North East, a region which is considered ecologically sensitive with little arable land and which is inhabited by culturally sensitive indigenous communities (Chapter 25). The EIA of a project is meant to assess the upstream, downstream, and cumulative ecological and social impact of a project. However, in practice this is often done in a cursory manner. Given the irreparable damage that large projects could cause to the ecology of water resources, it is important that more comprehensive and credible EIAs are carried out (ibid.).

Water Conflicts

The 'rights' associated with water are complex and absence of proper democratic, legal, and administrative mechanisms to handle various issues that arise with water lead to conflicts. These conflicts take the form of conflicts over equitable access, conflicts over competing uses, conflicts over dams and displacement, conflicts over privatization, conflicts over water allocations, and trans-boundary, inter-state, and intra-state conflicts (Chapters 3 and 4).

Fairness is always an underlying issue, which can possibly be addressed through efficient use of a resource, respect of historical rights, and pareto-efficient solutions. Conflicts are expected to persist though as long as the bargaining power is unequal and there is an absence of an acceptable negotiating framework. Some measures that will help avoid conflicts are: clear norms for equitable water allocation and distribution, relative prioritization of different uses (including environmental/ecosystem needs versus other needs), integration of large and small water management systems rather than favouring one over the other, and well-defined role for the private sector in public-private partnerships (PPPs) so that the assigned role does not infringe upon the rights and entitlements of those who hold them (Chapter 4).

Water pricing could be an important tool for efficient water allocation and conservation and for minimizing conflicts. Unfortunately, water prices are rarely efficient and water rates are highly subsidized due to political compulsions (Chapter 23).

Managing Water Resources—A Sectoral Perspective

Irrigation

Public irrigation systems are losing their position of dominance. Yet, despite poor performance of canal based irrigation, governments at all levels have continued to invest heavily in large canal projects. Shah (Chapter 6) argues that while the colonial government treated large-scale canal irrigation as an economic enterprise which made significant returns to investment, the socio-technical and agrarian conditions under which the system performed have changed considerably since then. Currently, the water fee recovered from irrigators is less than 10 per cent of working expenses and a key problem is poor maintenance and system management, especially below the outlet. The system is over-designed to justify higher returns, but it is rarely able to deliver water to more than half of the command area. Farmers at the upper-end over-appropriate water to cultivate high-value crops, leaving little for tail-end farmers. As a result, farmers in the periphery started relying on groundwater, which also gives them greater control of timing their water use.

The benefits of groundwater irrigation, coupled with supportive policies of the government, led to an explosion in groundwater tube wells. The government's 'green revolution' policies promoted a package of inputs including high yielding varieties of seed, fertilizers, and agrochemicals, requiring intensive and timely irrigation. The development was given further impetus by cheap and un-metered electricity, and subsidized credit for irrigation dug-cum-bore wells. Groundwater irrigated farms performed better compared to those irrigated by other sources in terms of cropping intensity, input use, and yields (Chapter 7). Groundwater was also relatively more equitable than surface irrigation, though recent trends favour richer farmers who can afford deeper wells and larger pumps.

As a result of the poor performance of public canal irrigation and the relative advantages of groundwater use, tube wells have become the predominant means of irrigation. Over 85 per cent of the increase in net irrigated area between 1961 and 2001 was from groundwater sources, and groundwater now accounts for 62 per cent of the total irrigated area.

Rampant use of groundwater has, however, brought about serious problems. Lack of regulation and its indiscriminate extraction has led to a lowering of the water table and increasing salinity and water quality problems in many regions of Punjab, Rajasthan, Haryana, Gujarat, Tamil Nadu, and Uttar Pradesh (Chapter 7). The severity of the problem can be seen from the fact that these 6 states account for half the food grain production in the country.

In contrast to the meteoric rise in groundwater irrigation, the net irrigated command area under canals has continued to decline. Even the efforts aimed at reversing the deceleration in canal irrigated areas by stepping up investment in last-mile projects under the Accelerated Irrigation Benefits Programme have not yielded favourable results. Shah (Chapter 6) argues that central and state governments have been throwing good money after bad and have to invest twice as fast in canal irrigation projects every year just to keep their command areas from shrinking.

More recent thinking on improving the performance of surface systems has promoted rehabilitation of irrigation schemes combined with institutional reforms relying on the participation of farmers and local bodies through participatory irrigation management (PIM). Accordingly, many states have instituted laws empowering farmers' participation in the management of irrigation systems through the creation of water users' associations (WUAs). Involving WUAs, as the PIM institutions are called, in the operation, maintenance, and management of water facilities was expected to improve the performance of canal systems. However, the evidence with regard to WUAs' ability to improve systems management has been inconclusive. Shah argues that based on the experiences with WUAs so far, the large scale impact of these institutions on restoring the canal irrigation system is limited and has worked only in some cases where large NGOs have been involved over a long period (Chapter 6).

Another factor for their lack of success may be due to the fact that, while the rights of WUAs have been legislated (such as to receive information in time about water availability, and to receive bulk water according to an approved schedule), the obligations of irrigation departments to deliver water to WUAs are rarely legally binding (Chapter 5).

In their study of WUAs in three states (Andhra Pradesh, Maharashtra, and Gujarat), Bhamoriya and Gandhi (Chapter 9) find that there have been substantial differences in the way WUAs were instituted and their scope and hence their performance. WUAs in Maharashtra and Gujarat have performed better than those in Andhra Pradesh because given the way the WUA laws were formulated in these two states, the institutional structures such as bye-laws, general bodies, and management committees are better specified. Operationally as well, WUAs in Maharashtra and Gujarat are more flexible and autonomous than they are in Andhra Pradesh (ibid.).

What then can be a solution for improving the performance of public irrigation systems? Shah suggests that the biggest opportunity for unlocking value from canal systems is by spreading their water on much larger areas to expand the areas under conjunctive management of surface and groundwater (Chapter 6). The canal systems can be transformed into extensive systems as they were originally meant to be, without much investment. However, the key lies in improving the management of the main systems, which can only be achieved by reforming the irrigation bureaucracy (ibid.). This will require unbundling the irrigation monolith into independent management units with operational autonomy and greater accountability by instituting a performance-based reward system (ibid.). Of course, it is arguable whether reforming state irrigation monopolies will be more successful than the experience with WUAs. In any case, as a beginning, a basic precondition for any management turnaround will require a reliable management information system to monitor the performance of irrigation systems.

Another proposal is to evolve a public-private partnership between farmers and irrigation departments for efficient utilization of canal water. There are a number of schemes where the irrigation department has constructed weirs or otherwise ensured supply of bulk water at regular intervals for lift irrigation schemes and pump and (underground) pipe systems to distribute water to farms (Chapter 6). Water lifting, conveyance, and distribution are done by the private and cooperative sector which charges farmers for the water supplied. Evidence suggests that the cost recovery in such schemes is better than under gravity flow irrigation systems. These lift irrigation schemes are also more equitable since the tail-end weirs are filled first and the head-end last.

In parallel, it is important to control excessive groundwater use. In line with the public trust doctrine for water resources—which needs to be legislated—a possible option is to move to a government administered permit/licensing system for groundwater extraction; examples of such laws exist in the US, Australia, Italy, England, and Wales (Chapter 7). As an alternative to central and state mechanisms, a community-based system, such as a water/aquifer users association has been suggested which could collectively decide on priorities in the use of groundwater (ibid.; Iyer 2011).

As it may be difficult to enforce regulations on some 20 million pump sets in the country, market-based instruments should also be used. These include rationalizing electricity prices together with separation feeders to agriculture from other uses. Given the political resistance to raising electricity tariffs it has been suggested that at the least, state governments should consider imposing a cess on electricity for agricultural use in all areas where the water level has sunk too low, and earmark the proceeds for groundwater recharge (Ahluwalia 2011).

Besides arresting the depletion of water tables, there are opportunities to harness more water from precipitation. Rainwater harvesting has significant potential for replenishing and recharging groundwater. Though it has been promoted in the National Water Policy 2002 and the last two Five Year Plans allocated budgets for watershed development programmes, the extent of rainwater harvesting is minuscule (Chapter 8). If there are appropriate legal and regulatory regimes, local solutions for better management of groundwater will emerge. The check dam movement in Gujarat is an example of check dams being constructed by public and NGO efforts to store water during monsoons, which not only recharges aquifers but also fills up wells for use during the lean periods (Chapter 7). Gandhi and Bhamoriya (Chapter 8) in fact argue that small decentralized water harvesting structures can capture more water and are a major alternative to co ventional river basin water resource development.

Decentralized traditional methods of rainwater harvesting could provide water for drinking as well, and should be encouraged as these have provided local solutions to the scarcity of drinking water in some regions of the country. Locally built tanks and wells, such as *kuia* and *kundi* in Rajasthan, have provided excellent storage, minimizing losses.

Rural Drinking Water

The major problems with rural drinking water are its adequacy and quality. Government programmes, such as Bharat Nirman have not been able to supply adequate, good quality water to rural households. Much of the rural drinking water needs are met by groundwater. Declining water tables and deteriorating quality of groundwater has rendered government schemes untenable. In fact, many rural habitations which have been provided drinking water supply over the past years have 'slipped back' because the same aquifer is also being tapped for irrigation 'and the left hand of drinking water does not know what the right hand of irrigation is doing' (Planning Commission 2011b). Availability of water in rural areas is getting further strained due to urbanization that is expanding urban boundaries and policies that allocate rural land to attract investment for economic activities (Chapter 11). The accompanying real estate development is causing damage to agricultural land and water bodies (ibid.).

Decentralization of water service delivery to Panchayati Raj Institutions (PRIs) has not been accompanied by adequate financial resources and capacity building for PRIs to fulfill their responsibilities for the O&M of rural water supply schemes. Moreover, the top-down approach in planning and implementing these schemes by the Centre or state has led to unwillingness on the part of PRIs in taking over the completed schemes for O&M (Planning Commission 2011a).

Fundamental changes are required in the approach towards rural drinking water supply. Foremost amongst these is setting legally binding water quantity norms and quality standards that are equitable. In the new Rural Drinking Water Policy, minimum water quantity norms are defined at the level of a household, which is diluting the fundamental right of an individual. Second, local government institutions, the gram sabhas and gram panchayats, must be given the necessary regulatory and fiscal powers to ensure effective implementation of the tasks that they have to perform. Their role should be supplemented by the upper levels of the government (Chapter 10). Third, the inconsistencies between binding legal principles and rural drinking water programmes need to be addressed. For example, the characterization of water as an economic good in these programmes is in contrast with the principles of a fundamental right (ibid.). Water should be considered as a socio-economic good only after meeting the minimum core obligations.

Urban Water Sector

The urban water sector in India is in a state of despair. Inadequate access, poor quality, and poor reliability are major problems with urban water supply. Water utilities are operationally inefficient and financially weak. Similar to the experience of public irrigation systems, public agency focus on asset creation with limited or no incentive for their O&M, has led to deterioration of water supply systems. Urban local bodies (ULBs) are dependent on higher levels of government for funds, which undermines their motivation for effective asset management, service delivery, and cost recovery. Institutional fragmentation with regard to policymaking, financing, regulation, and service delivery has also contributed to the poor state of urban water service delivery. The failure of the state in supplying adequate water to meet the needs of urban dwellers has led to the emergence of unorthodox supply systems (Chapter 17).

Several reforms are required to improve the performance of utilities. International experience suggests that effective leadership, political will, improvement in management practices, corporatization, measures for demand side management and wastewater reuse, and full cost recovery have been necessary elements for the successful transformation of utilities (Chapter 16).

However, these reform measures will take some time to be instituted in India. Moreover, given the weak state of finances of the ULBs, central and state governments will continue to play a predominant role in the foreseeable future. Focused action on three thrust areas is needed to address the long-term financial sustainability issue in the sector (Chapter 14).

First, concerted efforts on the part of ULBs will be required to harness operational efficiency through increasing coverage, metering, and reduction in non-revenue water. Such measures, coupled with tariff revisions that are based on rationalized cost structures, are needed to achieve cost recovery. Water tariffs levied by ULBs are low. Political interference has hindered upward revision of tariffs for most utilities. An appropriate basis for determining water tariffs is short-run marginal cost. An analysis in Chapter 24, comparing the short-run marginal cost of water delivery with current tariffs, shows that there is significant potential for increasing tariffs. However, if municipal water tariffs are raised without rationalizing and increasing electricity tariffs, people may resort to greater groundwater use, which is difficult to regulate.

Second, public funds should be efficiently allocated to achieve desired outcomes. This will require a shift in focus from augmentation of bulk supply to improvement in infrastructure which is necessary for service delivery. To achieve improved outcomes from investment, greater predictability of funding streams is required which will enable ULBs to plan on a three- to five-year basis.

Third, corporatization or private sector involvement will help increase efficiency of water utilities. The private sector, however, views participation in water and sanitation services as risky. Its concerns stem from poor project preparation, lack of capacity of ULBs in structuring public-private partnerships, and unpredictability of revenues (Chapter 15). These concerns will have to be addressed if private sector participation is to reach scale.

Industrial Water

Two concerns that dominate the industrial water sector are (i) rising demand, and (ii) pollution caused by the discharge of wastewater by industries. In the absence of effective regulations, about 70 per cent of the wastewater generated by industries is discharged untreated (Chapter 18). As per an estimate, each litre of discharged wastewater further pollutes 5–8 litres of water (Chapter 18).

Water productivity in industries is low. One of the main reasons for inefficient use of water by industry is its poor pricing. Industries pay three charges related to water: a water cess (the purpose of which is to raise resources for state pollution control boards), tariff to municipalities or other suppliers of water, and cost of extraction of water from rivers or groundwater. The levels of these charges are so low that overall they constitute a very small proportion of the cost structure of industrial output.

Aggarwal and Kumar (Chapter 18) find that the average shadow price (the maximum price that a firm is willing to pay for an extra unit of water consumption) of water is about Rs 7.21 per kilolitre, about 3.7 times higher than what industries pay today. There is, thus, a potential for revising water tariffs upwards. The pricing policy can act as an appropriate instrument for achieving water conservation in the sector as the price elasticity of demand for water by industry is fairly high (ibid.).

A major hurdle in managing water use in the sector is the involvement of a multiplicity of institutions, MoWR is the principal agency responsible for water in India but water pollution does not fall under its purview, nor does the industrial use of water; the Ministry of Commerce & Industry (MoCI) is concerned with the planning and development of water resources for industrial use but has no mandate to control or regulate water use by industries; the Central Ground Water Board/Authority (CGWB/A) are meant to regulate the groundwater quality and quantity in the country but they have not achieved much success in regulating either; Central Pollution Control Boards (CPCB) and State Pollution Control Boards (SPCBs) regulate industrial water pollution and charge water cess based on the amount of wastewater discharged by companies, but they have no mandate for controlling the sourcing of water from various sources. Unless all aspects of water use by industry are regulated by fewer agencies or even a single agency, it will not be possible to achieve either water conservation or pollution control in the sector.

Wastewater Recycling and Pollution Control

Wastewater recycling offers immense potential for becoming a viable and practical solution for non-potable water uses (Chapter 21). The costs of recycling have also reduced dramatically to make this option viable, particularly for industrial use. There are a growing number of cases where large industries, forced by lack of freshwater supply from municipalities, have resorted to wastewater recycling (IDFC 2011). Though the cost of recycled water to industries may be slightly more than the tariff that municipalities charge for the supply of freshwater, the reliability of supply makes it worthwhile for industries to recycle wastewater. The main constraints that industries face in setting up their own recycling plants, though, are (i) huge capital costs, which means that for scale economies, recycling plants make sense only for large industries or cluster of industries, (ii) access to sufficient sewage at a reasonable cost, and (iii) land to accommodate recycling plants (ibid.).

Municipalities can supply sewage or sewage treated water (STW) to industries but some municipalities have been reluctant to forego the revenue that they receive from the supply of industrial water (due to higher tariff on water for industrial and commercial use). They may be far more willing to invest in supply augmentation projects (as the capital cost is met through state/central grants, such as the Jawaharlal Nehru National Urban Renewal Mission or JNNURM) than in wastewater recycling. The use of sewage treated recycled water by large industries (including power plants) located near urban areas should be mandated. Eventually industries should recycle all their water. Tariffs should reflect the opportunity cost of freshwater to incentivize a shift to the use of recycled water (IDFC 2011).

Although CPCB rules require that all sewage generated be collected and treated by municipalities, very little is actually treated. The total installed treatment capacity in the country is about 19 per cent of the total sewage generation (Chapter 21). Given that municipalities have weak financial capacity, to incentivize them to construct sewage treatment plants, grants or loans should be provided. Grants could fund the pipeline network for collection of sewage and loans could fund the construction of sewage treatment plants (ibid.). For sustainability, it is important that there is an orientation towards O&M cost recovery and operational efficiency. In allocating grants like JNNURM, it could be mandated that all bulk water supply projects be complemented by an increase in sewage infrastructure. Incentives and funding should be tied to reaching certain sewage treated water reuse benchmarks.

Since the cost of a sewage network is high, CPCB is encouraging decentralized treatment plants. In Chennai, for instance, regulations mandate all new housing colonies to set up their own sewage treatment plants for management of wastewater. Tariff structures for domestic uses could be devised in a way that the consumption of freshwater is charged higher while STW is supplied at a subsidized rate or free of cost, to incentivize use of recycled water (Chapter 21). All these regulations and incentives will need to be supported by strong awareness programmes on using recycled water, as was done in Singapore (Chapter 16).

The use of market-based instruments for water pollution control has been limited. Even where they are specified, in the form of tax concessions on adoption of pollution control equipment, they are for specific abatement technologies and activities leaving no incentive for innovation. There is some evidence of informal regulation of polluting industries. This includes public interest litigations filed by locals affected by pollution from industries and civil society protests forcing industries to comply with regulations (Chapter 19). Moreover, consumers are beginning to demand green rated products.

Effecting pollution control will require a number of initiatives: (i) extensive data on physical accounts of environmental changes, which are gathered by monitoring stations, (ii) fiscal incentives for adoption of abatement technologies with due scope for innovation, and informal regulation in the form of green ratings, (iii) for municipalities, stringent conditions which link treatment of sewage water as a precondition to fiscal devolution from states, (iv) a market for the use of treated water needs to be developed. Potential uses could include non-potable water uses, irrigation uses and groundwater recharge, and (v) norms for controlling pollution by agriculture. Though pollution discharge norms exist for the domestic and industrial sector, there are none for agriculture, which is a major source of contamination of groundwater in rural areas as a result of overuse of subsidized fertilizers.

Conclusion and Recommendations

The impending water crisis is already evident in several parts of the country. We need to act decisively to protect our water resources and use them judiciously. A radically new approach to water management and use is required. It must be understood at all levels, national, state, and local, as well as by the public at large, that our available water resources are finite and will be unpredictably affected by climate change.

The new water policy, which is being formulated, should set the strategic vision for the sector with ecological balance, equity, and demand management being central to all planning and actions related to water. To be effective, the policy should have statutory backing and be signed by all the states.

The policy should be governed by two doctrines—'public trust', implying that water is held by the state on behalf of the community, and the 'right to water', guaranteeing a minimum core quantity and quality of water to individuals. Water is essential to life. It should be enshrined in the Constitution as a fundamental right and not left to judicial interpretation. Along with its recognition as a fundamental right, the state should be legally obliged to provide a minimum amount of safe drinking water to each person. The rural drinking water policy, which has been 'diluted' to household averages from individual entitlements, needs to be in consonance with this. Meeting the 'right to water' should have priority over all other priorities of the government.

Water for all purposes over and above drinking water should be treated as a socio-economic good, which should be allocated for various uses according to priorities in an equitable manner. Appropriate pricing mechanisms should be used to incentivize prudent use.

There is an urgent need to control the over-exploitation of groundwater. Legislation is needed to separate water rights from private land rights. It needs to be understood that the landowner does not own the water beneath his land; it is a common pool resource. The state may control the use of water through a permit/licensing system as is being done in many countries, but it may be difficult to enforce regulations on the 20 million tube well pumps already in use. Alternatively, it may be more effective to introduce participatory processes in groundwater management through aquifer/water users associations, if democratically elected. In any case, appropriate pricing of electricity and water can only help to improve efficiency in water use and groundwater management. So, distortions such as subsidized electricity tariffs for agriculture and other forms of subsidy should be phased out to promote efficient utilization of water in agriculture.

The focus of irrigation development projects needs to shift from large canal based surface irrigation projects to greater conjunctive use of surface and groundwater resources. More important than investment, though, is a need to improve the management of the main systems by reforming the irrigation bureaucracy towards a performance-based system.

Similarly, in the case of urban water services, the focus should be on performance improvement. Utilities should undertake periodic water audits, reduce their non-revenue water, implement measures to improve O&M, and adopt energy-efficient solutions. There is a need to professionalize the municipal cadre and adopt transparent processes in the appointment of managers to run water utilities.

In fact, as required by the 73rd and 74th Constitutional amendments, states have devolved power to local institutions for water resource management and supply but these powers are merely on paper; they have not been accompanied with commensurate financial, technical, and managerial resources.

At the local level, major efforts are needed for harnessing, retaining, and re-using water. Small, decentralized rainwater harvesting structures, and innovative watershed management programmes involving community participation need greater thrust.

Wastewater recycling offers immense potential particularly since the costs of recycling have reduced dramatically. This makes reuse of wastewater for non-potable purposes a viable option. Industries do face some challenges in setting up their own recycling plants, such as huge capital costs, access to sufficient sewage at a reasonable cost, and land to accommodate recycling plants. But as a start, the use of sewage treated recycled water by large industries (including power plants) located near urban areas should be mandated. Eventually all industries or clusters of industry should recycle all their water. Municipalities too should recycle wastewater and supply it at a discount to fresh water prices to promote use of recycled water by residential and commercial establishments. It may need effective regulation to force them to undertake treatment of sewage water.

Water pollution is a major problem that is threatening the sustainability of water bodies. Punitive mechanisms, such as closure of industries for non-compliance, alone have not worked. Market-based mechanisms comprising taxes on polluting industries, and tax concessions for adoption of abatement technologies, should supplement the current legislation. Mechanisms such as green ratings should also be promoted and eventually be made mandatory.

The security of our water future depends on how we manage our water resources today. This will require a concerted effort on the legal, policy, regulatory, and institutional front for better management and efficient usage of water. Accurate data and information systems are key to effective planning and management of water. Appropriate valuation of water uses will be necessary to design and promote demand management, recycling of wastewater, rainwater harvesting, and also to deter the polluting of water bodies. Extensive awareness and education programmes need to be undertaken in parallel.

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Section I

Macro

1 A River Basin Perspective of Water Resources and Challenges

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Introduction

The surface water resources potential in India is estimated to be around 1,869 km^3. Due to topographical constraints and spatio-temporal variations in resources, it is estimated that only about 1,123 km^3, (690 km^3 from surface water and 433 km^3 from groundwater) (Central Water Commission [CWC] 2010), can be used. According to the Food and Agriculture Organization (FAO), United Nations, the per capita availability of less than 2,000 m^3/year is defined as a water-stressed condition, and the per capita availability below 1,000 m^3/year is termed as a water-scarce condition. Due to a 3-fold increase in population during 1951–2010, the per capita availability of water in the country as a whole decreased from 5,177 m^3/year in 1951 to 1,588 m^3/year in 2010 (CWC 2010). This suggests that at a macro level, India is in a water-stressed state. The story at the local/regional level is far starker. Increasing shortages are felt at local levels which can spread to the regional level as the population continues to grow. India is divided into 20 river basins. Out of these, 14 basins are in a water-stressed condition (of which 10 are water-stressed, Table 1.1). The disparity among river basins is wide. The Brahmaputra-Barak basin has a total water availability of 11,782 m^3/per person. On the other hand in river basins, such as Sabarmati and east flowing rivers (Pennar and Kanyakumari), the availability of water is as low as 260 m^3 per person per year (Table 1.1).

The stress on water resources (both surface and groundwater) is increasing rapidly due to rising demands of various users and the deteriorating quality of water. In many regions in India the extraction of groundwater is more than the recharge (Chapter 7). The pollution of water resources caused by discharge of untreated municipal sewage and industrial effluents in rivers and the sea, and agro-chemicals penetration in groundwater has further exacerbated the availability of good quality water.

In short, the country's fragile resources are stressed and are depleting fast, both in quantity and quality.

Preserving the quality of water and managing multiple demands on it require an integrated water management strategy. The problem, however, is that water is a state subject and its management is spread across multiple organizations with hardly any coordination. This has posed difficulties in streamlining management issues. Another challenge in the management of water is that state boundaries do not coincide with the geographical boundary of the resource. Though the National Water Policy, 2002 recognizes that river basins should be the

† The authors are thankful to Jai Mansukhani for his help in preparing the database. The views expressed in this chapter are those of the authors alone and do not necessarily represent the official position of the World Bank.

TABLE 1.1 Surface and Groundwater Resources in River Basins in India

S.No.	*Name of the river basin*	*Population (million)*	*Catchment area (km^2)*	*Average annual surface water potential (km^3)*	*Estimated utilizable surface water (km^3)*	*Estimated replenishable groundwater resources (km^3)*	*Total utilizable water (km^3)*	*Surface storage potential, (km^3)*	*Total surface and groundwater storage (km^3)*	*Per capita water available (2010)*
1	Indus (up to the border)	59.01	321,289	73.31	46	26.49	72.49	19.14	45.63	1,242
2	Ganga	505.54	861,452	525.02	250	170.99	420.99	94.35	265.34	1,039
2.1	Brahmaputra, Barak, others	49.71	236,136	585.6	24	35.07	59.07	52.94	88.01	11,782
3	Godavari	76.02	312,812	110.54	76.3	40.65	116.95	41.89	82.54	1,454
4	Krishna	85.62	258,948	78.12	58	26.41	84.41	49.61	76.02	912
5	Cauvery	41.27	81,155	21.36	19	12.3	31.3	12.96	25.26	518
6	Subernarekha	13.23	29,200	12.37	6.81	1.82	8.63	3.93	5.75	935
7	Brahamani & Baitarni	13.80	39,033	28.48	18.3	4.05	22.35	13.72	17.77	2,063
8	Mahanadi	37.45	141,589	66.88	49.99	16.46	66.45	26.52	42.98	1,786
9	Pennar	13.67	55,213	6.32	6.86	4.93	11.79	4.82	9.75	462
10	Mahi	14.78	34,842	11.02	3.1	4.2	7.3	5.21	9.41	746
11	Sabarmati	14.80	21,674	3.81	1.93	3	4.93	1.56	4.56	257
12	Narmada	20.70	98,796	45.64	34.5	10.83	45.33	27.14	37.97	2,205
13	Tapi	20.85	65,145	14.88	14.5	8.27	22.77	12.26	20.53	714
14	West flowing rivers From Tapi to Tadri	36.33	52,900	87.41	11.94	8.7	20.64	16.42	25.12	2,406
15	West flowing rivers From Tadri to Kanyakumari	45.91	56,200	113.53	24.27	9	33.27	13.81	22.81	2,473
16	East flowing rivers between Mahanadi & Pennar	33.25		22.52	13.11	9	22.11	4.24	13.24	677
17	East flowing rivers between Pennar and Kanyakumari	63.29	100,100	16.46	16.73	9.2	25.93	1.38	10.58	260
18	West flowing rivers of Kutch, Saurashtra including Luni	31.10	321,900	15.1	14.98	11.23	26.21	9.59	20.82	486
19	Area of inland drainage in Rajasthan desert		60,000							0
20	Minor river basins draining into Bangladesh & Myanmar	2.11	36,300	31		18.8	18.8	0.31	19.11	14,679
	Total		3,184,684	1,869	690	431	1,122	411.81	843.21	1,588

Source: Central Water Commission and Central Ground Water Board.

basic hydrological unit for integrated planning and development of water resources, this has not happened so far.

This chapter presents an overview of the state of water resources in India. Though the strategies and policies to address various issues affecting the sector are discussed in later chapters, key strategic issues to bridge the gap between increasing demand and supply at the basin level are presented in this chapter.

Status of Water Resources Availability in India

The system of surface water resource in India comprises of 20 major river basins. Seven rivers and their tributaries feed these river basins (Figure 1.1). Of these 20 river basins, 13 are large comprising an aggregate catchment area of 2.6 million square km (Table 1.1). These 13 major river basins together are spread over about 81 per cent of the geographical area of the country. There are, however, substantial challenges and variations that these river basins face in their water availability.

These river basins depend on precipitation for water. Rainfall being the major component of precipitation is highly seasonal as most of the rain is concentrated during the monsoon season which lasts over 4–5 months (June to September/October). Further, there are huge geographical variations in the rainfall across the country. The western parts of Rajasthan get merely

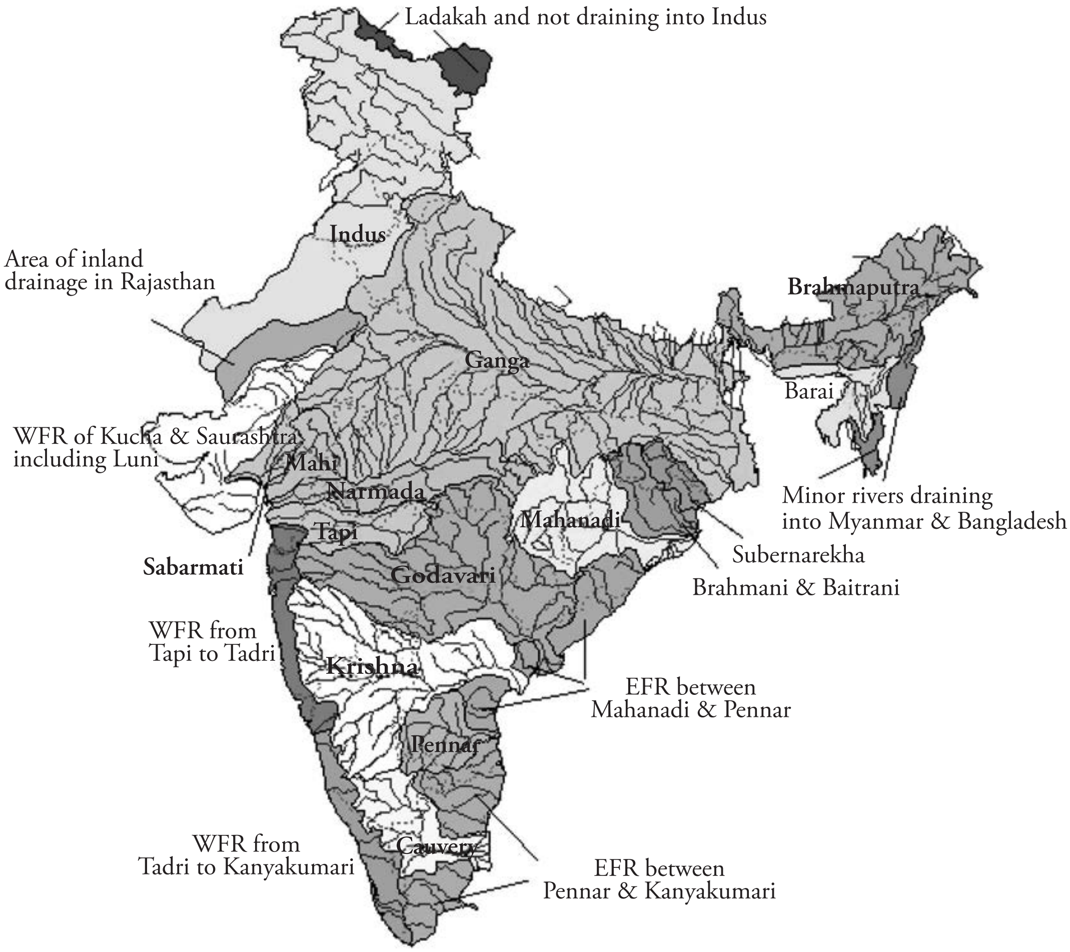

Figure 1.1 Major River Basins in India

Source: Adapted from CWC (2010).

100 mm of rain during the year, while Cherrapunji in Meghalaya gets yearly rainfall of 11,000 mm. Hence, the annual average surface water that is available in the river basins varies a lot. Table 1.1 presents the estimated average annual surface water potential across various river basins.

There are huge variations in the extent of catchment areas of river basins and their surface water potential. The geographical coverage of the Ganga and Brahamputra-Barak river basins is the largest and covers about 34 per cent of the country served by all river basins. The Ganga and Brahamputra-Barak river basins account for 60 per cent of the average annual water resources potential. However, due to topographical constraints and spatio-temporal variability of the availability of water only 48 per cent of the total water potential in the Ganga basin and 4 per cent of the total water potential in the Brahmaputra basin is utilized. On the other hand, three river basins in southern India (Godavari, Krishna, and Cauvery) together represent 21 per cent area of the country area while they account for only 11 per cent of the surface water.

Table 1.1 also presents information on basin-wise utilizable surface water. The utilizable surface water as a percentage of the total water resource potential is far higher for southern river basins, such as Godavari, Krishna, Cauvery, Pennar, and east flowing rivers between Pennar and Kanyakumari river basins, than others. In the Pennar, Kanyakumari, and Tapi river basins, nearly all the water resource potential is utilizable. However, there is huge potential to tap the water resource in other river basins.

Surface Water Development through Storage

In order to address spatial and temporal variations across river basins and to increase water availability, water storage capacities have been developed along the rivers to meet the demand for water throughout the year. Surface water storages are categorized as major (live storage >10 km^3), medium (2–10 km^3), and minor projects (or irrigation tanks with culturable command area <2,000 ha). The total live storage in major and medium projects is 221 km^3 (from completed projects), which contributes 32 per cent to the total utilizable surface water. In addition, the storage capacity of 191 km^3 is either under construction or is being considered for development. Estimated total storage capacity of completed, ongoing, and contemplated projects, would be 412 km^3 which will take the total utilizable surface water to 881 km^3 from the present level of 690 km^3 for all river basins taken together.

The Krishna basin leads in terms of existing storage capacity (41.80 km^3), followed by the Godavari (25.12 km^3), and Narmada basins (16.98 km^3). In the southern river basins, where availability of water resource is a problem, including Krishna, Godavari, Cauvery, and west flowing rivers, water harvesting is prevalent through tanks. Indiscriminate increase in storage, however, affects the natural regenerative capacity of rivers. Certain amount of river flow is therefore necessary. In the Krishna basin, the surge in storage development since the 1960s resulted in a drastic reduction in river discharge and outflow into the sea from an average annual flow of 57.22 km^3 during 1950–60 to 24.94 km^3 during 1995–2005 (Gaur et al. 2007). The actual surface water usage during a normal year in the basin is 117 per cent of the storage capacity in the basin. The existing storage capacity in the west flowing rivers of Kutch, Saurashtra including Luni, Narmad, Brahmani, and Baitarni exceeds 50 per cent of their respective average annual natural flows. As a consequence, the overall flows reaching the sea from these rivers have reduced drastically. On the other hand, water rich basins, such as Brahmaputra and Barak have very low storage capacity, just about 9 per cent of the annual natural flow. In terms of planned storage capacity, the southern river basin of Pennar, which faces immense water shortages, leads in terms of planned storage development followed by the Tapi basin. This additional storage will, however, reduce the average annual natural flow of rivers in these basins by more than 70 per cent. On the one hand while it is necessary to tap the river flow by increasing storage capacity, it is important to balance the new development of storage in a way that the regenerative capacity of the river is not affected.

Status of Groundwater

The potential groundwater resource has two components—static (10,812 km^3) and dynamic reserves (433 km^3). Although static reserves are high, they cannot be exploited except in an emergency as they are non-replenishable. Only the usage of dynamic reserves, which are replenished seasonally, is permitted (Ministry of Water Resources 2002). The zone of fluctuation for the dynamic resource is about 450 m below the ground level in the alluvium soil aquifer in the Indo-Gangetic Valley, 100–150 m in the inland river basin, and 200 m in hard rock aquifers. The major source for dynamic recharge is rainfall, which contributes about 67 per cent of the recharge. The rest of the groundwater recharge happens from non-rainfall sources, such as leaky canals, tanks, and local water bodies (Central Ground Water Board 2004).

Table 1.1 gives the estimated replenishable groundwater resource by river basins. Though a detailed discussion on groundwater is presented in Chapter 7, the key points that emerge from the distribution of groundwater across the country are discussed here. Nearly half of the replenishable groundwater resource is located in the Ganga-Brahmaputra-Barak river basins. The Indus river basin accounts for another 25 per cent of the replenishable groundwater resource. Of the total utilizable water, groundwater comprise about a third except in Ganga-Brahmaputra-Barak, where it is about 42 per cent, and in Subernarekha, Brahmani, Baitarni, Mahanadi, and Narmada where it is 25 per cent or less. Unlike the availability of surface water, which is highly seasonal, groundwater is a steady source of water throughout the year. Of the total storage of water that is available throughout the year (comprising surface water storage plus the replenishable groundwater resource), groundwater constitutes nearly 50 per cent, though there are inequalities across river basins. In the Ganga river basin, the share of groundwater in the total water storage is about 64 per cent. In basins like Krishna, Mahanadi, Subernarekha, and Narmada the share is 35 per cent or less.

Groundwater Resources Development

At the national level, the net annual groundwater draft is about 231 km^3 which is 58 per cent of the dynamic reserves. Nearly 92 per cent of the groundwater draft is used for irrigation while the remaining is used for domestic and industrial use.

The groundwater resource has been exploited to the extent that many regions in the country are facing severe problems (Chapter 7). The overexploitation of groundwater has resulted in a number of problems, such as sea water ingression in coastal areas and groundwater pollution in different parts of the country.

The challenges for further development of groundwater systems are two-fold: (i) how to restrain groundwater use to sustainable levels in overexploited regions? and (ii) how to develop the large untapped groundwater potential, which exists in eastern India? The willingness to control the overexploitation of the groundwater resource by farmers by using efficient irrigation systems has remained weak. Subsidized electricity supply in most regions has further exacerbated the overexploitation of groundwater.

Water Demand at the River Basin Level

The demand for water will grow from 656 km^3 in 2010 to 1069 km^3 by 2050 (Thatte et al. 2009). Irrigation is the largest consumer of water, which accounted for 85 per cent of the water demand in 2010 (Table 1.2), followed by domestic use (6 per cent), energy development (3 per cent), and industries (6 per cent). The demand for water from non-irrigation sectors will grow rapidly over the next 40 years. The demand for water in the domestic sector will grow 2.6 times, energy 3.7 times, and industry 2.2 times during 2010–50 (Thatte et al. 2009).

The National Commission on Integrated Water Resources Development (NCIWRD) has estimated the multi-sector uses within basins (Table 1.3). Following the National Water Policy, 2002 criteria for allocation, priority was accorded to domestic use, followed by irrigation, industries, and other uses. For agriculture, NCIWRD assumed that the efficiency of surface irrigation systems would increase to 60 per cent from the present level of 35–40 per cent. The estimates indicate that 9 out of the 20 river basins do not have sufficient water for industry or other uses. Based on the availability of water according to priority of use, river basins like Indus and Sabarmati did not have any residual water left for industrial and other uses even in 2010. The situation will be worse in 2050 when Ganga and the basin fed by the east flowing rivers Mahanadi and Pennar will also face severe water availability problems. Estimates for 2010 indicate that at the basin level, d mestic water accounted for 9 to 46 per cent of the total water demand (based on Table 1.3). Even in water rich basins, such as the Barak, domestic water constitutes the major demand for water. Due to low storage capacity the availability for other uses cannot be enhanced. By

Table 1.2 Available Water Resources in India and Demand Projections by 2025 and 2050

Water Resources	*Year*		
	2010	*2025*	*2050*
Estimated annual precipitation (including snowfall) (km³)	4000		
Average annual potential in rivers, (km³)	1869		
Estimated utilizable water (km³)	1123		1379
Surface (km³)	690		910
Ground (km³)	433		469
Existing surface storage (km³)	214	412	412
Population (million)	1150	1394	1750
Per capita actual water availability (m³)	977	806	685
Per capita actual storage (m³)	186	296	235
Irrigated area SW (M ha)	87	139	175
Water demand † (km³)			
Domestic	43	62	111
Irrigation	557	611	807
Industry	37	67	81
Energy	19	33	70
Total	656	773	1069
Water regeneration (Mega Litre/day)	45133	68123	132253
(km³)	16	25	48

Source: Central Water Commission, † Adapted from Thatte et al. (2009).

2050, domestic water will account for 12–55 per cent of the total water demand mainly due to an increase in population. Three more river basins of Ganga, Krishna, and Subernarekha will be added to the list of water scarce basins, taking the number of water-scarce basins to 12 by 2025. By 2050, the Indus basin may also become water-scarce while the Godavari basin may come closer to the water-scarce level.

By 2050 the level of water demand will reach closer to the utilizable level. Harnessing all of the 690 km³ of utilizable surface water will be possible only if matching storage is built. As shown in Table 1.2, by 2025 the use of recycled water may be able to partially serve a basin's water demand through water conservation schemes but that will add only a tiny component to the overall water availability. Adopting various measures for exploring and tapping the remaining water resources, in addition to innovative water conservation and management techniques, would be necessary. Central Ground Water Board has estimated that it is possible to increase the groundwater availability by about 36 km³, by taking up rainwater harvesting and artificial recharge over an area of 45 M ha utilizing surplus monsoon run-off. Trans-basin transfer of water, if taken to the full extent could further increase the utilizable quantity by approximately 220 km³ (Planning Commission 2008).

Challenges for Water Resource Availability, Management, and Sustainability

There are a number of externalities associated with the water resource that affect its availability, management, and sustainability. Externalities, such as floods

Table 1.3 River Basin-wise Water Demand Projections for 2010, 2025, and 2050

S.No.	River basin	Total of surface and groundwater resources (km^3)	Estimated demand for Water in 2010 (km^3)					Balance available for industries and other uses (km^3)		
			Irrigation	Domestic	Total	Return Flow †	Net for irrigation and Dom.	2010	2025	2050
1	Indus	72.5	102.09	2.83	104.92	12.47	92.45	–19.95	–49.5	–71.81
2	a) Ganga	421	311.99	22.19	334.18	48.95	285.23	135.77	43.91	–24.25
2.1	b) Brahmaputra	50.55	12.91	1.31	14.22	2.34	11.88	38.67	34.87	32.07
2.2	Barak & others	8.52	1.61	1.42	3.03	1.3	1.73	6.79	6.44	5.65
3	Godavari	116.9	34.37	3.22	37.59	6.01	31.58	85.32	75.2	67.72
4	Krishna	84.4	42.85	4.28	47.13	7.71	39.42	44.98	32.32	22.94
5	Cauvery	31.3	16.13	1.98	18.11	3.2	14.91	16.39	11.59	8.01
6	Subarnarekha	8.6	3.45	0.61	4.06	0.83	3.23	5.37	4.31	3.47
7	Brahamani & Baitarni	22.35	7.15	0.51	7.66	1.12	6.54	15.81	13.7	12.11
8	Mahanadi	66.5	26.32	1.52	27.84	3.85	22.99	43.51	34.79	29.05
9	Pennar	11.83	5.81	0.64	6.45	1.09	5.36	6.47	4.72	3.33
10	Mahi	7.3	5.07	0.62	5.69	1	4.69	2.61	1.12	0.01
11	Sabarmati	4.9	7.01	0.87	7.88	1.4	6.48	-1.58	-3.68	-5.23
12	Narmada	45.3	11.26	0.83	12.09	1.79	10.3	35	31.69	29.24
13	Tapi	22.77	3.89	1.1	4.99	1.27	3.72	19.05	17.86	16.96
14	West flowing rivers from Tapi to Tadri	20.6	3.9	2.51	6.41	2.4	4.01	16.59	15.47	14.25
15	West flowing rivers from Tadri to Kanyakumari	33.3	5.99	1.94	7.93	2.15	5.78	27.52	25.67	24.27
16	East flowing rivers between Mahanadi and Pennar	22.1	21.01	1.43	22.44	3.25	19.2	2.9	–3.26	-7.84
17	East flowing rivers between Pennar and Kanyakumari	25.7	24.21	3.49	27.7	5.21	22.49	3.21	–4.01	-9.35
18	West flowing rivers of Kutch and Saurashtra including Luni	26.2	22.46	1.61	24.07	3.53	20.54	5.66	-1.02	-6.15
19	Area of inland drainage in Rajasthan		18.27	0.68	18.95	2.37	16.58	–16.58	–22.04	–26.52
20	Minor river basins draining into Myanmar (Burma) and Bangladesh	18.8	0.67	0.12	0.79	0.16	0.62	18.18	17.98	17.82
	Total	1,121.42	688.42	55.71	744.13	113.4	629.73	491.69	196.73	135.75

Source: † Adapted from Thatte et al. (2009) and Planning Commission (2007). Estimated by the National Commission for Integrated Water Resources Development (NCIWRD).
Note: † (80% of domestic + 10% of irrigation)

and droughts caused by extreme climatic factors, affect the livelihood and economy of a region. The quality of water and trans-boundary issues have an impact on the availability of this resource for consumption.

Extreme Climate Factors: Flood and Drought

Floods and droughts affect vast areas of the country that transcend geographical boundaries of states. One-sixth of the geographical area of the country (about 40 M ha) is drought-prone. Similarly, floods affect around 7.5 M ha of land each year. Despite such an impact of these calamities, experience in managing their impact has been poor. Managing the impact of droughts as well as floods requires a system of data collection, transmission, forecasting, and dissemination through an early warning system. However, a majority of the flood warning systems in India are not timely, primarily due to poor transmission. Delays cause enormous damage to property and lives every year. Moreover, models that are used for flood forecasting and its influence zones are not rigorous enough due to lack of integration of hydrology and the weather forecasting systems.

The lead time for flood forecasting can be improved through the use of hydraulic and hydrologic models which are linked to the weather forecasting system, the real time data acquisition system, and the reservoir operation system. It is possible to improve the current forecasting methods by using satellite based information for better estimates of rainfall and snowmelt. Attempts are being made to modernize site-specific forecasting systems with satellite based telemetry, which will improve overall basin-wise forecasting.

Water Quality

Poor water quality will further strain the availability of freshwater for various uses. The quality of water has become a serious problem in river basins. About 70 per cent of the surface water resources and large proportions of groundwater reserves have been contaminated due to indiscriminate discharge of wastewater from the industry, agriculture, and households sectors which contain biological as well as toxic organic and inorganic pollutants.

Water pollution across river basins varies in severity depending on the degree of urban development, agricultural and industrial practices, and systems for collecting and treating wastewater. The Central Pollution Control Board (CPCB) has identified some of the polluted river stretches and possible sources of pollution (Table 1.4).

Most of the polluted stretches of rivers are located in and around large urban areas. Municipal sewage contributes about 75 per cent and industrial pollution accounts for the rest of the point source pollution. Class-I and Class-II cities together generate an estimated 38,254 MLD of sewage (CPCB 2009). The treatment capacity of 11,787 MLD in 2009 was far behind the requirements. By 2050, the sewage generation from Class-I, II cities will increase by three-and-a-half times to 132,253 MLD, which will pose serious problems if concerted efforts to add wastewater treatment capacity are not undertaken.

Groundwater is also polluted due to point and non-point source pollution. In some areas, the groundwater is not of the desired quality due to geogenic elements. For example, occurrence of high fluoride content has been reported in 13 states. Other pollutants, such as arsenic in West Bengal, and iron in the north-eastern states, Orissa, and other parts of the country have also been reported. In the canal irrigated land of Haryana, Punjab, Delhi, Rajasthan, Gujarat, Uttar Pradesh, Karnataka, and Tamil Nadu, groundwater is affected due to salinization (the affected area comprises over 193,000 km^2 of land) (Thatte et al. 2009).

Efforts were made in the past to clean water resources through government intervention. The Ganga Action Plan implemented under the National River Conservation Plan (NRCP—1995/96) covers pollution abatement activities in 34 rivers and 160 towns in 20 states. Major interventions under the plan include interception and diversion of sewage into networked channels, construction of sewage treatment plants (STPs), low cost sanitation works, and river front development activities. Pollution abatement plans have been adopted for some rivers for implementation through a designated authority for the purpose (for example, the National Ganga River Basin Authority in 2009), where holistic approaches are being utilized. Though other formal or informal authorities are being set up for river pollution abatement activities, synergy between regulatory and implementing authorities is necessary for future water development programmes.

Table 1.4 Pollution in Selected Stretches of Rivers Basins

S. No.	Name of the river basin	Polluted Stretch	Existing Class*	Critical Parameters	Possible Causes of Pollution
1	Indus (up to the border)	Satluj: Downstream of Ludhiana to Harike	D/E	BOD, DO	Domestic from Ludhiana and Jalandhar, and industrial from hosieries, tanneries, electroplating, and engineering
		Satluj: Downstream of Nangal	D/E	Ammonia	Waste from fertilizer, cholarlkali mills from Nangal
2	Ganga	Chambal River: Downstream of Nagda and Kota	D/E	BOD, DO	Domestic and industrial
		Gomti: Downstream of Lucknow	D/E	BOD, DO, Coliform	Domestic and industrial from distilleries
		Hindon: Sahranpur to confluence with Yamuna	D	DO, BOD, Toxicity	Domestic and industrial
		Kali: Downstream of Modinagar to confluence with Ganga	D/E	BOD, Coliform	Domestic and industrial
		Yamuna: Delhi confluence with Chambal	D/E		Domestic and industrial waste from Delhi, Mathura, and Agra
2.1	Brahmaputra, Barak, others	Downstream of Dhanbad	D/E	BOD, Toxicity	Industrial pollution from Dhanbad, Asansol, Haldia, and Brunpur
3	Godavari	Downstream of Nasik, Nanded		BOD	Industrial waste from sugar industries, distilleries, and food processing industries
4	Krishna	Karad to Sangli	D/E	BOD	Industrial waste from sugar industries and distilleries
5	Subernarekha	Hatia Dam to Bharagora	D/E	Ammonia	Domestic and industrial from Ranchi and Jamshedpur
6	Sabarmati	Starting from u/s of Ahmedabad to Vautha through Sabarmati Ashram	E	BOD, DO, Coliform	Domestic and industrial from Ahmedabad

Source: Central Pollution Control Board and Jain et al. (2007).

Notes: *As per CPCB (http://cpcb.nic.in/data2005.php last accessed on 20 September 2011) the existing classes for water quality are A (good) to E (very bad):

- D is best suited for wildlife and fisheries (pH 6.5–8.5, Dissolved Oxygen $\geq$ 4 mg/l, Free Ammonia $\leq$ 1.2)
- E is best suited for irrigation and controlled waste disposal (pH 6–6.5, EC $\leq$ 2250 Mmhos/cm, SAR $\leq$ 26 Boron $\leq$ 2 mg/l).

Trans-boundary Water Issues: International and Inter-state Scenarios

From a river basin perspective, water resource development and management has to address trans-boundary water allocation issues. Since water management is done through sector-wise administration by a number of government entities spread over 11 Central ministries, state governments, and local bodies water politics, rights, and conflicts are commonplace (discussed in detail in Chapters 3 and 4). Hence, the political economy drives the water agenda nationally and internationally.

Out of the 20 river basins, the two largest–the Indus and the Ganga-Brahmaputra-Barak basins are international river basins and the management of water resources is, therefore, driven by agreements or treaties between riparian countries. The remaining basins are mostly inter-state basins and a majority of them have commissions or boards to manage water issues. According to the Indian Constitution, water is a state subject and the role of the centre is limited only to the extent of managing the water resource in case inter-state river water disputes arise (Thatte et al. 2009). It may seem that the states have absolute rights over rivers and lakes but the Indian Easement Act, 1882 allows other users to claim prescriptive rights to the waters if customary usage of water can be established for a period of 20 years or more (D'souza 2006). In that sense, there are multiple rights holders—states, sectors, individuals, and communities—who hold various types of water rights. Multiplicity of rights poses problems for an integrated management of the water resource and hence its equitable availability. Rights related to water need an appropriate framework (this aspect has been discussed in Chapter 5) to reduce water conflicts between states, sectors, and people.

Programmes and Institutions Involved in the Sector

Growing demand across competing sectors, increasing occurrence of droughts, declining water quality, extreme weather conditions, inter-state river disputes, and inadequate institutional reforms and enforcement are some of the problems that the water sector in India faces today. The major areas that need attention are: management of existing water assets (used for irrigation and water supply systems) and water resources together with water sector institutional reforms. Towards this end, the Government of India has initiated a number of programmes and projects including the Accelerated Irrigation Benefits Programme, Hydrology Projects II, setting up of a Water Quality Assessment Authority, Command Area Development and Water Management Programme, National Project for Repair, Renovation and Restoration of Water Bodies, Flood Management, and setting up of River Basin Organizations. In addition, water resources restructuring projects are on in Andhra Pradesh, Maharashtra, Rajasthan, Uttar Pradesh, Madhya Pradesh, and Tamil Nadu which are aimed at modernizing irrigation systems. These programmes aim at a dressing the infrastructure gaps that exist and managing the water resource to enhance its quantity, quality, and sustainability.

Despite the conceptualization of a number of programmes, effective implementation has been challenging due to different priorities of implementing agencies, poor coordination among implementing departments, and low level of monitoring mechanisms. For example, from a functional point of view, the responsibility for ensuring adequate availability of water for agricultural use is divided among the Ministry of Water Resources (MoWR), which is responsible for major, medium, and minor irrigation programmes, the Department of Land Resources which is responsible for watershed management, the Department of Rural Development which is responsible for the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) which deals with water conservation issues, and the Department of Agriculture which addresses issues associated with water use efficiency (Figure 1.2). Requirements of rural drinking water, which are largely met through groundwater sources, are in the functional domain of the Department of Drinking Water Supply (DDWS) within the Ministry of Rural Development (MoRD). The development and management of groundwater involves other players and schemes that lie outside the purview of DDWS. Similarly, in the urban context, the Ministry of Urban Development (MoUD), states and its various departments and urban local bodies (ULBs), are involved in the supply of water within cities. In order to make these institutional arrangements effective, proper planning, convergence of various agencies, site-specific design, and monitoring using modern techniques, such as remote sensing have to be in place.

Given that water availability in India will be under tremendous stress in the future and many river basins will face severe water shortages rising demand and the deteriorating quality of water needs policies and strategies that manage the resource holistically.

Policies and Strategies

While the policies and strategies for the water sector and the institutional arrangements to deliver them have been discussed at length in various chapters in this

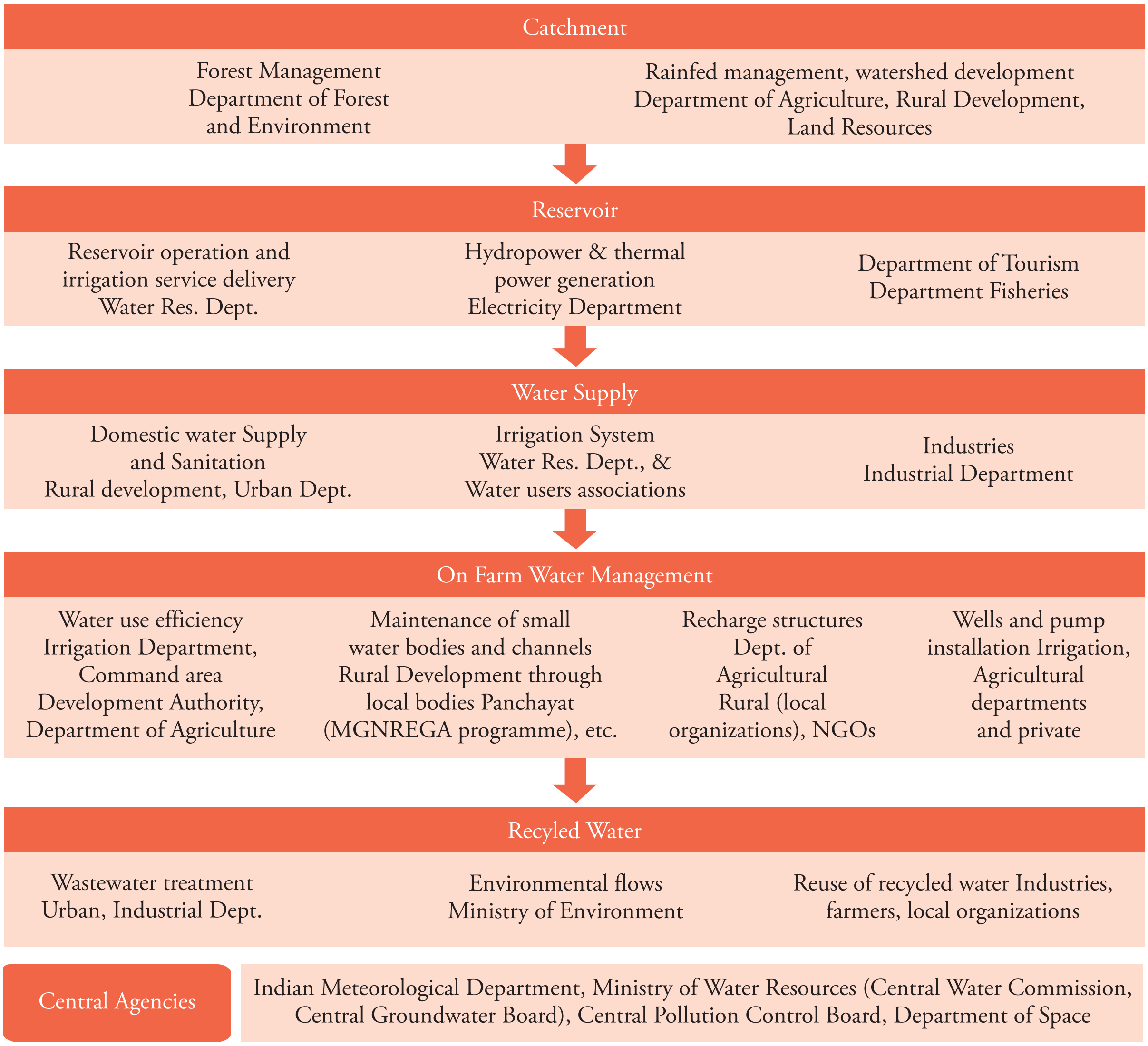

Figure 1.2 Existing Multi-disciplinary Approach for Water Resource Management in A River Basin

Source: Authors' own.

volume, a brief review of select policies and strategies is presented here.

Integrated Water Resources Management and River Basin Organization

In order to cater to multi-sectoral water demands and an optimum and judicious utilization of the available land and water resource, integrated water resource management (IWRM) is necessary. A basin authority, such as a river basin organization (RBO) is best suited to implement the principles of IWRM and for planning inter-state water allocation. The functions of an RBO should include assessing water availability, preparing comprehensive plans for the operational development of surface and groundwater systems, and promoting measures for prevention of water logging, water conservation, and ensuring water quality. The need for RBOs for inter-state water allocation and decision-making has been extensively discussed at the government, non-government, and political levels in the country. However, with the exception of the Brahmaputra and Barak Board and the Betwa River

Board, such basin authorities have not been realized. These boards were set up by the MoWR in 1980 for planning and for the integrated implementation of measures for the control of floods and bank erosion in the Brahmaputra Valley.[1] A few basin authorities, such as the Narmada Control Authority and the Upper Yamuna River Board are involved in the operation of the water system, but are not considered full-fledged basin authorities. While the Brahmaputra and Barak boards have comprehensive functions encompassing a whole range of inter-state and basin management functions, other river basin authorities, such as the Narmada Control Authority have limited functions relating only to the construction of a project. These boards were set up at the initiative of MoWR with not much support from states causing inefficiencies in their operations. If such boards are created with the support of the state, their functions will become more effective (see Box 1.1 for details about the Brahmaputra Board).

Recently, the Krishna Water Distribution Tribunal II suggested that a Krishna Basin Authority should be created along the lines of the Murray-Darling Basin Authority in Australia for the integrated management of the water resource (see Box 1.2).[2] The authority is proposed to be constituted by the Government of India and will be headed by a panel of experts representing environment, irrigation, agriculture, groundwater, geology, health, and ecology to protect the river basin area for its long-term sustainable productivity and ecology.

National Water Policy

The National Water Policy (NWP) was first formulated and adopted in September 1987 and later updated in 2002. It covers a comprehensive plan for India, and if adopted at a basin level, it can add value to water development programmes. We now discuss some of the highlights of this policy.

Box 1.1
The Brahmaputra Board

The Brahmaputra-Barak Basin

- One of the largest rivers in the world with a specific yield of 85 ha m/km^2 or 850 millimetre next to the Amazon river (87 ha m/km^2 or 870 millimetre).
- The basin extends over an area of 592,000 km^2 and falls in Tibet, India, Bhutan, Bangladesh, and Myanmar.
- The seven riparian states are Arunachal Pradesh, Assam, Meghalaya, Manipur Mizoram, Nagaland, and Tripura.
- The system serves a population of 50 million in India.
- Out of the total water potential of 585 km^3 within India, only 42 km^3 is available for beneficial use due to topographical constraints.
- Due to high yield, the basin is highly prone to floods with very low storage capacity of 2.3 km^3. Almost 50 km^3 of storage is under construction or consideration for development.
- In 1980, the Brahmaputra Board was set up under the Brahmaputra Board Act, 1980 to prepare a master plan for the control of floods in the Brahmaputra Valley giving due regard to the overall development and utilization of the water resources.
- Institutions involved in the Brahmaputra Barak Basin are the board, state representatives, the Central Water Commission, Central Electrical Authority, Geological Survey of India, and the Indian Meteorological Department.

Main Functions

The Board became effective in 1982. Its main functions are:

- Preparing a plan for flood control and utilization of water resources for various uses.
- Preparing a detailed report and estimates for proposed projects.
- Construction, maintenance, and operation of multi-purpose projects with the approval of the central government.

Source: Brahmaputra Board. Available at: http://brahmaputraboard.gov.in/organisation.htm

[1] Brahmaputra Board. Available at: http://brahmaputraboard.gov.in/organisation.htm last accessed on 20 September 2011.
[2] Murray–Darling Basin Authority. Available at: http://www.mdba.gov.au/last accessed on 20 September 2011.

Box 1.2
The Murray-Darling Basin Authority

The Murray-Darling Basin

- Possesses 23 river valleys covering 1 million square km, covering 14 per cent of Australia.
- The riparian five states and territories are New South Wales, Victoria, the Australian Capital Territory, Queensland, and South Australia.
- Provides one-third of Australia's food supply. It serves a population of 2 million inside the basin and 1.2 million outside the basin.
- The total average annual rainfall in the basin is 5,306 km^3: 94 per cent evaporates or transpires through plants, and 2 per cent drains into the ground, leaving only 4 per cent as runoff.
- The total volume of water storage capacity in the basin is around 350 km^3.
- First Murray-Darling Basin Commission was established in January 1988 under the Murray-Darling Basin Agreement to efficiently manage and equitably distribute River Murray water resources.
- The Water Amendment Act, 2008 (amendment to the Water Act, 2007) was introduced to transfer authority from the Murray-Darling Basin Commission to the Murray-Darling Basin Authority (MDBA), creating an independent, expert-based body that would manage the Basin holistically for the first time.
- Institutions involved are MDBA, basin states, the Australian Government Minister for Sustainability, Environment, Water, Population, and Communities.

Main Roles and Responsibilities

Since 2008, MDBA has been planning the integrated management of water resources of the Murray-Darling Basin. The Murray-Darling Basin Authority is an integral element of the Commonwealth Government's programme 'Water for the Future' which has four priorities: (i) tackling climate change, (ii) supporting healthy rivers, (iii) using water wisely, and (iv) securing water supplies.

In addition to the commission's former functions, the Authority's role includes:

- Preparing the Basin plan for adoption by the Minister for Sustainability, Environment, Water, Population, and Communities.
- Implementing and enforcing the Basin plan.
- Advising the minister on the accreditation of state water resource plans.
- Developing a water rights information service which facilitates water trading across the Murray-Darling Basin.
- Measuring and monitoring water resources in the Basin.
- Gathering information and undertaking research.
- Educating and engaging the community in the management of the Basin's resources.

Source: Murray–Darling Basin Authority. Available at: http://www.mdba.gov.au/

Information Systems

National Water Policy supports the development of a standardized national information system. MoWR's efforts towards developing a Water Resources Information System (WRIS), are a welcome development where central and state level information can be integrated to look at water issues from a river basin perspective. Efforts are being made under the Hydrology Project II to standardize databases and data are being used for proper planning and management practices. The information system can be further modernized with the use of satellite based telemetry and Light Detection and Ranging (LIDAR) based surveys. Though the use of satellite based telemetry and LIDAR is expensive, their benefits would outweigh the costs.

Water Resources Planning

NWP recognizes a drainage basin as the basic unit of planning, development, and management of the water resource and calls for appropriate measures to optimize the utilization of the water resource. Under Hydrology Project II, and other projects, efforts are being made to develop a decision support system for certain aspects within sub-basins in the states.

Groundwater Development

The development of groundwater is affected by policies and strategies from multiple sectors, including power and agriculture. Improved access to electricity in the eastern parts of India and incentives that have motivated head enders in canal irrigated area to use groundwater in place of canal water have contributed to substantial groundwater development, leading to overexploitation of groundwater in many regions. Some states, such as Gujarat, are implementing regulations to counter the overexploitation of groundwater.

A typical way by which overexploitation is addressed is by constructing groundwater recharge structures. However, this strategy needs careful evaluation. If overexploited areas in the upstream are supplemented with recharge structures, it may affect water availability (even for priority use, such as drinking) in the downstream projects. In closed or water-stressed river basins, water recharge structures should be implemented only after a proper analysis of the upstream and downstream implications and their effectiveness, particularly in southern India where infiltration potential for groundwater recharge is low.

Participatory Approaches to Water Resources Management

NWP recognizes the need for legal and institutional changes at various levels and participatory water resource management. Some reforms like establishing water users associations (WUAs) have been undertaken but their outcomes appear to be highly variable across the states (see Chapter 9). WUAs will need to be further strengthened and empowered. This may even require changes in the legislature. Currently, a majority of water-related schemes are introduced through gram panchayats and not WUAs. Clarity of roles and responsibilities between these two local bodies will strengthen implementation processes. Apart from WUAs for canal irrigation, water user groups of water bodies, such as tanks and groundwater also need appropriate policy frameworks for a more holistic management of water development processes within the basins.

Irrigation Projects

Managing irrigation water is necessary to conserve water in a sector that constitutes 85 per cent of the water demand and a large part of this demand is due to inefficient use. There are good examples of well-run irrigation projects. A case in point is the Parambikulam-Aliyar Project (PAP) in Tamil Nadu. This project has a planned operation system which encompasses a system of rotation of alternate canal system for alternate seasons, with opportunities for conjunctive use, fixed schedule, a gravity-based pipe conveyance system, and a drip irrigation system.

Water Quality

Water quality has become a major concern from a river basin perspective as upstream pollution has a downstream impact. Greater emphasis on the use of clean technologies and adopting context-specific technological options at different points along the waste streams is the way forward. In order to achieve this, from a regulation perspective, economic instruments (taxes and incentives), which are aimed at resource conservation, waste minimization, and reuse of wastes, would be necessary.

Monitoring of Projects

Ongoing and outcome monitoring is the key to measuring the success of projects and should be emphasized in all water development programmes. Modern technologies, such as management information systems to monitor the progress in implementation, mobile based technology, a global positioning system (GPS) based cameras, and satellite based imageries should be promoted to monitor the impact on land use. The reliability of data and quick assessment ability can help in good decision-making which is based on evidence.

Private Sector Participation

Although public-private partnerships (PPPs) for developing the water resource have been promulgated, the outcomes have not been as expected. This may be due to the fact that irrigation projects require large capital investments and given the low water charges, these may not appeal to a private investor (discussed in Chapter 14). An approach for promoting PPPs could be initiating collaboration by outsourcing services, such as irrigation system operations and maintenance, implementing efficient water management techniques, and agricultural extension projects with agreed output criteria for improved efficiency of the systems that clearly define irrigated areas and crop productivity.

These projects could be of a small size. An appropriate unit for the size is the command area, which can be easily monitored.

Research and Development

Research and development offers an array of tools and techniques for water resource modelling on a basin scale (discussed in Chapter 2). Opportunities that are available for developing models suitable for India with national and international collaboration should be explored as sophisticated modelling at a hydrological unit is necessary for integrated water resource management.

Conclusion

Given that India is likely to face severe water shortages in the future, measures to tap the water resource with prudent conservation measures will be required. Water shortages are likely to be exacerbated in some basins more than in the others due to pressures of demand, inadequate storage, deteriorating water quality, and rising disputes in inter-state water allocation.

Integrated water management strategies that look at water in a holistic manner are required. In its present state of governance, water is managed by various local, state, and central agencies. It is necessary to re-look at the management of this vital resource. The natural boundary of surface water is its hydrological boundary—the river basin. There are tremendous opportunities for improving water availability and security from a basin perspective, provided the resource is managed in a holistic and integrated manner at this level. To achieve integrated water resource management, administrative set ups, such RBOs consisting of multi-disciplinary units, are required for planning and implementation. The National Water Policy, 2002 encompasses vital initiatives for water resource management. However, their implementation requires strategic innovations to meet future demands. Modernizing information systems, having innovative resource planning, implementation, and monitoring of strategies, and focused evaluation systems using modern and advanced techniques supplemented by efficient governance mechanisms are the way forward. River basin level water development strategies will require revisiting policies and politics that affect the use of water which are sectoral. The sectoral nature of water use creates strategy silos such as energy, agriculture, remote sensing centres, and environment without giving due consideration to their inter-linkages.

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2 Implications of Climate Change for Water Resources Management

P.P. Mujumdar

Introduction

Adequate scientific evidence (for example, Intergovernmental Panel on Climate Change 2007) exists that confirms the global climate is changing. Three prominent visible signals of climate change are: (i) increase in global average temperature, (ii) change in regional precipitation patterns, and (iii) rise in sea levels. Projections based on climate models indicate that on a global scale, temperatures will keep rising over the next century, causing rise in sea levels and change in circulation patterns that affect precipitation. In terms of impacts affecting normal human life, the biggest impact will be on water—with respect to both water availability and extremes of floods and droughts. Although global scale projections indicate a possible increase in the mean precipitation over India, considerable spatial variation in the regional precipitation patterns will result in some regions within the country receiving lower rainfall in the future. The three prominent signals of climate change convert into signals of regional scale hydrologic change in terms of modifications in water availability, changes in agricultural water demand, hydrologic extremes of floods and droughts, changes in water quality, salinity intrusion in coastal aquifers, modification in groundwater recharge, and other related phenomena. Increase in atmospheric temperature, for example, is likely to have a direct impact on the runoff in snow-fed rivers and on the evaporative demands of crops and vegetation apart from the indirect impacts on all other phenomena of interest in hydrology and water resources management. Climate change, in conjunction with other changes occurring in the country such as rapid urbanization and industrial growth, has serious implications for policy and infrastructure growth in water and other related sectors.

To understand the regional implications of climate change on water policy and infrastructure, it is necessary to first obtain regional projections on temperature, precipitation, streamflow, and other relevant variables and then use these in the impact models to work out the specific impacts of the projections. Then, implications for infrastructure assets and their operations can be worked out. A common methodology for assessing the regional hydrologic impacts of climate change is to use climate projections provided by the General Circulation Models (GCMs) for specified greenhouse gas emission scenarios in conjunction with process-based hydrologic models (see Box 2.1) to generate the corresponding hydrologic projections. The scaling problem that arises because of the large spatial scales at which GCMs operate (compared to those required in most distributed hydrologic models), is commonly addressed by downscaling the GCM simulations to smaller scales at which impacts are needed. This commonly used procedure of impact assessment is burdened with a large amount of uncertainty due to the choice

Box 2.1
GCMs and Hydrologic Models

The GCMs also commonly known as Global Climate Models are the most credible tools available today for projecting the future climate. The GCMs operate on a global scale. They are computer-driven models used for weather forecasting, understanding climate, and projecting climate change. They use quantitative methods to simulate the interactions of the atmosphere, oceans, land surface, and ice. The most frequently used models in the study of climate change are the ones relating air temperature to emissions of carbon dioxide. These models predict an upward trend in the surface temperature, on a global scale. A GCM uses a large number of mathematical equations to describe physical, chemical, and biological processes such as wind, vapour movement, atmospheric circulation, ocean currents, and plant growth. A GCM relates the interactions among the various processes. For example, it relates how the wind patterns affect the transport of atmospheric moisture from one region to another, how ocean currents affect the amount of heat in the atmosphere, and how plant growth affects the amount of carbon dioxide in the atmosphere, and so on. The models help us to understand how climate works and how it is changing. A typical climate model projection used in the impact studies is that of global temperatures over the next century. The GCMs project an increasing trend in the global average temperature over the next century, with some estimates even showing an increase of more than 4^0C, with respect to the temperature during 1980–99 (for example, see IPCC 2007). Such projections of temperature and other climate variables provided by the GCMs are used to obtain projections of other variables of interest (but are not well simulated by the GCMs), such as precipitation and evapotranspiration, in the impact studies.

The Hydrologic Models simulate the hydrology much as the climate models simulate the climate. The hydrologic models are concerned with natural processes dealing with water such as the flow of water in a stream, evaporation and evapotranspiration, groundwater recharge, soil moisture, sediment transport, chemical transport, growth of microorganisms in water bodies etc. Hydrologic models operate at a river basin or a watershed scale. They play a significant role in understanding and addressing a range of problems dealing with water resources at these scales. These problems could be, for example, availability of water in a basin (its distribution with space and time), quality of water, inundation of land due to flood waters, consumptive use of water by vegetation and crops, extent of backing up of water due to the construction of a dam and other structures, sediment deposition and bank erosion, and so on. The inputs required by hydrologic models depend on the purpose for which the model is built. A river flow simulation model, for example, will need inputs such as precipitation, catchment characteristics such as the soil type, slope of the catchment, type of vegetation, type of land use, temperature, solar radiation, and groundwater contribution etc. The typical output from such a model will include the river flow at a location during a period (such as a day, a week, or a month) and evapotranspiration during the same period.

In climate change impact studies, the projections provided by the GCMs are typically used as inputs to the hydrologic models to obtain the projections for the hydrologic variables of interest.

Source: Author's own.

of GCMs and emission scenarios, small samples of historical data against which the models are calibrated, downscaling methods used, and several other sources. Development of procedures and methodologies to address such uncertainties is an important current area of research. Vulnerability assessment, adaptation, and policy issues form the logical extensions to provide water resources managers and infrastructure developers with options for adaptive responses.

In this chapter, climate change issues specifically related to water availability and water quality are discussed, and an overview of implications for water resources management policies is provided. An accepted working definition of sustainability of water resources systems is given and some commonly used measures of sustainability are introduced. The procedure for climate change impact assessment is then explained. Recent studies carried out in India and elsewhere on impact assessment and development of adaptive policies, along with implications for urban water infrastructure are reviewed.

Sustainable Water Resources Management

Figure 2.1 shows a typical water resources system. A surface water reservoir created by a dam construction across a river serves the purpose of hydropower generation, irrigation, municipal and industrial water supply, and flood control, apart from other minor purposes such as recreation and navigation. The physical

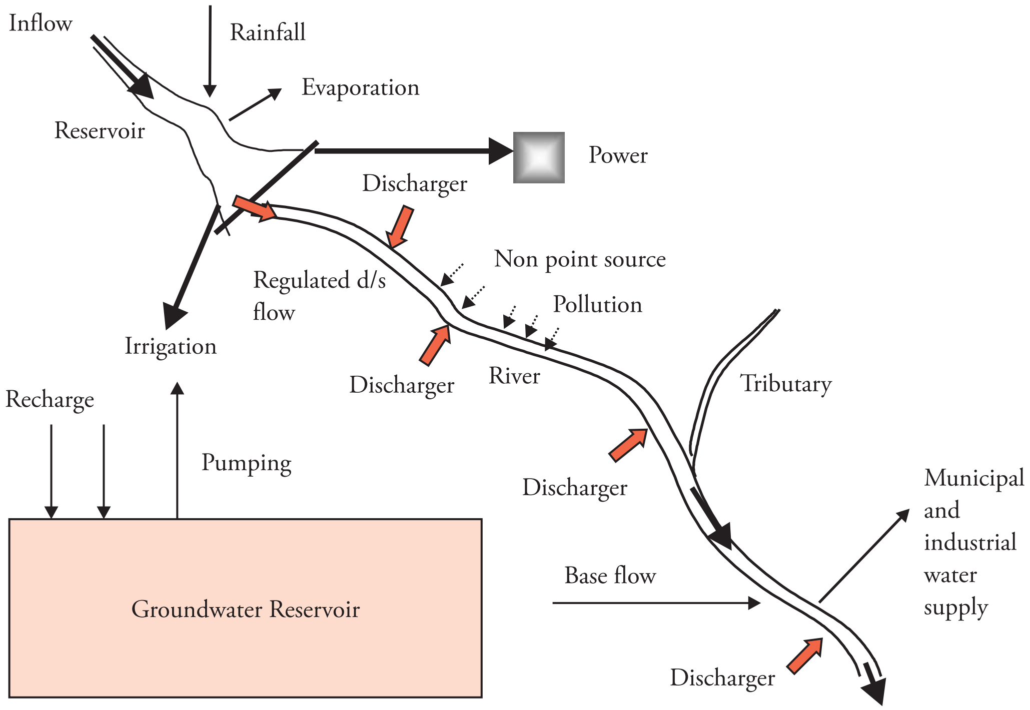

Figure 2.1 Water Resources System

Source: Author's own.

infrastructure associated with the reservoir includes the structure of the dam itself with its large structural and instrumental paraphernalia, such as the spillway gates, the canal and pipe networks with regulators, siphons, and cross drainage works etc. for supply of water for irrigation and municipal and industrial purposes, as well as penstocks, turbines, and other hardware in the power house for generation of power. The downstream structural components of a reservoir often consist of embankments for flood protection, pump houses and intake structures for lift irrigation schemes, and water supply systems for municipal and industrial supply. The surface water system is hydrologically complemented by the groundwater system. The structural components of groundwater usage typically consist of bore wells, tube wells, dug wells, and pumping systems. As may be seen from Figure 2.1, there is a continuous hydrologic interplay among the various components of the system. The inflow to the reservoir that actually determines the water available for use is governed by rainfall (or, broadly, precipitation) in the catchment area. The downstream flow in the river is governed by the release of water from the reservoir and the flow resulting from rainfall in the catchment downstream of the reservoir. The groundwater reservoir (aquifer, in a general sense) also contributes to the river flow through what is termed as the 'base flow'. Groundwater recharge takes place through rainfall and water used for irrigation, both from surface water and groundwater sources. The dischargers shown in Figure 2.1 are effluent dischargers. These may consist of industries and municipalities that use the assimilative capacity of the river to discharge wastes in conformity with the regulations stipulated by the pollution control boards. The non-point source of pollution of the river waters is mainly storm runoff that gathers pollutants (for example, pesticides and fertilizers) from agricultural lands on its way to the river. The water quality in the river, downstream of the reservoir, is thus governed by the release from the reservoir, the intermediate catchment flow, and the effluent discharges which constitute the point and non-point sources of pollution.

Structural measures for water resources development almost always involve a large number of conflicts with the surrounding environs. Such conflicts include, but are not limited to, those related to ecological damages due not only to submersion of forest areas rich in biodiversity but also due to irreversible alterations in habitat environs, displacements of large human populations, water quality, siltation, soil erosion, ability to meet future demands, structural and functional failures of the systems, and so on. In addition, uncertainty due to changes likely to occur in the future (such as climate change and land use pattern) poses the question of sustainability of water resources systems. Defining and measuring the sustainability of a water resources system is a major challenge. A working definition for sustainable water resources systems is given by Loucks (2000), which defines: 'Sustainable water resource systems as those designed and managed to fully contribute to the objectives of society, now and in the future, while maintaining their ecological, environmental, and hydrological integrity'.

Three measures commonly used to examine the sustainability of a water resources system are: (i) reliability, which is a measure of the ability of the system to meet demands—both in terms of quantity and quality of water, (ii) resiliency, which is a measure of the ability of the system to recover from failure, once a failure occurs, and (iii) vulnerability, which is a measure of the loss or damage incurred because of a failure. The failure periods in a water resources system may be defined variously as, those periods in which the supply is less than the demand, or the quality of water is less than that expected, and so on. Resiliency indicates the time it takes to come out of a failure state. We would prefer systems with high reliability and high resiliency but with low vulnerability. These measures are determined by mathematical simulation of the water resources system (for example, Mujumdar and Vedula 1992) for specified operating policies of the system. All the three measures are directly impacted by climate change in as much as they depend on water availability, demands, and water quality among other criteria. In examining the sustainability of a water resources system, therefore, it is necessary to project availability of water, possible deterioration of water quality, and modifications in occurrence of floods and droughts under climate change scenarios.

Projections of Water Availability under Climate Change Scenarios

Figure 2.2 describes the general procedure used to assess climate change impacts on water resources at the

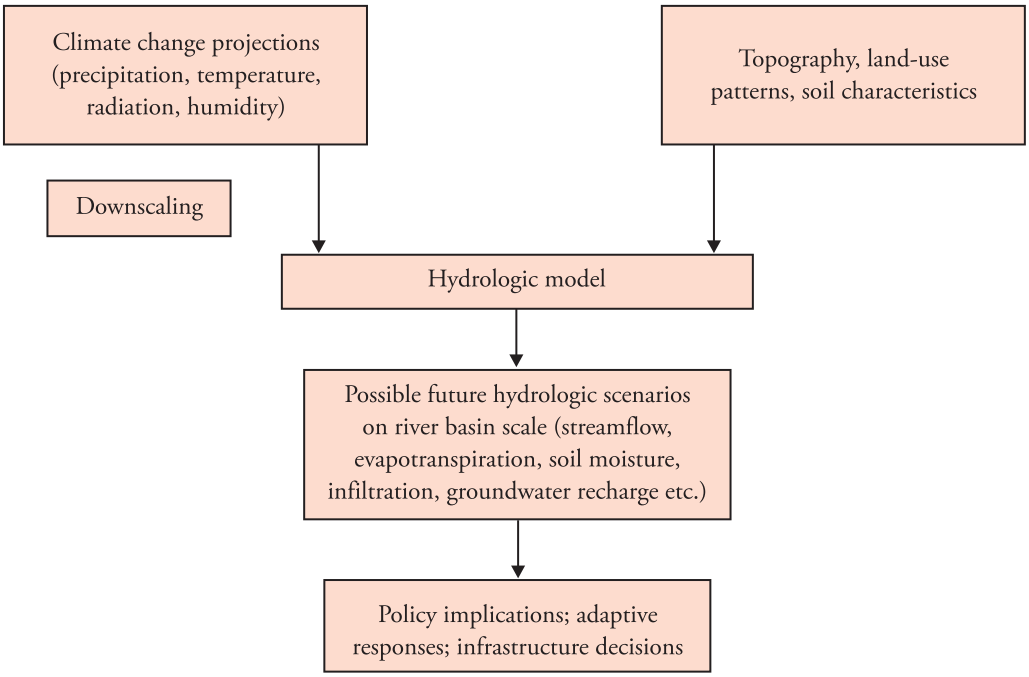

Figure 2.2 Block Diagram Showing the Procedure for Climate Change Impact Assessment

Source: Author's own.

river basin scale. Climate projections for pre-specified scenarios of greenhouse gas emissions in the atmosphere are obtained from the GCMs. The projections are next brought down to the spatial scales of interest. For example, if we are interested in precipitation at a sub-division scale, the projections on climate variables influencing precipitation, provided by the GCMs—which are at scales typically of the order of about 250 km by 250 km are 'downscaled' to sub-division scales and used for obtaining projections for future precipitation. These projections are used as inputs to run hydrologic models that are calibrated with historically observed hydrologic variables (for example, streamflow, evapo-transpiration, and soil moisture etc.). Other inputs used relate to land use patterns, soil type, and catchment characteristics etc., which are not likely to be influenced by climate change. This step of running the hydrologic models with future projected variables influenced by climate change produces projections of streamflow and other variables of interest, and provides an estimate of what the future streamflow is likely to be in comparison with the historical flows; thus quantifying the future water availability in the river basin, under climate change scenarios. The time windows used for such assessment are, typically, the years 2020s and 2040s. Such assessments should be used for long-term planning and infrastructural decisions.

Figure 2.3 shows the flow duration curves projected for the Mahanadi river in East-Central India, using several GCMs. The flow duration curves specify the flow that may be exceeded at a given level of probability, and are used in hydrologic designs of dams, culverts, bridges, and stormwater drainage networks etc. The dark blue curve in the figure is the flow duration curve with the historical data. Other curves show projected flow duration under climate change scenarios. The mid-level flows (for example, flows that are exceeded 40–70 per cent of the time) govern the performance of the system in

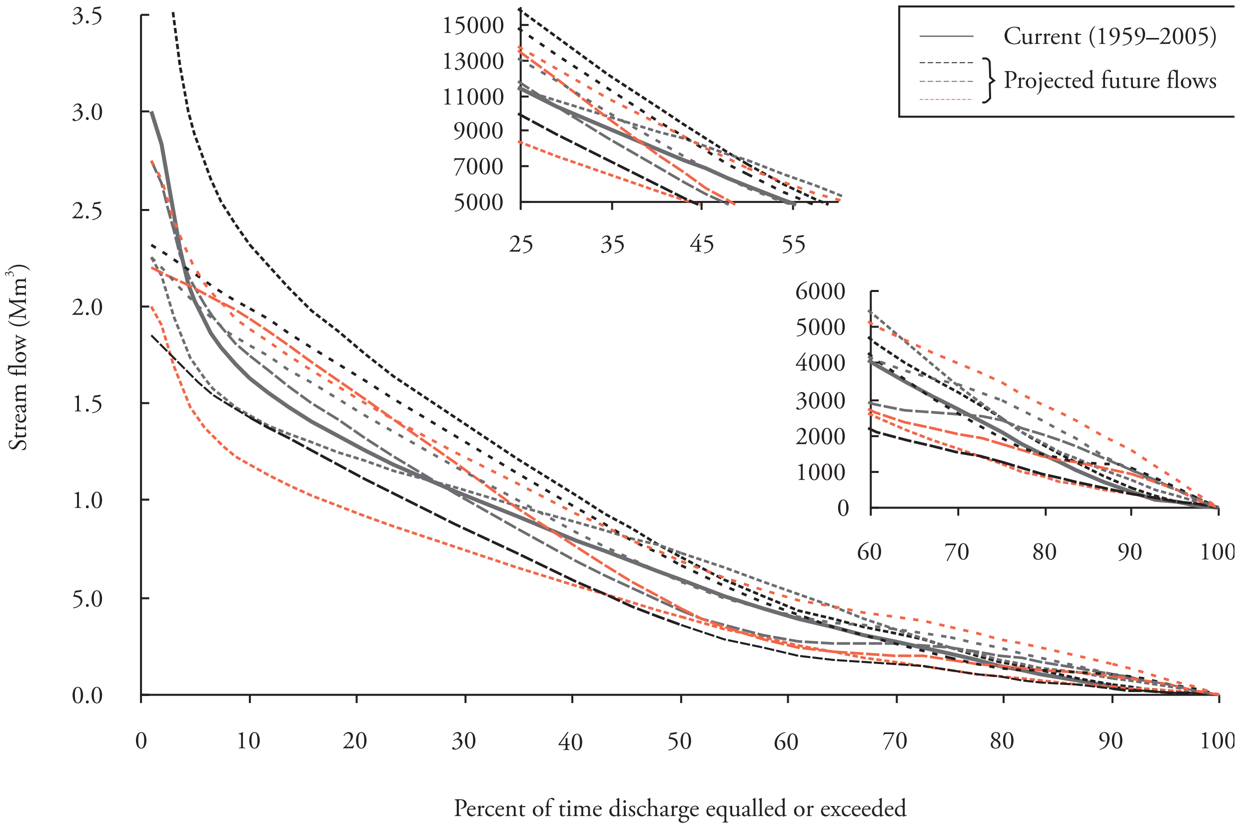

Figure 2.3 Flow Duration Curve for Mahanadi River at Hirakud (2045–65)

Source: Raje and Mujumdar (2010).

terms of the water supply for irrigation and hydropower generation. With many projections indicating a likely decrease in the mid-level flows (see insets in Figure 2.3) it is important that the water use polices are designed to take care of the likely deficit in the coming decades. This projected decrease in streamflow is because of the likely decrease in precipitation in the region. However, as seen from the figure, the direction of change in the streamflow projected by different models may be different; that is, some models project an increase while others project a decrease in the streamflow. Addressing such uncertainties to provide policy makers with options of adaptive responses is a challenging task. Raje and Mujumdar (2010) provide examples of adaptive reservoir operating policies for hydropower generation. They use the flow duration curves shown in Figure 2.3 and develop reservoir operating policies for the Hirakud reservoir to best maintain the reliability of hydropower generation at the current level, considering trade-offs between hydropower, irrigation, and flood control. This work is still at the research stage and needs to mature to a level where it may be transferred for actual implementation, because of the large uncertainties involved in assessment of the climate change impacts. However, it is clear that water management policies need to be adjusted to take into account the possible decreases in inflow to the Hirakud reservoir.

Climate Change Impacts on River Water Quality

Figure 2.4 shows an example of impact of climate change on river water quality. This example relates to the case study of the Tunga-Bhadra river in Karnataka, discussed by Rehana and Mujumdar (2011). Historical data analysis shows evidence of decrease in the streamflow over the last few years in the river, along with an increase in the temperature in the region. The checkpoints referred to in the figure are locations along the stream at which the river water quality is measured or estimated. Hypothetical climate change scenarios are used to construct the graphs. The water quality (which, in this case is measured by dissolved oxygen [DO] concentration) at a location in a stream is primarily affected by the upstream activities in terms of pollutant discharge, streamflow and air and water temperatures. Given the same level of effluent discharge

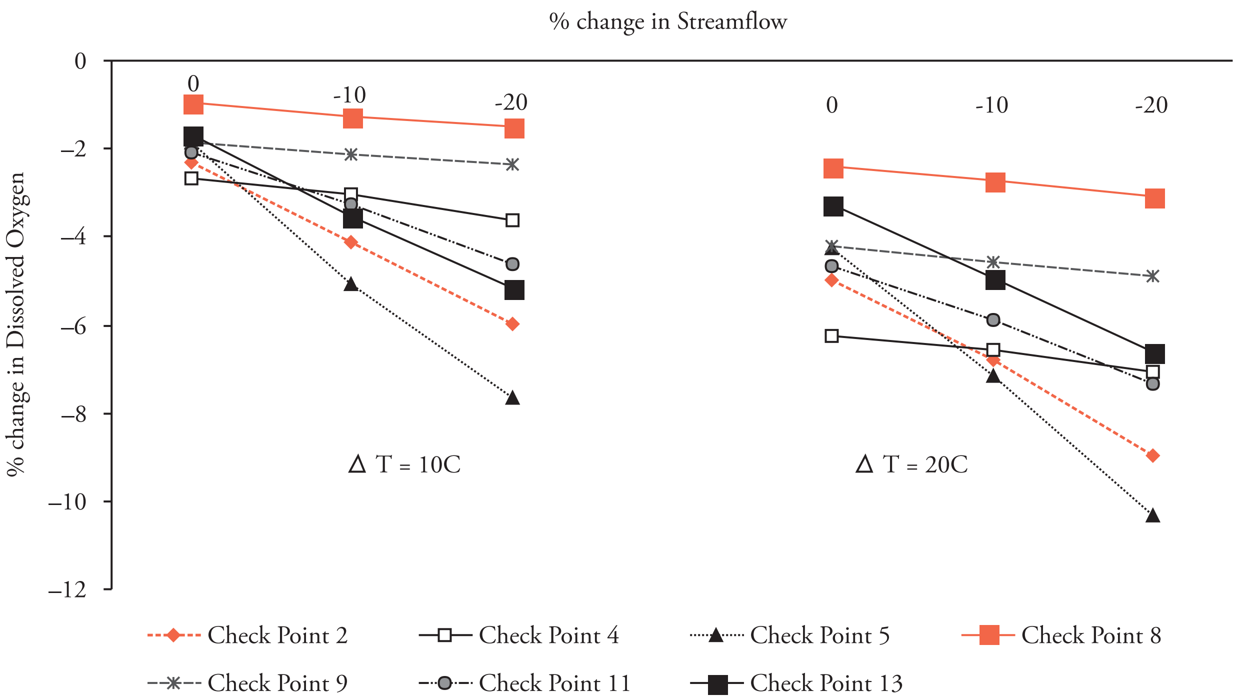

Figure 2.4 River Water Quality in Response to Climate Change

Source: Rehana and Mujumdar (2011).

upstream of a location, the lower the streamflow, the lower will be the DO level at that location, because of lower dilution effects. Similarly, higher temperature, in general, implies a lower water quality in terms of DO concentration. The hypothetical scenarios presented in Figure 2.4 are combinations of: (i) 1^0 and 2^0 rise in air temperature, and (ii) 10 per cent and 20 per cent reduction in streamflows. The graphs on the left show the response of water quality for a 1^0 rise in temperature; points along the given line correspond to different levels of reduction in streamflow (0 per cent, 10 per cent, and 20 per cent). Similarly, the graphs on the right show the response of water quality for a 2^0 rise in air temperature. A line corresponds to a particular checkpoint, as given in the legend. These results were obtained by simulating the water quality in the stream, taking into account the non-point and point source pollution due to industrial and municipal effluents at various locations along the stream (for details of the case study and the methodology used see Rehana and Mujumdar 2011). The results from the study suggest that all the hypothetical climate change scenarios would cause impairment in water quality. It was found that there is a significant decrease in DO levels due to the impact of climate change on temperature and flows, even when discharges were at the safe permissible levels set by pollution control agencies (PCAs). The need to improve PCA standards and develop adaptation policies for dischargers to take climate change into account is examined through a fuzzy waste load allocation model developed earlier. Such studies are useful tools for revising the standards for effluent discharges in the streams. The pollution control standards may be designed to take cognizance of the extreme projected situations, or, given the uncertainties, may be designed on the basis of the intermediate scenarios.

Implications of Climate Change on Urban Water Infrastructure

Climate change presents a significant challenge to the urban water management agencies. The urban water infrastructure, consisting of water supply systems and sewage networks, stormwater drainage systems, pumping systems, detention tanks, groundwater pumping, and recycling of wastewater, is vulnerable to stresses caused by climate change. Most cities in India depend on surface water sources for municipal water supply, although locally a large number of city residents rely also on groundwater. The first level of impact of climate change on urban water supply is through the depletion of surface and groundwater sources, because of reduction in streamflows and reduction in recharge due to rainfall. An indirect effect of climate change is an increase in water demand, because of rise in temperatures, for the same given population. Increasing intensities of rainfall along with unplanned development of cities exacerbate the already critical problem of urban flooding. It is essential that the water administrators as well as companies in charge of municipal and industrial water supply and stormwater drainage account for climate change impacts in planning for infrastructure investments. The science of developing adaptive policies to offset climate change impacts is, however, still young across the world and issues related to infrastructure adaptation have begun to be addressed only recently. In the Indian context no comprehensive study is yet available on implications of climate change on urban infrastructure.

Brugge and Graaf (2010) and Graaf and Brugge (2010) recently investigated how urban water management organizations in Rotterdam, Netherlands, developed climate change adaptation strategies that are sensitive to water issues. A key factor in the strategies was the recognition that additional water retention in urban areas could only be realized if this aspect was taken in the urban renewal programme. Their study indicated that the Rotterdam management organizations realized a successful water policy innovation, but that institutional mechanisms necessary for implementation of this innovation are still missing. Jollands et al. (2007) report a study of the impact of climate change on infrastructure services in Hamilton city, New Zealand and conclude that many of Hamilton's infrastructure systems demonstrated greater responsiveness to population changes than to climate change. The Hamilton city case study considered by them is the first of a series of case studies (to be) taken up by Climate's Long-term Impact on New Zealand Infrastructure (CLINZI). Such large projects that address all aspects of urban infrastructure services with climate change as an important component are needed in the Indian context. Semadeni-Davies et al. (2008) assess the potential impacts of climate change and continued urbanization on waste and stormwater flows in Helseingborg, Sweden with present conditions and projections provided by two climate change scenarios and three progressive urbanization storylines. They report that city growth and projected increase in precipitation are set to worsen the current drainage problem in the city.

Infrastructure to manage/mitigate urban flooding consists of storm water drains, pumping systems, and detention/retention tanks. Hydrologic designs of these components are based on the design intensities of rainfall, which are obtained from the intensity-duration-frequency (IDF) relationships for a given location. The IDF relationships are derived with the historical, observed rainfall, generally using an extreme value distribution for maximum rainfall intensity. It is expected that climate change will alter the frequency of occurrence of extreme rainfall events and we are likely to experience more frequent high intensity rainfall in cities. To account for climate change effects in hydrologic designs for urban flooding, it has now become necessary to examine the possible change in IDF relationships in the future and to use revised intensities of rainfall, both for checking adequacy of the existing systems and for making new designs. Changes in rainfall intensity have two consequences for drainage infrastructure design: (i) the flow for which a structure is designed is no longer constant over time, and (ii) the level of service provided by drainage infrastructure will also gradually decrease over time, as storm sewers will flood more frequently (Arisz and Burrell 2006). Bruce (2002) suggests that the costs of expanding drainage capacities must be weighed against the projected costs of more frequent flooding, with return periods of severe rainfall events projected to be cut in half. Watt et al. (2003) recommend designing drainage infrastructure based on modelling a design storm determined using available climatic records and then increasing the magnitude of the design storm by 15 per cent to accommodate the effects of climate change. This is equivalent to recommending that infrastructure should be designed and built with hydraulic capacities appropriate for the end of its service life rather than hydraulic capacities appropriate for present-day requirements, but at costs that have to be incurred before the increased hydraulic capacity is fully needed. However, the oversized infrastructure would provide greater capacity to handle extreme flood flows, whether or not such flood events are associated with climatic change. Kirshen et al. (2008) analyse the interdependencies of the impacts of climate change and adaptation strategies upon infrastructure systems in the Metro Boston urban area in north-eastern USA. They find that taking anticipatory actions well before 2050 results in less total adaptation and impact costs to the region than taking no actions.

Mailhot et al. (2007) assess a possible change in the IDF relationship for Southern Quebec, Canada. They conclude that the return periods of events of 2-hour and 6-hour durations will likely halve in future climate. That is, the average no. of years between the occurrence of rainfall intensities corresponding to 2-hour (and 6-hour) duration will be halved, implying more frequent occurrences of these events. They suggest that annual extreme rainfall events may result from more convective (and thus more localized) weather systems in Quebec. There are no such studies available for Indian cities at present. The author's team is now working on developing IDF relationships for Bengaluru city, accounting for climate change effects.

This brief review suggests that the design and operation of urban water infrastructure needs to take into account the climate change impacts, while planning for future. Action now as adaptation to climate change is likely to save costs compared to non-action. The recently released National Guidelines for Urban flooding (National Disaster Management Authority [NDMA] 2010) list out several issues in urban flooding in India, and refer to the recent flooding in Hyderabad in 2000, Ahmedabad in 2001, Delhi in 2000 and 2003, Chennai in 2004, Mumbai in 2005, Surat in 2006, Kolkata in 2007, and Guwahati and Delhi in 2010. Poor land use planning with old and aging stormwater drainage infrastructure of grossly inadequate carrying capacity along with increased intensities of rainfall are the main causes for the frequent urban flooding witnessed in India in recent years. Corrective actions must account for the possible increases in rainfall intensities in the years to come, due to climate change.

Adaptation to Climate Change: Policy Issues

Climate change is expected to produce water stresses in several parts of the country. The water management policies—both at the large river basin scales and at the local administrative levels—must account for uncertainties due to climate change, and, include the worst possible scenarios projected by climate models in their plans. In England, the water companies have recently released their draft Water Resources Management plans that set out how each company intends to maintain a balance between supply and demand over the next 25 years. Chaltron and Arnell (2011), who have reviewed these plans, state that whilst the magnitude of climate change appears to justify its explicit consideration, it is rare that adaptation options are planned solely in response to climate change but as a suite of options to provide a resilient supply to a range of pressures, such as the pressures on supply-demand balance, which occur even without climate change.

In India, water is primarily governed by the government. There is increasing acknowledgment by the government of the importance of climate change issues in water resources management in the country. The National Water Mission proposed in the National Action Plan on Climate Change listing out the following priority actions: focus on ensuring integrated water resources management to conserve water; minimizing wastage and ensuring equitable distribution across and within states; developing a framework to optimize water use in line with provisions of the National Water Policy; recycling of wastewater to meet a large part of water needs in urban areas; adoption of new and appropriate technologies such as low temperature; desalination for coastal cities; basin level management strategies in consultation with states; enhanced storage; rain water harvesting; equitable and efficient management structures; and optimizing efficiency of existing irrigation systems (rehabilitation, expansion along with increase in storage capacity, incentives for water neutral or water-positive technologies, re-charging of underground water sources, adoption of efficient large-scale irrigation programmes). These constitute a comprehensive list of actions planned. The challenge is to implement the actions at the local level. Vulnerabilities of local communities to water stresses caused, among other factors, by climate change, need to be assessed. An example of the vulnerability assessment is provided by Kelkar et al. (2008). They present a participatory approach to investigate vulnerability and adaptive capacity to climate variability and water stress in the Lakhwar watershed in Uttarakhand. Modelling results were shared by them with the communities in two villages to stimulate discussions on possible future changes and adaptive interventions. Similar studies are needed in other vulnerable regions, with a specific focus on rural areas to put adaptive responses in place. To institutionalize the assessment of vulnerability, a bottom–up rather than a top–down approach may be necessary, where the village *panchayats* are empowered with information and knowledge tools (such as, for example, Geographic Information Systems with relevant databases and inbuilt climate change projections), to provide information to the district administration set ups and further to the state level and so on. Given the current level of technology and the economic capability in the country, this is a very achievable goal.

The following issues and actions are of importance in evolving climate-resistant water management policies at local administrative levels:

- Heterogeneities in space and time are significantly important in the national context, with respect to water. Most parts of the country receive precipitation in the form of rainfall over a period of about four months; the spatial distribution of the rainfall is also highly non-uniform. Any larger level policy intervention must take such heterogeneities into account.
- Rapid urbanization will continue for the next three to four decades. Many towns and cities will struggle to meet water demands even for domestic purposes unless specific policy and administrative mechanisms are put in place. Climate change is only likely to increase such stresses. In this context, wastewater recycling and desalination technologies gain importance. Diversion of flood waters for groundwater recharge must also be practised by the municipal corporations. Legal regulation of groundwater use will soon be a necessity.
- The current level of hydropower generation in the country is quite low compared to the potential. Being a clean form of energy (in terms of carbon emission), hydropower is proposed to be increased from the current level of 7 million tons of oil equivalent (mtoes) to 43 mtoes in the National Action Plan for Climate Change. Such actions require prioritization in the National Water Policy.
- Even with a stabilized urban population by around 2040s, a considerable fraction of the rural population will still depend on agriculture, as a means of

livelihood. Unlike in most developed countries, agriculture in India (and other similar countries) is characterized by small farmers (farmers with small land holdings, typically less than 2 hectares) most of whom depend on rainfall for agriculture. For food security and long-term sustainability of agriculture—and ensuring enhanced quality of rural life—irrigated agriculture needs to be given importance, with technologies and non-structural measures put in place to increase efficiency of water use. Alternatively, decentralized irrigation systems including watershed development, rainwater harvesting, development of village tanks and water bodies, need to be encouraged as an insurance against the uncertainties due to climate change.

The challenge is to bring in institutional reforms and collaborations to achieve these. There are far too many institutions dealing with various aspects of water, as related to climate change: the India Meteorological Department (IMD) that is primarily the custodian of all meteorological data, the CWC, in charge of the hydrologic data, apart from being an approving authority for major water resources projects, the state water departments, government and private hydropower corporations, state and Central PCAs, agricultural departments, irrigation departments, city development agencies, municipal bodies, the private water industry, and so on. Bringing them together to evolve integrated adaptive responses to climate change is necessary.

Conclusion

Climate change is expected to cause water stresses in several regions of the country, and is likely to exacerbate the already critical water situation in most river basins. While the climate change projections derived from climate models are useful at large regional scales, the impacts need to be assessed at local scales. The water management agencies and policy makers must use projections provided by climate models in assessing local impacts to take into account the uncertainties, while planning for the future.

The following specific adaptation options are relevant in the water sector, to combat the adverse effects of climate change: (i) demand management to suit the supply, by choosing appropriate cropping patterns and technologies to reduce water consumption in industry; (ii) increasing efficiency of water usage, particularly in the irrigation sector where the current efficiencies are very low; (iii) structural measures of increasing reservoir storage; (iv) non-structural measures of developing and operationalizing adaptive reservoir operating rule curves, taking into account the likely mismatch between supply and demand; (v) out-of-the-box solutions to use the flood waters as a resource, say through diverting flood waters to potential groundwater recharge zones; (vi) large scale recycling of wastewater; and (vii) desalination of sea water to meet the municipal needs.

In addition, the standards of effluent discharge into streams and water bodies may need to account for climate change effects, and where necessary must be revised. The hydrologic designs dealing with floods (for example, stormwater drains, flood embankments etc.) should take into consideration the likely changes in the frequency of floods of a given magnitude. These actions will necessitate significant interventions in the institutional mechanisms.

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3 Opportunities for Trans-boundary Water Sharing in The Ganges, The Brahmaputra, and The Meghna Basins

Mashfiqus Salehin, M. Shah Alam Khan, Anjal Prakash, and Chanda Gurung Goodrich

Introduction

The huge system of the Ganges, the Brahmaputra, and the Meghna (GBM) basins, second only to that of Amazon, is made up of the catchment areas of 1.75 million km^2 stretching across five countries: Bangladesh, Bhutan, China, India, and Nepal (Ahmad et al. 2001). While Bangladesh and India share all the three river basins, China shares only the Brahmaputra and the Ganges basins, Nepal only the Ganges basin, and Bhutan, only the Brahmaputra basin (see Figure 3.1 and Table 3.1). The three basins are distinctly different in characteristics; the three rivers originate and travel through different physiographic units, and have geographically distinct catchment zones with dissimilar valleys and drainage networks (Khan 2005).

Water is the single most important natural resource of the basin countries; the three river systems contribute an annual discharge of 1350 billion cubic metres (BCM), of which the Ganges contributes about 500 BCM, the Brahmaputra 700 BCM, and the Meghna 150 BCM (Ahmad et al. 2001). The three major rivers have always played pivotal roles in shaping the sustenance of life, living, and the environment. However, the countries sharing the GBM basins are beset by a number of water management problems due to gross inequalities in the temporal and spatial distribution of water, mainly floods, droughts, and dry season water scarcity. This poses a threat to infrastructure and properties, irrigated agriculture, navigation, and ecosystem sustenance. Management of water resources in the region becomes all the more challenging because of the huge population, the anticipated population growth, and the prevailing poverty situation. About 10 per cent of the world's population lives in this region, representing only 1.2 per cent of the world's land mass (Biswas 2008).

The development and management of the GBM basins have been subject to a number of geopolitical constraints in spite of having huge potential for being a great example of regional cooperation (Brichieri-Colombi and Bradnock 2003). Country-specific management options have led to water disputes, which are ranked amongst the most well-known trans-boundary water conflicts in the world. Attempts to solve these disputes have been bilateral in nature, for example, the Ganges Water Treaty between India and Bangladesh, and the Mahakali Treaty between India and Nepal.

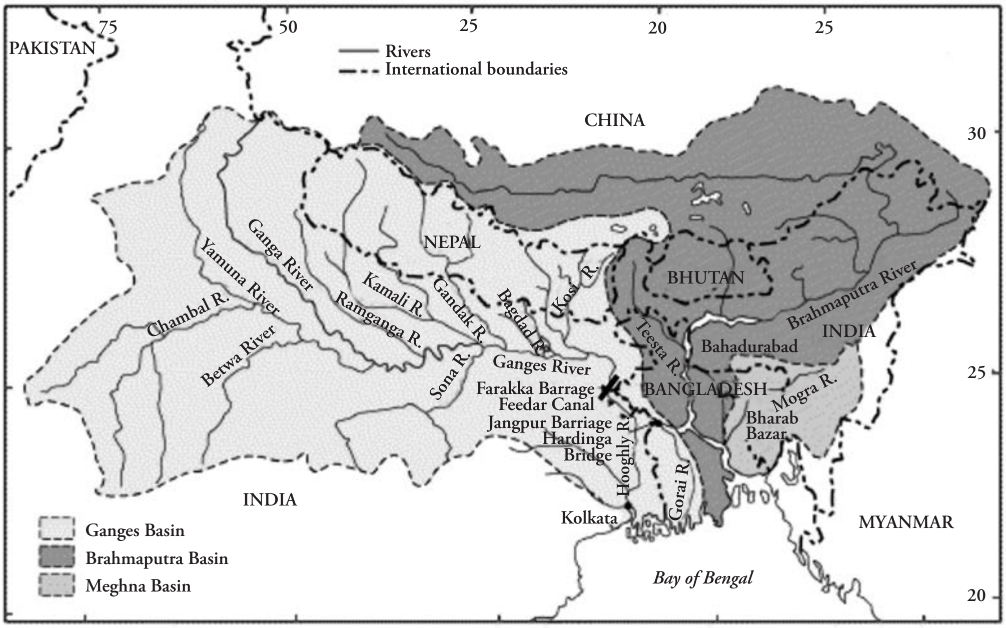

Figure 3.1 Ganges–Brahmaputra–Meghna Basins

Source: Rahaman (2005).

Table 3.1 Catchment Areas of the GBM Basins

Country	*Ganges basin*		*Brahmaputra basin*		*Meghna basin*	
	Basin area (1000 km²)	*Percentage of total area*	*Basin area (1000 km²)*	*Percentage of total area*	*Basin area (1000 km²)*	*Percentage of total area*
China	33	3	293	50		
Nepal	140	13				
Bhutan			45	8		
India	861	80	195	34	49	58
Bangladesh	46	4	47	8	36	42
Total	1,080	100	580	100	85	100

Source: Rangachari and Verghese (2001); Pun (2004).

These are regarded by many as creating a climate of goodwill and mutual confidence, and offering a window of opportunity for water-based collaborative development endeavours in the region (Rahaman 2009). The close and friendly ties between Bhutan and India have created a win–win situation for both countries in the hydropower sector. Besides, some bilateral cooperation is in place, through exchange of data for the purpose of flood forecasting and warning, between India and Bhutan, India and Nepal, and India and Bangladesh.

However, while so much more could have been done, achievements in terms of sharing, development, and management of water resources of these rivers as well as sharing and exchange of information and data through mutual cooperation have not been encouraging thus far (Biswas 2008; Khan 2005).The recent plans of river linking and construction of Tipaimukh dam, without consensus among riparian countries, have generated considerable concerns in Bangladesh and also widely in India. It is important to recognize that water resources must be developed and managed in a rational, efficient and equitable way, so that it can act as the engine to promote socio-economic development, shaping the future of millions of people living in this region (Biswas and Uitto 2001). A number of studies and syntheses of information have demonstrated that trans-boundary cooperation in integrated water management in the GBM basins can offer these countries greater benefits than those that can be achieved through isolated national efforts (Ahmad and Ahmed 2003; Ahmad et al. 2001; Gyawali 2001).

Water Resources Management Issues in GBM Basins

There are a number of common water resource management issues for all countries in the GBM basins. The river systems exhibit wide variations between peak and lean flows as the major part of the basins belongs to the monsoon region, where 80 to 90 per cent of annual rainfall is concentrated in 4–5 months of the South-West monsoon. While excessive precipitation in these months is the main reason for recurrent floods, which cause damage to life, property, and infrastructure, the unequal temporal distribution of rainfall creates the problem of low water availability during the dry season and unequal spatial distribution creates water stressed conditions in some parts of the basin. Future climate change impacts may aggravate this situation further. The GBM river systems carry up to one and a half billion tons of sediments per year that originate in the foothills of the Himalayas (Ahmad and Ahmed 2003; Biswas 2008). The high rate of sedimentation of the major rivers and their tributaries has been affecting not only the carrying capacity of the rivers but has also drastically reduced their retention capacity, thus often compounding the adverse effects of floods.

Major water management problems in Nepal include floods in hill valleys due to sudden cloud bursts over several days, floods in the mountains induced by glaciers, termed glacier lake outburst floods (GLOF) (Bangladesh–Nepal Joint Study Team 1989; Ahmad et al. 2001), and overbank monsoon flooding from rivers, mainly Sapta-Kosi, Gandaki, Karnali, and Mahakali, causing immense damage in the *terai* area of Nepal (and also in adjacent areas of India). Besides, frequent rockslides and landslides aggravate the flooding and river erosion problems. Unreliable river flows coupled with inefficient management have been affecting the performance of irrigation systems and industrial pollution has been leading to deteriorating water quality.

In India, floods affect, on an average, about 7.5 million hectares of area per year (Ministry of Water Resources [MoWR] 2002). Of the total estimated flood prone area in India, 68 per cent lies in the GBM states, mostly in Assam, West Bengal, Bihar, and Uttar Pradesh. The Ganges in northern India, which receives water from its northern tributaries originating in the Himalayas, has a high flood damage potential, especially in Uttar Pradesh and Bihar. The unequal spatial distribution of rainfall means that the flows in many of the rivers in north-western, western, and southern parts are considerably less than the Himalayan parts, rendering the areas water stressed. One-sixth area of the country is drought-prone (MoWR 2002). Other water management problems in India include degrading water quality mainly due to industrial and domestic wastes (Adhikari et al. 2000), and arsenic contamination of groundwater in many parts of the northern states, particularly West Bengal.

Bangladesh, being the lowest riparian with only 7 per cent of the country lying in the GBM basins and with extensive floodplain topography bears the major brunt of widespread flooding. About 91 per cent of flood flows in Bangladesh enter from upstream catchments in India through 54 border rivers (Rashid 1991); the entire volume of the GBM river systems, about 142,000 cubic meters per second at peak periods (Rahman et al. 1990), discharges into the Bay of Bengal through a single outlet at the Lower Meghna in Bangladesh. Besides, the country is beset by flash floods in the northern and north-eastern hilly streams, and tidal floods and occasional cyclonic storm-surge floods in the coastal region. The country suffers from moderate to severe droughts spreading over 10 districts; very low dry season water availability in the southwest region due to upstream withdrawal of water at Farakka, and associated increased salinity intrusion and threatened agriculture and ecosystem including the Sundarbans;

river erosion (including riverbank, *char*, and coastal erosion) along about 75 rivers; degrading water quality due to industrialization in urban areas along major rivers; and widespread arsenic contamination of groundwater (Chowdhury et al. 1997; Water Resources Planning Organization [WARPO] 2001).

In Bhutan, the water management problems include mounting pressure on the water resources due to competing demands from different users, seasonal and local imbalances of flows, localized and seasonal water shortages for drinking and agricultural purposes, and rising fluctuation between lean season and monsoon season flows, leading to sub-optimal utilization of generating capacity of hydropower plants, and GLOFs. Besides, increasing sediment loads in rivers are affecting the expected output and economic life of the hydropower plants, as well as causing floods and landslides (Bhutan Water Partnership 2003).

Policies and Plans

Water resources management in any country is generally governed by its policy directions, which are manifested in its national water policy document. National water policies provide the basis for formulating water management strategies and national water management plans. An examination of the national water policies of the GBM countries is imperative since it would shed light on the position of these countries with respect to regional cooperation.

The Indian Water Policy (MoWR 2002) envisions the river basin as a hydrological unit for water resources development and management and river basin organizations are given utmost importance in the context of planning for development and management of projects in a river basin as a whole or sub-basins, wherever necessary. The policy places emphasis on improving efficiency of water use through traditional water conservation practices such as rainwater harvesting, including roof-top harvesting. The policy also highlights the need for non-traditional practices, for example, inter-basin water transfers, artificial recharge of groundwater, and desalination of brackish or sea water.

The National Water Policy of Bangladesh (MoWR 1999) articulates the need to undertake essential steps for realizing basin-wide planning for development of the resources of rivers entering its borders. The endeavours will include: agreements with co-riparian countries for sharing the waters of international rivers; establishment of a system for exchange of information and data on relevant aspects of hydrology, morphology, water pollution, and ecology; joint assessment of the international rivers for better understanding of the potentials of the overall basins; and harnessing, developing, and sharing the water resources to mitigate floods and augment flows of water during the dry season. The policy gives directions on comprehensive development and management of the main rivers through a system of barrages and other structural and non-structural measures, and development of water resources of the major rivers for multipurpose use.

The Water Resources Strategy (WRS) of 2002 and the National Water Plan (NWP) (WECS 2006) of 2005 of Nepal ask for river basins to be treated as fundamental planning entities. Both the Strategy and the Plan emphasize, among others, cost-effective hydropower development for domestic use and export, enhanced water-related information systems, regional/bilateral cooperation framework/norms for substantial mutual benefits, and appropriate institutional mechanisms for water resources management. Sharing of water resources benefits among the riparian countries on equitable basis, establishment and enhancement in cooperation with neighbouring countries in data exchange and information systems, encouragement of joint investigation into GLOF with China, and promotion of international cooperation for flood forecasting and warning system, are underscored in the policy for mutual benefits.

The National Water Policy of 2003 of Bhutan (Bhutan Water Partnership 2003) also considers water resources management to be based on natural river basins, and hence highlights the need for appropriate institutional structures at the basin level. The policy recognizes the tremendous potential of hydropower for socio-economic development as well as its potential for earning revenues from exports. As articulated in the policy, trans-boundary water issues are to be dealt with in accordance with international law and conventions to which Bhutan is a signatory and taking into consideration the integrity of the rivers as well as the legitimate water needs of riparian states. Cooperation in information sharing and exchange, appropriate technology in water resources development and management, flood warning, and disaster management are to be initiated at the national, regional, and global levels.

While the water policies/strategic plans of the co-riparian countries draw heavily upon the concept of integrated water resources management, and articulate the need for basin-wide management of water resources, there are obvious differences in each country's stance on a number of issues. The Indian Water Policy does not touch upon regional cooperation with other riparian countries or sharing the basins for mutual benefits. Sharing or distribution of water is discussed when it comes down to allocation among states that share a particular basin. Regional cooperation received foremost recognition in the water policy of Bangladesh, with exchange and sharing of information and data, and joint assessment of the basins' potentials being among the major objectives outlined in the policy. Nepal too recognizes the potential for sharing water resources 'benefits' on equitable terms, and seeks to enhance regional cooperation in sharing and exchange of data, and improving disaster forecasting and warning systems. The water policy of Bhutan expresses similar pledges with regards to regional cooperation.

History of Regional Cooperation

There has been a history of conflicts in the GBM basins, but there has also been a history of attempts (bilateral in nature) to resolve these conflicts. This shows that, in spite of a significant number of conflicting issues in the region, compounded by the geopolitical complexity (for example, imbalance in hegemony or economic power among the countries), the countries did at least show interest in cooperation to resolve issues.

Nepal–India Water Cooperation

The water sharing disputes between Nepal and India date back to early twentieth century, and attempts to resolve the issues started with the Sarda Barrage Agreement in 1920, followed by several agreements through 1950s (Kosi river agreement in 1954; Gandak agreement in 1959). However, the story of success was far from being smooth; and the agreements were viewed by Nepalese people as favouring India (Uprety 2006; Salman and Uprety 2002; Biswas 2008). More recently, a number of Water Resources Development projects have been executed by India in cooperation with Nepal on rivers common to both the countries and a number of projects are also under negotiation with Nepal. The Mahakali Treaty has been signed, and negotiations are continuing for two important projects, Pancheshwar Multi-purpose Project on river Mahakali (Sarda in India) and Sapta-Kosi High Dam on Kosi River and Sun Kosi Storage cum Diversion Scheme.

Mahakali Treaty and the Pancheswar Project

The Mahakali Treaty signed between India and Nepal in January 1996 includes three components: the Sarada Barrage, the Tanakpur Barrage, and the Pancheshwar Project. While the first two projects have already been executed by India at Mahakali on the Indo-Nepal Border, the Pancheshwar Project involves new construction of a 315 metre high dam called the Pancheshwar on the Mahakali. The project is expected to generate 6480 MW of power for supply to India's northern power grid and to also provide the Gangetic plains with large volumes of regulated waters for irrigation. The provisions of the treaty constitute that India is willing to join hands with Nepal in the development of water resources for the common benefit for her people, and according to the principles of equity (Uprety 2006). The Treaty incorporated some principles to accommodate the divergent needs and interests of both riparian countries.

Implementation of the treaty has faced a great deal of difficulty. The treaty was met with resistance in Nepal, and was ultimately passed with specific strictures or conditions. Disputes still exist on the issues of defining consumptive use of the countries and fixing the selling price of Nepal's excess share of electricity to India. In addition, the treaty enactment is also contingent on the completion of the Detailed Project Report (DPR) for the Pancheshwar Project. A separate commission was formed for this project, and it was only in 2010 that the environmental impact assessment was prepared. During the second meeting of the Joint Standing Technical Committee (JSTC) held on 30–31 March 2010, it was decided to prepare a definite work plan along with the cost estimates to undertake the identified field works within two months so that decisions could be taken regarding funding (Central Electricity Authority [CEA] 2011).

Sapta-Kosi High Dam Project and Sun Kosi Storage cum Diversion Scheme

For Sapta-Kosi High Dam Project and Sun Kosi Storage cum Diversion Scheme, the Government of Nepal submitted an inception report in 1992. Crucial issues were discussed in the meeting of the Indo-Nepal Joint Team of Experts held in 1997. A Joint Project Team was formed for assessing the work load and preparing the estimates for investigations. The administrative approval and expenditure sanction have been conveyed by India for carrying out field investigations, studies and preparation of DPR of the Sapta-Kosi High Dam Multipurpose Project and Sun Kosi Storage cum Diversion Scheme jointly with Nepal by February 2013 (CEA 2011).

Bangladesh–India Water Cooperation

The major issues to be resolved between Bangladesh and India are the ones of sharing water of the common rivers. The major dispute has been on the sharing of the Ganges water during the lean period since the Indian plan for construction of Farakka barrage has been implemented.

Ganges Water Treaty

In 1961, the Indian government decided to construct a barrage across the Ganges river at Farakka, 11 miles upstream from the border with East Pakistan (later Bangladesh), to divert water to the Hooghly river to solve the siltation problems at the Calcutta port. The Pakistan government protested with an argument that adequate amount of flow did not exist in the Ganges to meet the water demands of both countries and that flow diversion from the main channel of the Ganges would result in adverse impact on the agriculture, ecology, and economy of East Pakistan (Crow et al. 1995). Construction of the barrage with a diversion capacity of 40,000 cubic feet per second of flow was completed in 1975, after the independence of Bangladesh in 1971, and a new phase of negotiations (1971–7) focussed on dry season flow division. During this period, a 40-day interim agreement for water sharing was also attempted. During the next phase of discussions (1977–82), a five-year water sharing agreement was signed between the two countries with an understanding of augmenting the Ganges flows at Farakka. A joint committee, Joint River Commission (JRC), was established under the agreement clause, which would be responsible for observing and recording at Farakka, the daily flows below Farakka Barrage and in the feeder canal in India, as well as Hardinge Bridge point in Bangladesh, and for implementing the water sharing arrangements and examining any difficulty arising out of the implementation of the sharing arrangement and of the operation of the Farakka Barrage. A mechanism was provided for the settlement of disputes. The agreement also instructed the JRC to look into a long-term solution of the dry season flow augmentation of the Ganges water. The flow augmentation proposal from the Bangladesh side included the construction of storage reservoirs in Nepal to harness the monsoon flows upstream, which would also facilitate hydropower generation. The proposal from India included import of water from the Brahmaputra through a 209-mile long link canal connecting the proposed Jogighopa barrage across the Brahmaputra in Assam and the Farakka barrage (Asafuddowlah and Khondker 1994). A memorandum of understanding (MoU) was signed in 1982 to extend the 1977 agreement excluding the 'guarantee clause',[1] which finally expired in 1988 after two similar extensions. Negotiations for a permanent water sharing agreement continued in the subsequent years while both the countries focused more on the national river development initiatives including river linking projects and barrages on the Teesta, Ganges, and the Brahmaputra. After a period (1989–96) without any agreement, the Ganges Water Treaty was signed between the two governments in 1996 to share the dry season flow of the Ganges and to seek ways for flow augmentation.

[1] In the 1977 agreement, the Ganges water sharing at Farakka from the 1 January to 31 May every year was based on 75 per cent availability calculated from the recorded flows of the Ganges at Farakka from 1948 to 1973. The actually available flow was divided on a 10-day basis between Bangladesh and India in an overall ratio of about 60 per cent for Bangladesh and about 40 per cent for India. If during a particular 10-day period the flow at Farakka came down to such a level that the actual share of Bangladesh would be lower than 80 per cent of the share calculated in the agreement for that 10-day period, this minimum flow would be released to Bangladesh during that 10-day period. Thus this clause guaranteed Bangladesh a minimum of 80 per cent of its share during each period whatever low the flow of the Ganges during that period. This is widely known as the 80 per cent 'guarantee clause'.

Although the main purpose of water diversion at Farakka was to improve siltation and navigation problems at the Calcutta port, Crow et al. (1995) indicate that the efficacy of the project was technically doubtful due to uncertainties in assessment of the flow and sedimentation processes in the lower Hooghly. Sir Arthurs Cotton's concerns in 1853 regarding the consequences of large-scale water diversion from the Ganges were not considered during implementation of the project. It was rather a political decision to proceed with the project.

The Ganges Treaty did improve the flow into Bangladesh, but it was lower than the flow that was available during earlier agreement periods, and lower by a considerable extent, for example, 40 per cent of natural state during March and April, as analysed by Chowdhury (2005) and Chowdhury and Datta (2004). A recent concern is that Bangladesh is getting lower volume of water than it should get as per the Treaty. One of the reasons is the decrease in flows arriving at Farakka because of upstream water uses (Chowdhury 2005). Although it seems unlikely that the flows to be received as per the Treaty would solve the water crisis in the dry season in the southwest region and recover its lost resources, it has ushered in a new era of cooperation between Bangladesh and India. This 30-year long Treaty has provided Bangladesh an opportunity for environmental restoration of the Ganges Dependent Area (GDA) (WARPO 2002).

Negotiations for Other Trans-boundary Rivers

India and Bangladesh share 54 rivers, however, the Ganges Treaty is the only water sharing agreement that exists today between Bangladesh and India. Article IX of the Ganges Treaty stipulated that, guided by the principle of equity, fairness, and no harm to either party, both Bangladesh and India would conclude water sharing treaties/agreements with regard to other trans-boundary or common rivers. The Joint Committee formed after the signing of the Treaty to implement this had prioritized seven rivers at the initial stage, viz. the Teesta, Dharla, Dudhkumar, Manu, Khowai, Gumti, and Muhuri rivers. Later the JRC recognized that the long-term sharing of waters for the Feni river should also be examined along with the other seven rivers. Recent media reports in both Bangladesh and India suggest that sharing agreements for Teesta and Feni rivers have been drafted, which might be signed by the end of 2011.

Bhutan–India Water Cooperation

The regional cooperation between India and Bhutan has worked very well, with India, which has a power shortage, providing both technical and financial assistance to develop numerous hydropower projects in Bhutan. India benefits from Bhutan's hydroelectric energy resource to meet a part of its huge power demand while Bhutan benefits from the revenues earned from the export of power. The hydropower cooperation between Bhutan and India started with the signing of the Jaldhaka agreement in 1961. The development of first major hydroelectric project started in 1974 when a bilateral agreement was signed between India and Bhutan for the construction of the 336 MW Chukhahydel project across river Wangchu in Western Bhutan for meeting internal power demand and exporting the surplus electricity to India (Biswas 2008). The project was commissioned in 1986–88. A number of mini and medium sized hydropower projects followed in later years. The Tala hydroelectric project of 1020 MW installed capacity and 860 metres gross head has been recently completed (Tshering and Tamang 2004).

The cooperation between Bhutan and India has also been with respect to the establishment of hydro-meteorological and flood forecasting network on rivers common to India and Bhutan. A scheme titled 'Comprehensive Scheme for Establishment of Hydro-meteorological and Flood Forecasting Network on Rivers Common to India and Bhutan' is in operation. The network consists of 35 hydro-meteorological/meteorological stations located in Bhutan and being maintained by the Royal Government of Bhutan with funding from India. The data received from these stations are utilized in India by the Central Water Commission for formulation of flood forecasts. A Joint Expert Team (JET) consisting of officials from the Government of India and Royal Government of Bhutan continuously reviews the progress and other requirements of the scheme (National Portal of India 2011).

Water Management Interventions and Regional Implications

Water management interventions in the GBM basins have already altered the natural flow distributions and have largely challenged the opportunities for trans-boundary and regional water sharing. The following sub-sections summarize the major water management interventions and their regional implications.

Ganges Water Diversion

Ganges water diversion at Farakka has caused adverse impacts in the Ganges dependent areas in the lowest riparian country Bangladesh (see Hoque et al. 1996; Crow et al. 1995; Asafuddowlah and Khondker 1994; Richardson 1994; Simons 1994; and Abbas 1984). Crow et al. (1995) present a detailed cause-and-effect diagram to explain the short and long-term consequences of flow diversion. The more direct consequences include changes in the hydraulic, hydrological, and morphological characteristics of the Ganges and its distributaries, resulting in a drastic decline in the river stage. This, in turn, has caused excessive siltation in the rivers, formation of new charlands, and reduction in conveyance capacity. The off take of the Gorai, the main distributary of the Ganges in Bangladesh, is blocked in the dry season due to siltation. Apart from adversely affecting navigational and industrial water availability, the reduced dry season flow has also caused water shortage for irrigation. One of the largest irrigation projects in Bangladesh, the Ganges—Kobadak Project, was shut down several times due to the drop in water levels. The decline in dry season river water level has also caused lowering of the groundwater level and affected the year-round water balance. Reduction in river flow has caused the salinity front (both surface and groundwater) to move further inland, resulting in crop damage, water shortage for drinking and industries, and adverse health effects. Reduced river flow and increased salinity have caused changes in the hydro-ecological condition in the lower reaches of the Ganges and its distributaries. Consequently, there have been major adverse impacts on the ecosystems, fisheries, forestry, and livelihoods.

River Linking Project in India

The National River Linking Project (NRLP) of India aims at transferring water from the Ganges and Brahmaputra basins to the water deficit areas of western and southern India. The overall goals of the NRLP are to increase irrigation potential, increase hydropower production, and control floods. Through this project the National Water Development Agency (NWDA) envisages achievement of food security and self-sufficiency by increasing area of arable land, increase in electricity production, and reduction of reliance on coal as an energy source, as well as moderation of floods, especially in the Ganges basin. The Himalayan component of the NRLP, consisting of 14 links, will have storage reservoirs on the main Ganges and the Brahmaputra rivers and their principal tributaries in India, Nepal, and Bhutan. Links of this component will transfer surplus flows of the Kosi, Gandak, and Ghagra to the west, and augment flows of the Ganges. Inter-linking of the Ganges and Yamuna are anticipated to transfer the surplus flow to the drought prone areas of Haryana, Rajasthan, and Gujarat. The component is also expected to provide irrigation benefits to large areas in south Uttar Pradesh and south Bihar (Sarma 2003). Detailed information on the links compiled from different sources (for example, Government of Bihar [GoB] 2003; NWDA 2005) can be found in SANDRP (2007). The peninsular component of the NRLP will consist of 16 links proposed by the NWDA.

The NRLP has faced a lot of review and scrutiny within India. Most 'donor' states have posed against the project although the conflict between 'donor' and 'receiver' states has not been a major issue. Major opposition emanated from a large number of observations raised by the prominent water professionals across India (for example, see Iyer 2003; Bandyopadhyay and Perveen 2002; and Singh 2003). A letter and a memorandum signed by 58 eminent professionals were sent to the prime minister to reconsider the project (ibid.). The validity of the basic principle of having 'surplus' water in some rivers, on which the NRLP was conceptualized, was questioned by some researchers on the argument of the need for a balance between the natural flow and ecosystem requirement (Bandyopadhyay and Perveen 2002). Drought mitigation is seen to be a local problem requiring local solutions. External water transfer will address only a small part of the arid regions leaving out most areas for augmentation of local resources. While efficacy of the project in flood control remains doubtful, large-scale constructions under the NRLP including big dams, reservoirs, and conveyance systems are likely to cause substantial environmental impacts and displacement problems. At the same time, the value of traditional water management systems and demand management through efficient water use may be undermined (Iyer 2003; Singh 2003).

Bangladesh, being the lowest riparian country, is likely to face adverse impacts on hydraulics and river morphology, water resources, agriculture, domestic water supply, fisheries, forestry, navigation, industry, biodiversity, and socio-economy. Chowdhury (2005) indicates that large-scale modifications may occur in the temporal distributions of the Brahmaputra and the Ganges. Reduced flow in the Lower Meghna as a result of reduction in Brahmaputra flow will increase salinity intrusion in the Lower Meghna, with a disastrous possibility of salinity intrusion into the freshwater wetland (locally called *haor*) ecosystem. Chowdhury (2005) also indicates problems of storing water in the wet season, and transferring water from one basin to another during different flood phases. Khalequzzaman et al. (2004) estimate that very low flow remaining in the Brahmaputra following withdrawal during the lean season will cause detrimental effects on the environment and ecosystem of the downstream areas in Bangladesh. Reduction in the Ganges flow due to transfer of Ganges water to the Indian peninsular region is likely to worsen the existing environmentally-stressed condition of the southwest region of Bangladesh.

Tipaimukh Dam in India

The proposed Tipaimukh dam across the Barak river in Manipur state in India is planned to be constructed primarily for flood control and power generation, envisaging secondary benefits including irrigation. A barrage is also planned to be constructed across the Barak at Fulertal, 100 km downstream of the dam site, to provide irrigation water for the Cachar Irrigation Project. The major environmental issues of the project emerging from an Environmental Impact Assessment (EIA) study include biodiversity conservation, rapid deforestation, and community participation for environmental planning and management (North-Eastern Electrical Power Corporation Ltd, NEEPCO 2000). There is a strong opposition to this project from both within and outside India (Institution of Engineers Bangladesh [IEB] 2005). The major likely impacts of this project inside India include loss of homes, lands, and livelihoods, loss of state and reserve forests, submergence of wildlife sanctuaries, and adverse impacts on fisheries, biodiversity, and navigation. In Bangladesh, flow alteration of the Barak will adversely affect the biodiversity of the freshwater wetlands (haors), increase the probability of flash floods that cause damage to the Boro rice, and retard the drainage of wetlands in the post-monsoon season. Implementation of the project will alter the natural flow regimes, water quality, nutrient and sediment load, temperature, salinity level. Consequently, fish spawning routes and habitats, and wetland ecosystems and biodiversity may be severely affected.

Water Diversion Plan from the Tibetan Plateau in China

The Chinese government has been considering a plan to dam or redirect the southward flow of water from the Tibetan plateau, the starting point of many international rivers, including major rivers like the Brahmaputra, the Yangtze, and the Mekong. In the context of trans-boundary flow in South Asia, the important rivers include the Brahmaputra, the Indus, the Sutlej, the Arun, and the Karnali. The plan includes diverting the waters of the Yangtze, the Yellow river, and the Brahmaputra to China's drought-prone northern areas, through huge canals, aqueducts, and tunnels. One of the water diversion routes, more specifically the southern component of the route cutting through the Tibetan mountains, will divert waters of the Tsangpo for a large hydroelectric plant and irrigation use. The planned water diversion will have adverse consequences in the downstream areas. Implementation of the plan will result in loss of land and ecosystems due to the submergence of a huge area in the Tibetan region. Flow control for power generation and irrigation during the dry season, and water release during the flood season may pose a serious threat to the flood management, dry season water availability, and ecosystem preservation of northern India and Bangladesh.

Regional Cooperation—The Way Forward

There are huge potentials of regional cooperation in the GBM basins on a number of issues, including sharing of major rivers during lean period, augmentation of flow of the lean period, hydropower generation and distribution, cooperation in flood management, sharing of data for flood forecasting, cooperation in navigation system, water quality improvement, and watershed management. However, lack of mutual trust and confidence among the co-riparian countries has played a major role in the long-standing disputes or conflicts surrounding trans-boundary rivers. The GBM countries have much to learn from the experiences of international treaties and river basin organizations, which underscore the importance of common or shared interests of nations, the perception of huge mutual benefits, usefulness of sharing of benefits, and the importance of basin-level management.

Water Resources Development Opportunities

Water resources development options could be a combination of cooperative non-structural (for example, sharing or exchange of data and information) and structural (for example, dams or reservoirs at 'suitable' locations) measures. Creation of storage reservoirs by dams for hydropower generation has been rather common in upstream riparian countries, especially India. However, storage projects for a single purpose are hardly economical and practical, and hence are less attractive. Storage projects need to be seen from the multipurpose point of view in a regional context to derive benefits from flood control, irrigation, navigation, hydropower generation, and enhanced economic condition of the people. Such structural interventions will need to be evaluated in terms of technical, social, and environmental considerations (seismic activity, submergence, population displacement, impact on land and ecosystem, physical impact downstream, and the equity issue in sharing costs and benefits).

Geographical and hydrological characteristics make Nepal the most suitable site for construction of multi-purpose reservoirs (Uprety 2006). Nepal has magnificent gorges where high dams can be built and the Himalayan waters stored (Bangladesh–Nepal Joint Study Team 1989). The prospects of construction of reservoirs in the Ganges basin in India have mostly been exploited; the middle and lower sections of the system in northern India have no physical dam sites to store monsoon flows (Adhikari et al. 2000), and the floodplain topography of Bangladesh is unfavourable for the construction of reservoirs. Since the tributaries flowing from Nepal contribute the major flows of the Ganges (about 40 per cent of the annual flow and 70 per cent of the dry season flow) (Malla et al. 2001; Tiwary 2006), tapping the flow in Nepal and harnessing the water under a multilateral framework among Nepal, India, and Bangladesh for a number of co-riparian benefits seems to be the most feasible option. Besides hydropower generation, the storage reservoirs are likely to mitigate floods in the downstream reaches of the Ganges. At the same time, the monsoon water stored in the reservoirs will be available for dry season augmentation of flow thus increasing dry season irrigation potential and also the possibility of river navigation.

The Bangladesh–Nepal Joint Study Team (1989) identified and recommended 30 potential reservoir sites in Nepal, nine of which were classified as large, each having live storage capacity over three BCM, with an aggregate gross storage capacity of 110 BCM. The total storage capacity of high dam projects in Nepal would regulate over 95 per cent of the total annual flow. Augmentation potential in Nepal during the dry season can range from 2400 to 4950 metre^3 per second, which is more than four times the present lean season flows in the Ganges at Farakka. From the Bangladesh perspective, as outlined in the Bangladesh–Nepal Joint study, the Sapta-Kosi High Dam Project has the maximum potential for augmenting the flows at Farakka, which could benefit Nepal, Bangladesh, and India (Ahmad et al. 2001; Adhikari et al. 2000). It is important that the planning and design for the Sapta-Kosi High Dam, now at an advanced stage of planning exercise between India and Nepal, takes into full consideration the concerns of Bangladesh as a co-riparian and that Bangladesh is allowed to equitably share the augmented dry season flows and hydropower through joint collaboration during implementation.

Considering the vast hydropower potential of the GBM basins, a thorough cooperative effort is needed to produce and share hydropower. Nepal and Bhutan, the two neighbouring countries of India, have rich hydropower potential far in excess of their domestic requirement; they have huge potential of earning rich revenue to boost their economy by selling it to other countries. Nepal leads the countries in terms of hydropower potential with a theoretical potential of 83,000 MW and an economically acceptable potential of over 42,000 MW (Uprety 2006; Onta 2001; and Biswas 2008). Bhutan, too, has a potential of about 20,000 MW. Cooperation between Nepal and India in this respect has been limited with the exception of the recently initiated Sapta-Kosi Dam, while there are close ties between India and Bhutan with regard to hydropower development. An integrated plan for hydroelectric development and sharing through an interconnected grid across the borders is becoming all the more essential.

River navigation connected with the sea plays an important role in the development process of the basin countries. The flow regulation through creation of multi-purpose reservoirs in the upper reaches of the rivers will open opportunities for inland river navigation in the downstream reaches. Nepal, a landlocked country, could benefit through the establishment of links with the inland water transport networks of India and Bangladesh; allowing Nepal access to Kolkata (India) and Mongla (Bangladesh) ports (Ahmad et al. 2001).

The major potential for regional cooperation lies in non-structural management measures, more specifically, flood forecasting and warning. After the disastrous floods in Bangladesh in 1988, the Indian Government showed interest in regional co-operation for flood mitigation in both the countries through a joint action plan. Through bilateral cooperation, Bangladesh receives water level and rainfall data from a number of stations (Ahmad and Ahmed 2003). There also exists cooperation between Bangladesh and Nepal, with Bangladesh receiving water level data from four stations in Nepal. Limited flood related data at three stations on the Chinese section of the Brahmaputra have also been transmitted from China to Bangladesh since 2006. There exists bilateral cooperation between India and Nepal and also between India and Bhutan in respect of sharing of data for flood forecasting. However, there is still a significant scope for strengthening the existing cooperation and extending it further in a regional perspective.

Shared Vision

There is a strong need to stimulate a mutual trust and confidence among the basin countries, which requires development and maintaining of 'common' or 'shared' vision or interests. The GBM countries may learn from the fact that agreements between economically and politically disparate countries were possible in the cases of the Indus Treaty, Mekong River Agreement, and Nile Basin Initiative. The Indus Treaty of 1961 was made possible because both India and Pakistan could perceive the huge advantage of the development of the waters of the Indus system. The Mekong River Agreement of 1995 was made possible because the four countries saw a common interest in jointly managing their shared water resources and developing the economic potential of the river. The Nile Basin Initiative of 1999 is another example of a 'shared vision' by the basin countries to achieve sustainable development through equitable 'sharing of benefits', with the focus not on water but on a win–win situation of regional development.

Sharing of Benefits

Shared vision of the co-riparian could best be achieved if sharing of 'equitable benefits', not 'water' itself, is seen as a negotiating approach. Traditionally, co-riparian states have focused on water as a commodity to be divided—a zero-sum, rights-based approach. Precedents now exist for determining formulae that equitably allocate the 'benefits' derived from water—a win–win, integrative approach. In fact, it is at the root of some of the world's most successful institutions (United Nations Educational, Scientific, and Cultural Organization [UNESCO] 2003). Examples of the 'sharing of benefits' approach date back to the 1909 Boundary Waters Agreement between USA and Canada, and the Columbia treaty between USA and Canada relating to the cooperative development of the Columbia River Basin in 1964 (United Nations Environment Programme [UNEP] 2002; cited in Rahaman and Varis 2007). The Nile Basin Initiative is perhaps the best example of a shared vision by the basin countries to achieve sustainable development through equitable sharing of benefits, with the focus not on water but on regional development.

In the GBM basins, the concern is the sharing of benefits from water use—whether from hydropower, agriculture, flood control, navigation, trade, tourism, or the preservation of healthy aquatic ecosystems. Nepal has the potential to supply hydroelectric power and water storage benefits to India, while India has the potential to supply navigation and transit facilities and to provide financing and expertise to Nepal. India has the potential to grant secure expectations of minimum flow to Bangladesh, while Bangladesh has the potential to permit navigation and transit access to India. Nepal has the potential to supply hydropower and storage benefits to Bangladesh, while Bangladesh has the potential to provide navigation and transit access to Nepal. Bhutan has the potential to supply hydroelectric power and water storage benefits to India, while India has the potential to provide financing and expertise to Bhutan.

Multi-lateral Cooperation

It will not be possible to materialize the huge potentials of 'sharing of benefits' in a sustainable way under a bilateral regime since bilateral negotiations are likely to exclude the positive and negative externalities (Crow and Singh 2009). Construction of storage reservoirs for a variety of multipurpose uses (dry season flow augmentation, irrigation, flood mitigation, navigation, and hydropower generation) concerns the interests of more than two countries, and can be achieved only through multilateral dialogues and cooperation among the co-riparian countries. Multilateral resolution, though not the most common of methods, is an ideal way to reach a permanent, fair, and effective agreement through its greater levels of participation and tendency for more permanent and effective agreements.

Basin-wide Approach

Multi-lateral cooperation has the potential of coming up with basin-wide approaches to dispute resolution, where all the riparian states organize a committee for the organization of the use of the waterway. While national water policies of the GBM countries emphasize the importance of basin-wide management approach, the planning and management of water resources have often been geared towards national interests, with very little acknowledgements of regional interdependency. Shared vision of the co-riparian states on equitable sharing of benefits can best be achieved through basin-wide management of water resources. Lessons may be drawn from the prevailing basin-wide management of trans-boundary rivers, for example, Rhine, Mekong, Danube, and Nile.

Resilient Institutions

Despite the potential for dispute in trans-boundary basins, the record of cooperation historically overwhelms the record of acute conflict over international water resources. There is a huge importance of resilient institutions, which is reflected in their roles in diffusing tensions in basins with large numbers of water infrastructure projects (for example, in the Rhine and Danube basins). As UNESCO (2003) points out, 'some of the most vociferous enemies around the world' have been able to negotiate and maintain water agreements because of resilient institutions that stood firm over time and during periods of otherwise strained relations. Examples are the Mekong Committee, which functioned since 1957 and exchanged data throughout the Vietnam War, the Indus River Commission which survived through two wars between India and Pakistan, and the Nile Basin Initiative in which all ten Nile riparian states have engaged in negotiations over cooperative development of the basin. Efforts are needed to have a similar resilient institution in the GBM region with sufficient authority and mutual trust among the representatives of the basin countries.

Participatory Fact Finding Mission

There are disparities among the countries with regards to hegemony and economic power. Given the political realities of the development of trans-boundary waters, a big question now is how to eliminate the mistrust among the GBM countries and create an environment in which the countries can see and materialize their 'shared' or 'common' interests. Experiences from Mekong and Nile elucidate the urgent need to stimulate a participatory process to allow, facilitate, and support stakeholder involvement in water resources planning process in the GBM region. Uitto and Duda (2002) observe that initial, strategic joint fact-finding projects among participating nations can serve as an important catalytic tool for achieving a shared vision and commitment among the riparian nations. All relevant stakeholders including national governments, civil society organizations, academia, research institutions, NGOs, and donors need to work together in joint research to address the challenges ahead. This proactive stakeholder participation will help build transparency and facilitate identification of options for win–win solutions to the existing problems in the GBM river systems. This, in turn, will serve as preventive diplomacy by generating political support and allowing the co-riparian nations to go ahead of the crisis curve through preclusion of future disputes or crises in the long run.

Multi-track Diplomacy

It is increasingly recognized that skills other than technical engineering expertise are required to facilitate and enable the trans-boundary water negotiation process. Diplomatic and negotiation skills are needed together with an understanding of the technicalities. Multi-track diplomacy often comes handy in complex negotiations between countries. Track I diplomatic efforts by the concerned governments in India and Bangladesh have been made for a long time through the Joint River Commission. Track II diplomatic efforts have also been pursued to enhance the effectiveness of the Track I efforts. One example is the signing of the Ganges Water Treaty in 1996, where Centre for Policy Dialogue (CPD) of Bangladesh and Centre for Policy Research (CPR) of India took the initiative to bring the two sides closer to each other by organizing meetings on Indo-Bangladesh relations where various issues, including trade and water sharing, were discussed. However, with growing complexities of water sharing issues and because of the highly politicized nature of discussions between the co-riparian countries, it seems that a Track III diplomacy approach is warranted, in which dialogue and advocacy efforts will be led by civil society organizations, with the aim to stimulate progress at more formal levels (Track I and Track II). The Track III approach will result in an open environment that enables listening to each other and understanding each other's view points, not hampered by political or other power oriented position.

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4 A Million Revolts in the Making

Understanding Water Conflicts*

Suhas Paranjape and K.J. Joy

Introduction

Water conflicts arise at various levels: between countries, states, regions, and sub-regions within states, districts, political parties, castes and groups, and individual farmers. These pose a significant threat to the economic growth, social stability, security, and ecosystem health.

Conflicts indicate the absence of proper democratic, legal, and administrative mechanisms to handle issues that give rise to such disputes. Water is a complex resource and is turned into a resource through ideological and material means, by isolating and imposing an economic and private property framework on a complex part of the ecosystem. However, the specificities of water as a resource continue to break through and create problems. Water is a mediated resource, made available by and through the ecosystem. It is available in common but is used individually; unlike other public utilities (roads, parks, etc.) it cannot be *used* in common. Water is divisible and amenable to sharing and has private benefits. It has multiple uses and users and involves tradeoffs. It is difficult to exclude people who receive it in the natural course as the costs of such exclusion are very high. Water has different scales of availability and usage such as water at the homestead, micro watershed, watershed, sub-basin, basin, inter-basin as well as inter-country level that require different ways of handling it.

Moreover, the way water naturally flows as well as the way it is planned, used, and managed causes unidirectional and asymmetric externalities. For example, upstream use affects the downstream users, but not vice versa. A rich farmer who grows sugarcane on the adjacent field causes water logging in the neighbouring plot. This makes it possible to externalize or shift costs on to someone else. These characteristics have a bearing on water related institutions.[1] Given the complexity of the problem, it is no surprise that there is a relative paucity of frameworks, policies, and mechanisms that deal with water resources, especially in comparison with those that deal with immobile natural resources like land.

* This chapter draws heavily on Joy et al. (2008) (the Compendium, hereafter) and its introductory chapter.

[1] There is a considerable amount of literature available on some of these, especially about common pool resources, their defining characteristics, and the 'fit' between these characteristics and the institutions to manage them. Lele (2004: 283–303) summarizes some of these discussions and debates.

A number of water conflicts arise which are difficult to classify into different types. Due to the complex nature of water, the boundaries of conflicting parties are not easily drawn and they tend to cut across class, caste, and gender issues to different degrees. However, to understand the nature of these conflicts we have classified them into seven categories (for more details see Joy et al. 2008).[2]

Conflicts over Equitable Access

The most important, and almost classical, type are the conflicts over equitable access for a common use—conflict between different users but *within the same kind of use.* Examples could be the conflict between middle class localities and slums over drinking and domestic water or that between big and small farmers over equitable access to irrigation. These conflicts overlap the most with class, caste, and gender issues.[3] However, there is a wide variety: for example, contestation over and between old and new water rights, old and new projects, tailenders, and head-reachers, inter-basin transfers (see Box 4.1).

The core issue here is the absence of clear cut norms for equitable water allocation and distribution. Allocation norms have evolved according to local situations, size and nature of the project, and historical socio-political relations. To tackle the conflicts over allocation and access we need a better concept of rights or entitlements to water. Water rights in the Indian Constitution are situated within 'Right to Life'. The rights need to be defined based on a minimum requirement needed for livelihood needs. There is also a prerequisite for a framework to allow sharing of shortages and surpluses in a principled manner. However, this is not possible without addressing equitable access to water by all segments of the society.

Conflicts over Competing Uses

Another type of conflict is between contending uses. Unlike the earlier type, here the conflict is between *different uses*.[4] This is difficult to resolve without some understanding of relative priority of the different uses and may not be simply reducible to sectional issues alone. Examples are conflicts over water for agriculture

[2] The Compendium divides water conflicts into eight themes and includes a thematic review for each theme. The theme of water conflicts around contending water uses is reviewed by Bhiksham Gijja; of water conflicts around equity, access and allocation by Suhas Paranjape and K.J. Joy; of water quality conflicts by Paul Appasamy; of sand mining by P.B. Sahasranaman; of micro-level conflicts by K.V. Raju; of dams and displacement by Bharat Patankar and Anant Phadke; of transboundary conflicts by Ramaswamy R. Iyer; and of privatization by Sunita Narain.

[3] See Joy et. al (2008) which discusses following conflicts around equity and access in more details: Water Users in the Bhavani River Basin in Tamil Nadu: Conflict among New and Old Ayacutdars by A. Rajagopal and N. Jayakumar; The Collapse of an Ancient System in the Tapi Basin: A River Strains to Meet the Farmers' Needs by S.B. Sane and G.D. Joglekar; Tail End Discrimination in an Irrigation Project in Maharashtra: Quota Reductions for the Palkhed Left Bank Canal by S.N. Lele and R.K. Patil; Mahad to Mangaon: Eighty Years of Caste Discrimination: What Caste is Water? by Suhas Paranjape, Raju Adagale, and Ravi Pomane; A Dialogue along the Jholapuri River, Coastal Gujarat: Addressing Water and Gender Conflicts through Multi-Stakeholder Partnerships by Sara Ahmed and UTTHAN Team; Tembu Lift Irrigation Scheme in the Krishna River Basin: Conflict over Equitable Distribution of Water by Namrata Kavde-Datye; Diverting Nar-Par-Damanganga to Tapi-Godavari: Linking Projects or Lurking Conflicts? by Datta Desai; Problems at the Indira Gandhi Canal in Rajasthan: Desert Brawl over Water Allocation by Binayak Das; Rehabilitating the Keezhparikkalpet in Pondicherry: Bore well Owners give in to Farmers by T.P. Raghunath and R. Vasanthan; Groundwater Irrigation in Northern Gujarat: Digging Deep for Answers by Jennifer McKay and H. Diwakara.

[4] Joy et. al (2008) includes the following articles on water conflicts related to competing uses: The Case of Keoladeo National Park: Conflicting Water Uses—Bio-diversity vs Irrigation by Malavika Chauhan; The Thaneermukkom Bund In Kuttanadu: Choking the Largest Wetlands in South India by V.K. Ravi Varma Thampuran; Ithai Barrage in Manipur: A Lake in Trouble by Mihir Kumar Maitra; Bridge over the Brahmaputra: Unleashing Nature's Fury by Chandan Mahanta and Anjana Mahanta; Whose is the Chilika? Fishing in Troubled Waters by R.S. Deshpande and Satyasiba Bedamatta; Crisis in the Gagas River Basin: Politics, Water and Forests in the Himalayas by Anita Paul and Kalyan Paul; Social Undercurrents in a Gujarat Village: Irrigation for the Rich vs drinking water for the poor by R.K. Sarma and Anjal Prakash; Water Conflict in Peri-Urban Areas of Chennai: Unequal Power, Unequal Contracts and Unexplained Resistance by S. Janakarajan; Contending Ground Water Uses in Sangolda and Saligao: Rural Needs vs Tourism in Goa by Sujeetkumar M. Dongre and Govind S. Poteker; Diverting Water from the Ganga Canal for Delhi: Rural Livelihoods vs Urban Need by Binayak Das.

Box 4.1
Equity, Access, and Allocation

Bhavani is an important tributary of the Cauvery in its mid-reaches in Tamil Nadu. It originates in the Silent Valley forest in Kerala and flows in a south-easterly direction for 217 km till it joins the Cauvery at a town named Bhavani. The total area of the Cauvery basin in the state is about 43,000 km^2 of which the Bhavani sub-basin constitutes roughly 5400 km^2. The Cauvery basin which drains Karnataka, Puducherry, Kerala, and Tamil Nadu comprises about 82,000 km^2 of which the Bhavani river basin is 6000 km^2. A major portion (87 per cent) of this area is situated in Tamil Nadu.

The Lower Bhavani Project (LBP) is a major multi-purpose reservoir, mainly constructed for water storage and distribution to canal systems in the basin. The reservoir is also used for hydel power generation and fishing. Apart from this, *anicuts* such as Kodiveri and Kalingarayan are used to divert water into different canal systems. These are old systems that have been in existence for several centuries. The upper part of the basin is not well developed and depends mostly upon wells and rain-fed agriculture.

The river plays an important role in the economy of Coimbatore and Erode districts by providing water for drinking, agriculture, and industry. Due to an increase in population, unplanned expansion in the command area, as well as the growing domestic and industrial water demand, the basin is already 'closing' and stressed. As a result, there is intense competition among water users and a sizeable gap exists between demand and supply in agriculture and domestic sectors.

Water shortage downstream is even worse due to a prolonged drought that has lasted several years.

There was already a conflict of interest between farmers in the valley, the original settlers and the new command farmers of LBP. Old command farmers are entitled to 11 months water supply whereas the new *ayacut* farmers were only able to grow a single paddy or dry crop in a year.

However, supply was at an all-time low in 2002 and water was not released to the new command area. This prompted the new *ayacutdars* to file a case against the state in the high court seeking water supply for at least one crop. Their contention is that water should be provided for the second crop in the old settlement only after meeting the requirements of the first crop in the new command as per the Government Order (no. 2274) issued as early as 30 August 1963. The court asked the Water Resources Organization to arrive at a compromise formula for water sharing between the two areas. The department prepared a plan on the basis of size of command area. However, the old settlers objected on the grounds that they are entitled to 11 months of interrupted water supply as per their riparian rights. The impasse prompted some ministers to bring the two sides to the negotiating table but this attempt to seek a solution also failed. The court in its interim order has now told the state to take prior permission from the court to open the system every season. Under the original regulation the canal was opened on 18 April for the old settlement and 15 August for the new ayacut.

The expansion of irrigation and hence demand has mostly taken place in upstream areas (and to some extent in the old ayacut too) through unauthorized tapping of river water by direct pumping.

Downstream farmers took the issue to court and even won a favourable judgment but the ineffective bureaucracy has been unable to implement the court's orders.

Source: Adapted from Rajagopal and Jayakumar (2006).

versus industry, for hydropower versus irrigation. A general trend is that in the conflict between rural and urban uses, rural needs are steadily losing out. One important issue that has emerged recently is that of environmental/ecosystem needs versus other needs (see Box 4.2). How much importance do we grant to ecosystem needs; first, to ecosystem needs in terms of preserving the very sources of water and second, also in terms of preserving the nature of the ecosystems themselves. In fact, there is evidence that structures built to improve the ecosystems may have unintended effects that actually harm both people and the ecosystems.

Conflicts over Water Quality

Issues related to water quality, or pollution, are fast emerging in various parts of India. Earlier these issues were treated as inevitable consequences of growth and industrial development, and were largely ignored as a necessary price to be paid. However, growing scale, increased awareness, and active civil society engagement have brought water quality conflicts more and more

Box 4.2
Contending Water Uses

Keoladeo National Park is situated in eastern Rajasthan on the edge of the Gangetic plains two km south-east of Bharatpur town and 50 km west of Agra. The park, known locally as 'Ghana', is a mosaic of dry grassland, woodlands, swamps, and wetlands spread over 29 km^2. About 900 ha are divided into small, seasonally inundated reservoirs by a series of *bunds* and dykes. Bharatpur experiences climatic extremes—hot dry summers and freezing cold winters, with temperatures ranging from 0 to 2º C in winter to above 48º C during summer.

Keoladeo was famous as a wintering site for a subgroup of the western population of the Siberian crane. Though this species is now locally extinct, extensive habitat management over the past century has resulted in exceptionally high biodiversity including over 370 species of avifauna.

Keoladeo is unique in that it is a rich man-made biodiversity zone in a predominantly arid and highly populated rural landscape. In pre-independence India the area was a common property resource used by local herder communities, but with independence the first expression of discontent surfaced, fuelled by a need for arable land and water for irrigation.

Under the circumstances it is inevitable that the issue of seasonal water requirement for the park and that of irrigation in the surrounding rural landscape has become a contentious one. This has, in fact, been a long-standing reason for discontent and conflict in the region.

In 1991 Panchna dam was constructed on the river Gambhir in district Karauli, Rajasthan, to mitigate high floods and fulfill the irrigation needs of the local farming community.

There are two dimensions to the issue of conflict over water for Keoladeo National Park. The first and older dimension has been conflict over the water in Ajan bund. Every year water allocation for the park versus that for local farmers is an issue of contention. The dispute often escalates and forest fires occur in the park with unnatural regularity during the dry season. Every year the park administration has to lobby with the state irrigation department for their quota of water from Ajan bund.

The second dimension surfaced in the post-monsoon season of 2004; this had to do with the demands of upstream agriculturalists. These are farmers in the command area of Panchna dam, which irrigates about 35 villages over a gross command area of 11,172 ha.

The latest conflict developed in August 2004, after a third consecutive year of low rainfall. The agitation was precipitated by a decision of the Rajasthan State Government to release 8.15 mm^3 water from Panchna reservoir to Keoladeo; which, at the time, had storage of 35.7 mm^3. The park had until then received a minimal 0.5 mm^3 of water.

In September 2004 farmers from the command area of Panchna dam protested and the government reversed its previous decision condemning Keoladeo to a dry year.

The reversal of the committee's original decision kicked off a spate of pro-park protests and media articles. Following numerous complaints, the Supreme Court held its first hearing on 31 January 2005The court directed the government of Rajasthan to release water to the Park from Panchna dam *Sources*: *Hindu*, 12 March 2005; *Indian Express*, 12 March 2005.

Fortunately, the monsoons have been good this year and as of 25 July 2005, Keoladeo has already received more than 8 mm^3 of water. Hopefully, it will receive an optimal amount by the end of the season. Though this makes the ongoing case temporarily redundant, there needs to be a policy that makes it mandatory for a certain amount of water to be set aside for the park, particularly during the dry years.

Source: Adapted from Chauhan (2006).

to the forefront.[5] The main issue here is how, and in what form, do users return water to the ecosystem. Polluted water returned by users causes problems to the 'downstream users,' and the decreased freshwater availability causes economic loss, social distress, and ill health. Studies show that water pollution impacts both the ecosystems and peoples' lives and livelihoods. The corollary is that any possible solution to conflicts related

[5] See Joy et. al (2008) for various cases of water conflicts around water quality and sand mining. Bridging the GAP in Kanpur Ganga: Failure of Monitoring Agencies Causes Pollution Disaster in Village by Praveen Singh; Kolleru Wildlife Sanctuary: Pollution through Aquaculture by J. Rama Rao, Jasveen Jairath, and P. Umesh; Unclogging the Khari River in Ahmedabad: Stakeholders Come Together to Halt Pollution by Srinivas Mudrakartha, Jatin Sheth, and J. Srinath; Noyyal River Basin: Water, Water Everywhere, Not

to water quality needs to address both the ecosystem needs as well as people's livelihoods. Sadly, however, the deterioration in quality becomes apparent only after the adverse impact becomes large enough, and in the last instance it is the poor and ecosystems that are the major losers.

In spite of considerable civil society initiatives, several legislations and pollution control boards at state and central levels, on the whole, we have failed in evolving a long-term answer that can protect our rivers and aquifers from contamination. There is a need for a three-pronged approach to deal with this. First, a legal framework based on rapidly enforced criminal and civil penalties; strict but non-implementable legal frameworks appear good only on paper. Second, environmental mediation, a pragmatic direction to settle issues quickly and amicably. Third, encouraging voluntary compliance. However, voluntary compliance is a long way from becoming effective in India, since consumers/users in particular are still focused mainly on price of water than on quality and safety.

Another issue, uncontrolled sand mining from river beds or sea beds has a deleterious effect on stream flows. Apart from its ecological impacts—to name a few, impact on stream flows and sandy acquifers, deepening of riverbeds, subsurface intrusion of saline seawater in coastal areas, and erosion of the banks—it also impacts the livelihoods of the local people, for example, through decreased availability of water for both domestic and irrigation purposes as the wells near the banks going dry. However, sand is also a building material and local people also depend on sand for housing construction. It provides seasonal employment to the local labourers. In many states it is one of the major sources of revenue for the gram panchayats. The contractor–bureaucrat–politician nexus further complicates the situation and the conflicts very often take the form of clash of interests between this nexus and the local people.

Sand is a local resource and it should be looked at in the context of rights over local resources and their management and the loss to local communities. Experts suggest that it is important to determine the quantity of sand that can be safely mined by taking into account the annual rate of accrual or replenishment, keeping a long-term perspective of about 25 years or so. Also appropriate pricing of alternative building materials to sand can be looked at by the building industry.

Conflicts over Dams and Displacement

Conflicts over dams and displacements are relatively well publicized and better documented.[6] Dams are important, but they must supplement and not supplant the local systems; they must strengthen rather than

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a Drop to Drink by N. Jayakumar and A. Rajagopal; Conflict Over Water Pollution in the Palar Basin: Need for New Institutions by S. Janakarajan; Toxic Hotspot on the River Periyar in Kerala: Corporate Crimes in God's Own Country by M. Suchitra; Bidding Farewell to Grasim: The Lessons that Remain Unlearnt by Abey George and Jyothi Krishnan; Factory in a Paddy Field in Pondicherry: Is Berger Paints Polluting Pandasozhanallur? by Benjamin Larroquette and Gaspard Appavou; The Arkavati Sub-basin in Karnataka: Industrial Pollution vs Rural Livelihood Systems by D. Dominic; Pollution in Hootgalli Village, Mysore: Water? No Thanks by S. Manasi and N. Deepa; Pollution of the Musi in Andhra Pradesh: River Metamorphoses into Drain by Jasveen Jairath, Praveen Vempadapu, and Batte Shankar; Water Turns into Sludge in Kohlapur: Villagers Ransack Industrial Unit by Binayak Das and Ganesh Pangare; Sand Mining in Coastal Tamil Nadu: Government Mining Threaten Local Irrigation Source by Benjamin Larroquette and Gaspard Appavou; Sand Mining in Papagani Catchment in Karnataka: Creating Ground Water Depletion in AP by M. Chandrasekhara Rao; Baliraja Memorial Dam on Yerala River in Maharashtra: A Case of Sustainable Utilisation of Natural Resources by Shruti Vispute; Mining and the Nandanvara Dam in Madhya Pradesh: When the State Turns Against its People by Ashim Chowla.

[6] For in-depth discussion, see Joy et. al (2008), which includes the following articles on the theme of water conflicts around dams and displacement. People's Struggle in the Narmada Valley: Quest for Just and Sustainable Development by Sanjay Sangvai; Alternative Restructuring of the Sardar Sarovar Project: Breaking the Deadlock by Suhas Paranjape and K.J. Joy; Haribad Minor Irrigation Project in Madhya Pradesh: How Multiple Conflicts Overlap by Rehmat Mansuri and Shripad Dharmadhikari; Struggle over Reservoir Rights in Madhya Pradesh: The Tawa Fishing Co-operative and the State by Vikas Singh; Tehri Dam Project: A Saga of Shattered Dreams by Vimal Bhai; Pulichintala Project on Krishna River: The Dam that Never Got Built by R.V. Ramamohan; The Polavaram Project on the Godavari River: Major Loss, Minor Gain by R.V. Ramamohan; Uchangi Dam in Kolhapur: Dispute over Dam Height and Alternatives by Raju Adagale and Ravi Pomane; The Stalled Bhilangna Micro Hydel Project: Community Anger over Community Rights by Pushpalata Rawat and Meera Kaintura.

weaken these systems and ensure dispersed, equitable access rather than sharpen inequity and create developmental islands/pockets. This can be achieved only by an integration of the large and small systems rather than favouring one over the other. If this approach is adopted, we can minimize the displacement of people, and provide for better and more acceptable rehabilitation. This is important because in many drought prone regions in India, water from large and medium dams may be needed to supplement and strengthen local water harvesting and their integration is the way to avoid dividing the poor and pitting them against one another as the drought-affected beneficiaries versus the displaced victims.

Conflicts over Privatization

Privatization of water is an important upcoming arena of conflict not only in India but also in many other countries in Asia, Latin America, and Africa.[7] What is important in these conflicts is that there is a privatization of rights and entitlements that is taking place under the garb of privatizing *services*. Equity and access to water are the aspects that are most threatened by privatization, whether it is bottled water or high-cost 24 × 7 schemes that tend to exclude the poor (see Box 4.3). This has created a peculiar situation where real benefits of privatization of services without privatization of rights and entitlements are not even being explored. The current debate about water privatization is highly polarized between two well-entrenched positions for and against and there seems to be hardly any attempt to explore the middle ground of seeing water as both a social and economic good.

There are other types of water conflicts that can also be identified, for example, upstream–downstream conflicts, conflicts over hydropower schemes, as also conflicts caused by impact of excess water and floods. However, the purpose here is not to arrive at a neat classification but to identify important issues and find ways of moving ahead. In this respect we would like to single out the major conflict issues that are going to be very important in the coming times; the issue of diversion of allocation of water from rural and irrigation use to industrial and urban use which is symptomatic of a larger issue of transition to an industrial society and trans-boundary conflicts.

Transition to an Industrial Society

There is now growing resistance to the diversion of water from rural areas and irrigation. Faced with a shrinking water supply, farmers are opposing the diversion of *any* water to industry. In almost every dam and reservoir, originally built for irrigation, there are now allocations made for urban drinking water and industry, encroaching upon irrigation allocations. This practice is most evident in projects under construction where irrigation is not yet established.

This diversion is part of a general pattern where industry is given incentives of various kinds in the interest of public good or development or growth. The establishment of Special Economic Zones (SEZs) and displacements due to power projects, including displacement for hydro projects are all part of the same pattern. The general problem is that the resources (especially land and water) that industry and urbanization need lie in the hands of someone else and industry finds it difficult to acquire these on its own. The state has stepped in where such situations arise and has provided the land and water (and other resources as well) as an incentive to industry and has, in effect, dispossessed people who owned that land and water. In the case of land, since ownership of land is much more visible, the conflict is clearly visible, whether it is in Singur or in the case of the Navi Mumbai airport. In the case of water, the conflict is not as visible, but every time an allocation is made that transfers water traditionally used by rural areas and farmers to urban areas and industry, a dispossession takes place.

The transition from agriculture to non-agriculture society which involves reallocation of resources is inevitable. However, a participative mechanism rather than coercion is required to achieve beneficial outcomes for

[7] Joy et al. (2008) includes the following articles on the theme of water conflicts around privatization: Coke vs People at Plachimada: Struggle over Water Continues by C. Surendranath; In Chhattisgarh, a River Becomes Private Property: A Sheepish Government Backtracks by Binayak Das and Ganesh Pangare; Rights over Kelo River Waters: People's Struggle for Water Rights by Prakash Kashwan and Ramesh Chandra Sharma. See also, Gleick (2002).

Box 4.3
Privatization

Sheonath river flows through Borai in Durg district, Chhattisgarh. This case is about the handing over of a stretch of the river near Borai to a private firm for supplying water to the region lying between two district headquarters, Durg and Rajnandgaon. Borai is a newly developed industrial hub, promoted by the Chhattisgarh State Industrial Development Corporation (CSIDC). Surrounding the Borai region is a cluster of villages that has traditionally used the river water for irrigation and fishing.

Sheonath river, a semi-perennial tributary of the Mahanadi has been contracted to Radius Water, a division of Kailash Engineering, for a period of 22 years. Radius Water is managing water distribution from the river. The build–own–operate–transfer (BOOT) project was commissioned in 2001 by the Chhattisgarh government.

The CSIDC is the regulating authority for the project. One of the clauses in the agreement was that the villages downstream would get water free of cost; the clause also mentions that 'under any circumstances, the industry will be provided 30 million litres per day (MLD) of water'.

The conflict did not start immediately. Initially, the locals were not aware that a private firm was managing the new barrage that had sprung up across the river. No prior information was provided about this contract. After a few months, however, Radius Water informed the local fishermen that they were no longer permitted to fish in the 200 m zone from the barrage (on both sides) for safety reasons. There were a few skirmishes and employees of Radius Water allegedly destroyed some of the fishermen's nets. The latter complained that their catch had dwindled after the construction of the barrage. Farmers who owned land near the river were also barred from taking water from the river with motor pumps. This ban had the endorsement of the district administration, which also banned the installation of tube wells. People from downstream villages started complaining that the groundwater table had plummeted. Many villagers from Pipalcheda, one of the surrounding hamlets, insisted that the water level in their wells had plunged since the construction of the barrage.

With complaints rising, many activists and members of the public launched a campaign against the project highlighting the fact that, by handing over the river to a private firm, the state government had privatized the river.

The pressured government ultimately decided to scrap the deal with Radius Water. However, according to reports, despite the supposed termination of the contract the private firm continues to manage the barrage and supply water to the industries.

The protesters have been questioning how the industries department signed a contract for a river that legally falls under the purview of the irrigation department. Activists and lawyers argue that the deal violates the Madhya Pradesh Irrigation Act of 1931 and the National Water Policy, which prioritizes agriculture over industries.

Radius Water on the other hand insists that the upcoming industries at Borai will boost the economy of the state and that they were merely ensuring that water was supplied to them at a low price. The company also argues that the construction of the barrage has helped the water table rise by 8 metres in upstream villages, which is sure to help the farmers.

This is an interesting case that has actually thrown open the debate about the rights of communities versus the rising demand from industry. The main agency responsible for creating friction is the government which went about the deal in a cloak and dagger fashion. By not respecting the National Water Policy and the Irrigation Act, it violated laws and is liable to be taken to court. The contract was signed without setting up any independent regulatory authorities that could establish guidelines under which a private firm could manage a common resource.

Source: Adapted from Das and Pangare (2006).

all.[8] The problem, however, is that the state, due to its entrenched ideas and the venality of its echelons, is becoming an instrument of such accumulation by dispossession in the name of a public good, visibly in the case of land and not so visibly in the case of water. In Maharashtra, for example, the High Power Committee of ministers has brought about such re-allocations on an unprecedented scale.

What is required is a more humane and just transition to an urban and industrial society. It is important

[8] Historically, the first transition from a non-industrial society to an industrial society, the prehistory of the industrial revolution has involved widespread non-economic and coercive dispossession of large masses of farmers and the colonies concentrating capital at one end and property-less workers at the other.

to find ways and means of making this transition a win–win situation and not a win–lose situation with the farmers and the rural population at the losing end. As an illustration, a water policy could be put in place which ties the diversion of water to industry to corresponding water savings in agriculture and increase in efficiency in agriculture for which industry participates by meeting the cost of savings in water as well as increasing agricultural efficiency.

Similarly, take the case of compensation. There are two ways of working out the value of compensation. One is based on the role that the resources play in the present production system and the other is based on the role that they would play in the new system. There is a vast difference between the two. The former is likely to be traditional, subsistence farming with very low levels of monetization in which much of the cost is not even itemized (for example, a farmer is unlikely to chalk down the expense of visiting the market to buy fertilizer as a business expense, and just as unlikely to monetize his land and water access, treating the same as an investment and adding a legitimate return on investment to the cost of his produce). In any case, resources representing a substantial livelihood source for the farmer may actually have a very small imputed monetary value. However, the same resources represent a very high value for modern industry as inputs. The right compensation strategy should involve providing an assured livelihood, or at least providing a fair share in the incremental gains generated by new opportunities rather than providing a monetary compensation based on the assessment of unmonetized economic practices.

Given that the diversion of water to industries usurps the right of famers, industries should not be allowed to externalize these costs, and they should be allocated water only after exhausting all other options such as local water harvesting, reuse and recycling, improvement in water use efficiency, and so on. The industries should also invest in water saving, especially in the agriculture sector, and only the saved water should be allocated to industries.

Trans-boundary Conflicts

Generally the term 'trans-boundary conflicts' refers to conflicts between sovereign countries over water. However, in India, water is a state subject and, therefore, we have a special class of conflicts called inter-state conflicts or disputes which have the same character.[9] These are basically conflicts based on political boundaries. However, underlying these conflicts is a complex mix of all the other kinds of conflicts—upstream–downstream issues, prior use issues, clash of priorities and allocations, and sometimes non-water conflict as well. An interesting method to resolve inter-state conflicts is to begin by ignoring state boundaries altogether and then trying to re-state the issue. This is not as trivial as it seems because in doing so we need to know what generic underlying issues are getting combined with issues related to the political boundaries, which aggravate and or modify the conflicts further.

Most trans-boundary issues can be solved by the involved parties through dialogue and discussion. India has negotiated several settlements with Pakistan over water with the help of mediators even while the two countries have fought wars. However, in India, there is a lack of a proper framework and mediating mechanism for conflict resolution both within the government and in civil society at all levels. The mechanisms that exist are meant for inter-state disputes, and hence most generic conflicts often become visible only in terms of conflicts between states, obscuring the underlying issues and the need for a reasoned dialogue on water issues. For example, it is common for downstream users to distrust upstream dam building and operation and these types of conflicts exist within the states and between regions, at scales ranging from village to the basin level. The other important lacuna in conflict management is that our systems are not oriented towards building trust.

[9] Joy et al. (2008) discuss the following examples of trans-boundary water conflicts: Baghlihar Project in Hot Waters: Two Neighbours and a Treaty by Rajesh Sinha; The Indo-Bangladesh Water Conflict: Sharing the Ganga by Sumita Sen; The Cauvery and Krishna Disputes are also Covered in the Earlier Effort by R. Doraiswamy and Biksham Gujja (2004); Telugu Ganga Project: Water Rights and Conflicts by R. Rama Devi and V. Balaraju Nikku; The Sutlej Yamuna Link Canal: Bogged Down by Politics and Litigation by Indira Khurana; The Jhanjhavati Medium Irrigation Project: Andhra Pradesh–Orissa: A Case of Interstate Conflict due to Submergence by R.V. Rama Rao.

Often a state may be within its rights to utilize part of its allocated share, but the manner in which it goes about it is hardly conducive to building of trust. For example, in the case of the Babhli barrage—Maharashtra may well be within its rights, but the question is why it is insisting on the right to bypass the Central Water Commission (CWC) and take unilateral action? Also it is unclear whether Andhra Pradesh is disputing the siting of the dam or Maharashtra's right to the water that it will store (see Box 4.4). What generally happens is that on both sides of the conflict, the state and civil society actors play the role of litigants, piling legal argument upon legal argument in the hope that one will hit! This makes the sides lose sight of the fact that water is a shared resource that needs to be shared in a spirit of accommodation and cooperation. This is also the reason why integrated river basin management has not come into existence and that the mandated river basin organizations are simply paper organizations in most cases. In fact, river basin planning is needed

Box 4.4
Babhli Water Conflict: Less Water, More Politics

The Babhli project, a gated *bandhara* (check dam or weir) on the Godavari river, is located at Babhli village in the Dharmabad *taluk* of Nanded district of Maharashtra, adjoining Andhra Pradesh. Babhli is part of a chain of 12 bandharas planned by Maharashtra to store and utilize its share of 1699 million cubic metre (MCM) (60-thousand million cubic feet or TMC) of water given by the Godavari Water Disputes Tribunal (GWDT) Award. These structures are planned on the river stretch between the Jayakwadi dam at Paithan and the point where the river enters Andhra Pradesh.

Babhli would operate more like a Kolhapur Type (KT) weir in which only the post-monsoon flows would be stored. The gates would be put up only after the monsoon, usually by 15 October. The project is supposed to irrigate about 8000 ha in Nanded district through private/cooperative lift irrigation schemes and also provide drinking water to 59 villages of Nanded, Mudkhed, Biloli, Dharmabad, Naigaon, Umri, and Loha tehsils, all in Nanded district. Central to the controversy is the adherence to the allocations made in the GWDT Award amongst the riparian states that include erstwhile Madhya Pradesh, Maharashtra, Andhra Pradesh, Karnataka, and Orissa. As per the award of the tribunal, waters available in different sub-basins from the catchments intercepted by major/medium projects, proposed on various tributaries by the different states, have been generally allocated among the respective states. The tribunal also allowed the states to use certain specific quantities for minor irrigation schemes, and industrial and domestic uses, etc. The remaining yield from the free catchment available in different sub-basins, as flowing into the Godavari, is left for utilization by Andhra Pradesh.

The provisions that are the cause of the current discontent/controversy around Babhli are the following: (i) Maharashtra can use all waters up to the Paithan dam site (Jayakwadi project) on the Godavari, (ii) Maharashtra is entitled to use 1699 mcm of water below Jayakwadi dam till the Godavari enters Andhra Pradesh and (iii) Andhra Pradesh can build its Pochampad Project (Sriram Sagar Project, SRSP) with full reservoir level (FRL) at 322 m and is free to utilize all remaining waters up to the Pochampad dam site in any manner it chooses for its beneficial use.

Andhra Pradesh contends that the Babhli barrage is being constructed within the water impounded area of the SRSP and so it is illegal and ethically wrong. Though the Babhli dam site is well within the boundaries of Maharashtra, the Andhra Pradesh government has paid compensation for the area submerged in Maharashtra under the SRSP. The Andhra Pradesh government appealed to the Supreme Court; and though it did not get a stay on the construction itself, a stay order was granted on installing the gates. The case is still pending in the Supreme Court. Apparently, the CWC has also taken a stand that the Maharashtra government is constructing the barrage on its own and it will have to face the consequences if this action is proved illegal.

Maharashtra's contention is that it is well within its rights to construct the Babhli barrage as it would use only part of the 1,699 mcm of water allocated by the tribunal. It is a small structure with storage capacity of only about 77.6 mcm and the water would be used for irrigating about 8,000 ha of *rabi* crops and providing drinking water to 59 drought-prone villages in one of its most backward regions. Maharashtra also claims that such small structures do not require permission from the CWC. AP fears, that though the storage at Babhli is only 1,699 mcm the actual water use would be many times the storage as the barrage can get repeated fillings. Also, AP is afraid that Babhli could be a conduit to pump more water as both Babhli and SRSP have a contiguous storage for at least part of the year.

Source: Adapted from Gujja et al. (2010).

even between countries (Chapter 3 of this *Report*). Appropriate institutional mechanisms are required for river basin planning to address inter-state issues before they escalate out of control.

Trans-boundary issues are often also a symptom of the lack of scientific approach to water management in India. The science and the policy to deal with water sharing have become considerably advanced in recent times. However, water management in India is stuck in old concepts, which evolved when water itself was not an issue, but the capital for investment to construct dams was the far bigger constraint. This approach views any water that flows into the sea as being wasted and the effort is to build dams to retain and use every drop of water that flows in the river. As a result, river flows have fallen below their regenerative levels and have practically disappeared in many delta regions, leading to salinization, salt water ingress, reduction in fish catch, reduction in channel induced recharge, and numerous other environmental problems. Rivers have to flow into the sea if people, and the ecosystems on which they depend are to flourish. Now, since technology and finances for dam construction are no longer constraints it has led to a construction race that aims at capturing every drop of water that one is entitled to.

This has also not been helped by the way the tribunals have approached the issue of inter-state water allocation. Water is allocated on the basis of flows estimated with 75 per cent dependability. In many years the water available is bound to exceed the allocated amount, while in some years it is bound to fall short of the estimated flow. This variation can be very large, with very high flows in good years and very low flows in lean years. In peninsular India the problem is acute in shortage years. The problem is to evolve proper modalities for sharing water, that is to deal with and share surpluses and shortfalls; however, the tribunals provide no guidelines on this, primarily because they see the issue in terms of legal property to be apportioned, without taking into account the fact that the stability of 75 per cent dependability flows is theoretical and that the 'property' under question is actually fluid and dynamic.

Moreover, there is an asymmetry in water regimes between upstream and downstream areas. Upstream processes can affect the downstream processes but not vice versa. This creates specific problems with tribunal allocations. If upstream states create a capacity capable of utilizing their share of 75 per cent dependability flow, they can trap and pre-emptively use a much higher proportion of the lean year flow than is warranted. Similarly, when water allocations are made to states, it is assumed that they will, in turn, allocate water equitably within the state. Unfortunately there is no mechanism to ensure equity within a state. In fact, there are bitter conflicts, much sharper and much larger in scope, in intra-state allocation than inter-state conflicts. For example, within Andhra Pradesh, Telangana region is fighting bitterly over 'illegal' allocations to other politically more powerful regions and an almost war-like situation exists over Pothireddy Padu, Rajolibanda, or Polavaram. Maharashtra too has many such examples. Regional disparity and backlog of water resource development in the state is severe and water is a contentious and bitterly fought issue between the backward regions of Marathwada and Vidarbha and the comparatively better-placed South Maharashtra. Focus merely on inter-state conflicts diverts attention from the core issues and converts them into an inter-state sentiment of conflict.

The complexity of the climate change adds another serious dimension to the conflict. While the precise change in periodicity and intensity of the rain fall may be disputable, all models agree on the fact that there will be an increase in extreme events (Chapter 2 of this *Report*)—extreme surpluses and extreme shortages—precisely the kind of events for which Tribunal Awards have no solution to offer. There will be no solution to water conflicts unless there is a change of approach: from an adversarial, legal approach which lays claim to a disputed property to an approach that views water as a shared resource, builds common institutions to manage it in common, and displays a spirit of dialogue, accommodation and negotiation. A change in approach is thus an urgent requirement.

First, there is a need to stop viewing the water flowing out to the sea as water going waste. This approach has led to a water management strategy that is centred solely around dams. The other important lesson is that water is a resource embedded within the ecosystems and cannot be treated as a resource that can be freely manipulated. Too many of our mega projects, whether big dams, or diversions or interlinking schemes treat water thus. This approach has done great harm to the long-term viability and sustainability of the resource itself. There is a need to change our thinking in respect of the role of large systems and dams. We need to see local water resources as the mainstay of our water system and large-scale irrigation as a stabilizing and productivity enhancing *supplement* feeding into it. For this we need to deliver water in a dispersed manner to local systems, rather than in concentrated pockets, creating ecosystem islands dependent fully on exogenous water that can only be maintained at great economic and social cost.

Another important question is that of who pays for water and how much. We need to first realize that so far it is the urban poor, the rural areas, and the ecosystems that have paid a much higher cost, directly as well as indirectly, for the water especially from public sources. There is a need to develop an appropriate pricing framework that is based on the principle of equity and affordability. Two other issues that have emerged are those of rehabilitation of project affected people and control of pollution. There is an urgent need for a policy and legal framework at the national level for the rehabilitation of project affected people. In respect to pollution, as already discussed above, we need to move towards a mix of civil and criminal penalties and also introduce environmental mediation as an active method of addressing pollution issues.

Stakeholder Interaction

The struggles and viewpoints around water issues in India are highly polarized (Joy et al. 2008). The richness and diversity of bio-physical, social, economic, and political contexts in India create a tendency of fragmentation and polarization leading to long drawn conflicts in which the losers are invariably the vulnerable and weaker sections.[10] It is important is to realize that while there are sectional interests at stake, there are wider issues on which a social consensus needs to emerge.

On the other hand, there is a need to evolve general guidelines, procedures, and institutions that will determine and regulate water use in an equitable and sustainable manner. A social consensus needs to be built that includes not only an explicit recognition of the needs of the poor and the priority they should receive but also the norms that should govern resource uses, their priorities, and responsibilities around those uses.

One such medium is multi-stakeholder platforms (MSPs) and interactions. However, if MSPs are to become meaningful and stable instruments of water governance they will need to account for the heterogeneity among stakeholders and their prior rights and will also have to be informed by an inclusive and principled approach to water sector restructuring supported by access to reliable data, information and decision support systems, and be based on an acceptable normative framework. The challenge is to evolve a consensual framework that will be inclusive enough even as it takes into account crucial concerns such as equity and sustainability.

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[10] The details of this normative framework essential for MSPs are discussed in Joy et al. (2004). See also, Rogers and Hall (2003).

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5 Water Rights and the 'New' Water Laws in India

Emerging Issues and Concerns in a Rights Based Perspective

Videh Upadhyay

Introduction

This chapter examines the status of human right to water and water rights in India today. After exploring the judicially evolved fundamental right to water, it discusses some key points on how water management and development is grounded under the Constitution of India. It goes on to identify areas to strengthen water rights in the country. It then reviews three broad areas within the 'water sector' where there has been maximum legislative activity across India since the dawn of the new century and makes some important inferences on the substance of these laws from a rights based perspective.

Right to Water and Water Rights Today

Legally, and conceptually, the human *right to water* to every person needs to be understood differently from the bundle of *water rights* available to water consumers and users in the country. Let us first examine the right to water. To the question as to whether there is a fundamental right to water for every person in India the short legal answer has to be yes. This is because such a right has been judicially evolved by the Supreme Court and various High Courts of the country over the years. The judicial creation of a fundamental right to water in India is briefly explored below.

Cases relating to Supply of Safe Drinking Water as Fundamental Right

The right to 'pollution free water' and the right of access to 'safe drinking water' has been read as a part of 'Right to Life' under Article 21 of the Constitution of India. This has been possible because of a liberal and activist interpretation of the fundamental right to life by the Supreme Court as well as the High Courts of the country in series of cases before them. After initially talking about the right to water in the context of pollution cases, courts have delivered a growing body of verdicts on the more fundamental concerns of access to drinking water and on the right to safe drinking water as a fundamental right.[1] One noticeable trend is that

[1] These cases include *Wasim Ahmed Khan* v. *Govt. of AP*, 2002 (5) ALT 526 (D.B.); *Mukesh Sharma* v. *Allahabad Nagar Nigam & Ors.*, 2000 ALL. L.J. 3077; *Diwan Singh and another*, v. *The S.D.M. and other* 2000 ALL. L.J. 273; *S.K. Garg* v. *State of UP*. 1999 ALL. L.J. 332; *Gautam Uzir & Anr.* v. *Gauhati Municipal Corpn.* 1999 (3) GLT 110.

this has happened mostly in cases where inadequate water supply to different cities was legally questioned and challenged. The context and evolution of the right in these cases are discussed below.

In a case relating to the scarcity and impurity of potable water in the city of Guwahati, it was contended that the municipal corporation is responsible for supplying sufficient drinking water.[2] The municipal corporation in its counter affidavit said that while it is well aware about its duties with regard to supply of drinking water to the citizens, due to its financial constraints it could not augment its existing plant.[3] The court made clear that 'Water, and clean water, is so essential for life. Needless to observe that it attracts the provisions of Article 21 of the Constitution'.[4] Likewise, in a petition filed by an advocate for suitable directions to ensure regular supply of water to the citizens of Allahabad, the High Court reiterated the fundamental right to drinking water.[5] The court cited with approval the Supreme Court's decision holding that the need for a decent and civilized life includes the right to food, water, and a decent environment.[6] In another case, the Supreme Court had observed, 'Drinking is the most beneficial use of water and this need is so paramount that it cannot be made subservient to any other use of water, like irrigation so that right to use of water for domestic purpose would prevail over other needs'.[7] In view of these decisions, the Allahabad High Court directed that a high powered committee be set up to look into the problem of access to water and decide on the ways and means to solve it on a war footing.[8] The Andhra Pradesh High Court reiterated this position saying that the right to safe drinking water is a fundamental right and 'cannot be denied to citizens even on the ground of paucity of funds'.[9] In this line of cases in 2006 a Public Interest Litigation (PIL) was decided by the Kerala High Court ventilating the grievances of the people of West Kochi who had been clamouring for supply of potable drinking water, for more than three decades. Noting that the petitioners 'have approached this Court as a last resort' the Court held that:

> We have no hesitation to hold that failure of the State to provide safe drinking water to the citizens in adequate quantities would amount to violation of the fundamental right to life enshrined in Article 21 of the Constitution of India and would be a violation of human rights. Therefore, every Government, which has its priorities right, should give foremost importance to providing safe drinking water even at the cost of other development programmes. Nothing shall stand in its way whether it is lack of funds or other infrastructure. Ways and means have to be found out at all costs with utmost expediency instead of restricting action in that regard to mere lip service.[10]

Incorporating Right to Safe Drinking Water directly under the Constitution

Even while the cases above make it clear that there is a judicially evolved fundamental right to water, such a right is not explicitly incorporated under the Constitution of India. The closest that we came to directly incorporating this right was when the National Commission that reviewed the Constitution recommended in its report in 2002 that a new Article 30D be inserted in the Constitution thus: *'Every person shall have the right—(a) to safe drinking water …'* That recommendation of the National Commission reiterated what the higher courts have been holding in similar words in the past few years. In that sense one may argue that the National Commission was merely recognizing a

[2] *Gautam Uzir & Anr.* V. *Gauhati Municipal Corp.* 1999 (3) GLT 110.

[3] Para 6 of the affidavit–in–opposition filed by Gauhati Municipal Corporation and quoted in 1999 (3) GLT 110.

[4] At p. 112, para 10.

[5] *S.K. Garg* v. *State of UP* 1999 ALL. L. J. 332.

[6] The Supreme Court held in *Chameli Singh* v. *State of UP* (1996) 2 SCC 549: AIR 1996 SC 1051, 'That right to live guaranteed in any civilised society implies the right to food, water, decent environment, education, medical care and shelter. These are basic human rights known to any civilised society. All civil, political, social and cultural rights enshrined in the Universal Declaration on Human Rights and Convention or under the Constitution of India cannot be exercised without these basis human rights'.

[7] *Delhi Water Supply and Sewage Disposal Undertaking* v. *State of Haryana*, (1996) 2 SCC 572: AIR 1996 SC 2992.

[8] Further, the Court said that since the matter involved technical expertise, the committee should consult experts also in this regards. If any complaints were made by the citizens of any locality that they were not getting water, the committee would look into it and do the needful. See para 9 in *S.K. Garg* v. *State of UP* 1999 ALL. L.J. 332.

[9] *Wasim Ahmed Khan* v. *Govt. of AP*, 2002 (5) ALT 526.

[10] *Vishala Kochi Kudivella Samrakshana Samithi* v. *State of Kerala*, 2006(1) KLT 919, para 3.

pre-existing right, not creating a new one! Somehow, the said recommendation of the National Commission that reviewed the Constitution, much like the Report of the Commission itself containing the recommendation, is gathering dust in New Delhi. The fact that it was the National Democratic Alliance (NDA) Government at the centre which had constituted the National Commission—and which soon went out of the government following the submission of the Report—has not helped. Even while recognizing that water is a state subject, and capable of evoking intensely political and emotive reactions, a national consensus in explicitly incorporating a fundamental right to water may not be elusive. Right to education of a child from 6–14 years age is a judicially evolved right which has been explicitly incorporated as a fundamental right under new Article 21A of the Constitution of India. There is no reason why drinking water being more fundamental than even elementary education—and similarly judicially circumstanced as education—should not follow the same route.[11]

There is another good reason as to why an explicitly recognized and well-defined right to water needs to find a direct entry into the Constitution of India. Chapter 10 of this *Report* points out, various cases before the courts confirm that the fundamental human right to water is well established. Yet, the actual content of the right has not been elaborated upon in judicial decisions. This has also meant that the judicial response to specific cases on violation of right to water can be adhoc. Even in the cases discussed above, a closer look at the verdicts can reveal fault-lines. Take, for example, the 2002 case in the High Court of Andhra Pradesh. The High Court said that the right to safe drinking water is a fundamental right and 'cannot be denied to citizens even on the ground of paucity of funds'. Then it contradicted itself. The judgement also says that though the state is under an obligation to provide at least drinking water to all its citizens, 'the limited availability of water resources as well as financial resources cannot be ignored'. The Court could have categorically declared that the state's failure to provide safe drinking water was unconstitutional. However, the judge felt that to issue such a direction would be only 'utopian'.

This judicial ambivalence explains why the *rights* regime in the country tends to be a *right without remedies* regime. In the above case while the court desisted from making a categorical declaration, it could say clean water is a fundamental right only because of the soft nature of the operative directions it ultimately made.

Need for a 'Good Quality' Right to Water

On a related note, the mere incorporation of a right need not necessarily be seen as remedy or result inducing in itself. There are three conditions for a 'good quality' human right to be effective: the right needs to be fundamental, universal, and clearly specifiable. Can the right to water in India meet the said three conditions? While the basic need for, and hence right to, water is universally accepted as a fundamental right, it has struggled to meet the test of specificity in the Indian context. This is simply because it has not been possible to specify a level below which the right to water can be said to be denied. It is for this reason that the literature on social and economic rights produced by the United Nations (UN) over the years emphasizes that all socio-economic rights subject to a regime of 'progressive realisation' can only be effective if 'minimum core obligations' are built in to them. The minimum core obligation of the state flowing from the right to water of every person has not yet been defined and specified in India either by the legislature or by the courts. Perhaps it is time to clearly recognize that a certain quantity of water (litres per capita per day or lpcd) is a most basic human need and should be seen as an inviolable part of the fundamental right to water.[12]

Explicit incorporation of a right that is fundamental and universal and, more importantly in the Indian context, clearly specifiable in terms as laid out above has the potential to catalysing changes in law and policy in the

[11] There are other countries in the world where the Constitution specifically mentions a fundamental right to water including South Africa, 'everyone has the right to have access to sufficient water' and Ecuador, 'the human right to water is fundamental and irrenounceable', amongst others.

[12] Say 40 lpcd—same as the Rajiv Gandhi National Drinking Water Mission rate to provide safe drinking water to the 'problem villages' and to the rural population—is a minimum requirement. On this specific point see Upadhyay (2003a).

area. A categorical carving out of a fundamental right to water in the Constitution of India has the potential to mobilize the people, the media, and ultimately the decision-makers. Besides, it can serve to underline the fact that ensuring a certain quantity of water to every person in the country is a non-negotiable and mandatory legal requirement. This is important given that the new national guideline for drinking water known as the National Rural Drinking Water Programme (NRDWP) states that it is necessary to 'move *ahead* from the conventional norms of litres per capita per day (lpcd) to ensure drinking water security for all in the community'. The basic unit now considered is the household, and as noted in Chapter 10 of this *Report* the key concern with the new framework is that 'the focus on the individual makes way for a focus on the household.'[13] A fundamental right to water to every person in the country making it explicit, categorical, and non-negotiable shall help to bring back the focus on every individual and will set the right legal route towards securing water security for all.

It is also often argued that given the limited financial resources of water utilities how can the incorporation of a right help work in such a scenario? In keeping with the tone and scope of the present chapter, a quick, legal, rights based answer is proffered here. As the author has noted in the past, the argument of realizing social and economic rights 'progressively' cannot be used by the government to say that its hands are tied when it comes to giving effect to its 'minimum core obligation' in respect of these rights. The fundamental rights under the Constitution of India can only be seen as representing these core obligations. Further, the rights language alone can enforce a cash-strapped, unwilling government to divert money to a cause that it never seriously paid attention to. The point here is not whether we have the resources to honour a right but whether we can shake the modest resource basket that we have, to the prioritize funding of areas more fundamental to our existence. We cannot wait for more resources to provide those conditions that honour the irreducible minimum 'right to be human'.[14] A fundamental right of access to safe drinking water squarely falls in this domain.

Water Supply and Local Self Governance in a Rights—Obligation Framework

In addition to the Constitutional space for a fundamental right of water, the other spaces relevant for water rights and management are Parts IX and IXA of the Constitution incorporated by the now famous 73rd and 74th Amendments to the Constitution of India that were brought into effect in 1993. The 73rd Amendment of the Constitution had cast a Constitutional imperative on all the state governments to come up with an appropriate *Panchayat Raj* Act detailing meaningful democratic devolution of functions, functionaries, and funds. Specifically, it empowers states to endow panchayats with such powers and authority to enable them to function as institutions of self-government and goes on to list 'Drinking Water', 'Water Management', Minor Irrigation', and Watershed Development' as subjects under the jurisdiction of panchayats.[15] In a similar vein, the 74th Amendment to the Constitution of India recognizes local self governance as an enforceable ideal and obliges the state governments to constitute urban local bodies ('ULBs').[16] The 74th Amendment also requires that 'the Legislature of a State may, by law, endow the Municipalities with such powers and authority as may be necessary to enable them to function as institutions of self-government'.[17] The 'matters that may be entrusted' to the Municipalities

[13] Cullet (2011).

[14] Upadhyay (2003b).

[15] The list can be seen under the Eleventh Schedule to the Constitution of India.

[16] The 73rd and the 74th constitutional amendments which provide for local elected bodies to 'function as institutions of self-government' in rural and urban areas, respectively are thus important landmarks in the history of Constitutional law in India.

[17] See Article 243W of the Constitution of India, relating to powers, authority, and responsibilities of municipalities. It adds that such a law may contain provisions for the devolution of powers and responsibilities upon municipalities with respect to: (i) the preparation of plans for economic development and social justice; (ii) the performance of functions and the implementation of schemes as may be entrusted to them including those in relation to the matters listed in the Twelfth Schedule.

include 'Water supply for domestic, industrial and commercial purposes', amongst others.[18]

Both the 73rd and 74th Amendments to the Constitution inspired changes in the existing state level panchayats, municipal corporation and municipal council laws so as to bring them in line with the mandate under the Constitutional Amendments. It is important to understand these refurbished state laws in a rights–obligation framework. To take one example from a state law, note the provisions of the Hyderabad Municipal Corporation Act, 1955 which provides that 'The Corporation shall make adequate provision for… the management and maintenance of all municipal water works and the construction and acquisition of new works necessary for a sufficient supply of water for public and private purposes' [Section 112 (17)] This provision is under the head titled *'Matters to be provided by the Corporation'* as distinguished from *'Matters which may be provided by Corporation at its discretion'* (Section 115) and thus it is an 'obligatory duty' of the Corporation. Interpreting this obligatory duty of a Municipal Corporation in a similarly worded 'parallel section' in the Bombay Provincial Municipal Corporation Act, 1949 the Gujarat High Court had said:

> It is therefore clear that it is an obligatory duty of the Corporation to take adequate steps for sufficient supply of water for public and private purposes within the municipal area. In other words the Corporation cannot deny the citizen … the basic amenity of supply of water which is provided to all other inhabitant(s) according to its plans. The obligatory duty is directed towards the management, maintenance and acquisition of water works to ensure a sufficient supply of water.[19]

Another aspect of the 74th Amendment to the Constitution of India is that while establishment of the ULBs is mandatory, the exact scope and extent of powers to be devolved to the ULBs is left to the discretion of the state governments. However, as the 74th Amendment was enacted with a clear view to strengthening local self governance in cities and towns, any weakening of the jurisdiction or control of the ULBs in terms of vesting of their functions to outside bodies can be seen as violation of the letter and spirit of the Constitution. This requirement should not be interpreted to mean that there can be no unbundling of municipal services, so long as they are accountable to ULBs. This aspect has been made specifically clear by the Memoranda of Agreement (MoAs) entered into by municipal corporations across the country under the Jawaharlal Nehru National Urban Renewal Mission (JNNURM) of the Ministry of Urban Development, Government of India. The JNNURM reform primers also make clear that it is possible for a municipality to arrange to provide water supply services through any agency so long as the responsibility and accountability for the service remains with the municipality. However, in a recent mid-term official appraisal of the Mission, it was found that in many states the water supply function is being carried out by parastatal agencies and mostly by State Water Supply and Sewerage Boards. Even in states showing progress on this aspect there are qualifiers. For example, in West Bengal large projects are designed and implemented by the parastatal agencies but are handed over for operation and maintenance (O&M) to the ULBs. In the same way in Ludhiana 'major' water supply and sewerage schemes vest with the Punjab Water Supply and Sewerage Board under the Punjab Water Supply and Sewerage Board Act, 1976 whereas 'minor' O&M projects vest with the Ludhiana Municipal Corporation under the Punjab Municipal Corporation Act, 1976. This is problematic as under the Statute no distinction exists between the major and minor works, thus making the classification of a project as 'major' or 'minor' arbitrary.

From the discussion so far it is critical to reconcile the fundamental right to water with the mandate for water supply and management with the rural and urban local bodies. First, both the fundamental right and the creation of rural and urban local bodies are non-negotiable, mandatory, and enforceable under

[18] See the Twelfth Schedule of the Constitution of India. Other related matters that may be entrusted to the municipalities include urban planning including town planning, planning for economic and social development; public health, sanitation conservancy, and solid waste management; safeguarding the interests of weaker sections of society, including the handicapped and mentally retarded; slum improvement and up-gradation and urban poverty alleviation.

[19] See Gujarat High Court's decision in *National Consumer's Protection Samiti and Anr* v. *State of Gujarat & Ors.* 1994 (2) GLR 1043.

the Constitution. Second, how and how much of the water supply function are taken out of parastatal agencies/water boards and how the accountability for the service remains with the panchayats/municipalities is to be worked out by the state governments. Third, in any event both the water supply and sewerage boards as well as municipal corporations/councils are 'State' within the meaning of the Constitution of India and are as of today duty-bearers obliged to honour the fundamental right to water of every person.

Towards a Group Rights Regime in Water

From the foregoing discussion another important notable aspect is that what has been recognized by the higher courts as a fundamental right is a right to each individual and not to a group. In the context of the fact that all the recent 'decentralizing' initiatives of the central and state governments have sought to vest powers to formal village groups and associations, this becomes an important point. In this context, the author feels that 'The water rights regime needs to evolve conditions under which a group entity can become a right holder so that an entity like a legally constituted village water supply committee (VWSC) or a water users' association (WUA) can exercise such rights to its advantage.… Apart from developing an understanding on the *external water rights* of the group, which it can use to its advantage against everyone outside the group, there is a need for better appreciation for *internal water rights* laying down the right of the group members vis-à-vis each other. A more mature regime on group rights in the water management sector is critical to resolving existing and potential conflicts surrounding access to and control over water resources.'[20]

Even while a more mature group rights regime in water is imperative, given the state of water laws today we are still some distance away from it. The point can be seen most clearly with respect to WUAs that have been created through a series of specific laws passed by various state governments in recent years. The next section begins with a discussion of these laws before noting down some inferences from a rights based perspective.

The New Water Laws of India in A Rights Based Perspective

Three areas within the 'water sector' where there has been maximum legislative activity across India since the dawn of the new century are laws creating WUAs, laws creating Water Resources Regulatory Authorities and state laws on groundwater management. This part makes some critical points from a rights based perspective on these set of laws before ending with a discussion about a new law creating an important right for victims of water pollution. Let us first consider the laws creating WUAs.

New State Laws Creating WUAs

Over the last two decades significant attempts have been made to involve the farmers—the beneficiaries of the irrigation canals—in O&M of the irrigation systems in India, as is the case in many parts of the developing world. Farmers' direct involvement in irrigation system management through WUAs is now almost universally seen as a lasting response to systemic inadequacies in irrigation. It is believed that where the state had failed in the past the farmers will not, and that O&M of the irrigation system by the farmers themselves can change things around. The result has been that state after state in India, and at last count 15 states, have specifically enacted new laws during the period 1997–2010, creating WUAs and supporting 'Participatory Irrigation Management (PIM)'[21] A few of these state level laws include: *The Andhra Pradesh Farmers' Management of Irrigation Systems Act, 1997; Madhya Pradesh Sinchai Prabandhan Me Krishkon Ki Bhagidari Adhiniyam, 1999; The Tamil Nadu Farmers' Management of Irrigation System Act, 2000; Kerala Irrigation and Water Conservation Act, 2003; Orissa Pani Panchayat Act, 2002; Karnataka Irrigation Amendment Act, 2003; Maharastra Management of Irrigation System by Farmers Act 2005; The Chhattisgarh Sinchai Prabandhan Me Krishkon Ki Bhagidari Adhinyam, 2006; and The Uttar Pradesh Participatory Irrigation Management Act, 2009.* Typically, all these laws empower the 'project authority'

[20] Upadhyay (2009).

[21] PIM refers to the programmes that seek to increase farmers' direct involvement in system management, either as a compliment or as a substitute for the state role.

to delineate every command area under each of the irrigation systems 'on a hydraulic basis which may be administratively viable' and declare it as water users' area. Every water users' area is to be divided into territorial constituencies. The laws then provide for establishing a democratically elected WUA for every water users' area. Every WUA is to consist of all water users who are landowners and members in such a water users' area.[22]

Notwithstanding the range of state laws empowering farmers' participation in the management of irrigation systems, it has been observed that a striking aspect of India's PIM programme is the little attention that is given to water rights. This has meant that the governments' rights to water are unchallenged, while its obligations to deliver water to WUAs are rarely legally binding.[23] The point needs some explanation here. Almost all of these laws make clear that the WUA has: (i) right to obtain information in time about water availability, opening/closing of the main canal, periods of supply and quantity of supply, closure of canals etc.; (ii) right to receive water in bulk from the irrigation department for distribution among the water users on agreed terms of equity and social justice; and also (iii) right to receive water according to an approved time schedule. However, all these laws do not make it clear what remedies might lay with the WUA if the right to receive water in bulk from the irrigation department is not honoured. In other words, whilst there is a generally worded right, there is no accountability of the department that has been established through these provisions. For this reason it has been argued above that group rights, like those of WUAs under state level laws supporting PIM, need to be strengthened and state level laws need to be revisited from this standpoint.

The other significant point from a rights based perspective is that the rights need to be located in the system. Thus, merely saying that rights exist with WUAs will not be enough if the irrigation systems are not properly rehabilitated to be in such a condition where minimum water flow can be maintained. In a recent study the author opined that given the state of irrigation systems there are at least two minimum conditions that need to be specifically put down as essential first steps in the laws as the way ahead.[24] First, with the existing legally empowered WUAs the irrigation departments across states need to carry out time-bound joint inspection of the irrigation canals followed by identification and execution of priority works for rehabilitation of the existing canal systems. This needs to be put down as an essential non-negotiable right of the WUAs because without these talking about their water rights is really putting the cart before the horse. Second, to ensure that a fully functioning turned-over system maintains the water flow in it, the minimum water entitlement of the WUA needs to be built into the laws so that a total volume of water is guaranteed to be supplied to a WUA at agreed points of supply. In other words, before talking about the *water rights* of the WUAs and the water users their *right to water* needs to be honoured. The state of Maharashtra has already taken a lead in this regard in the recently enacted *Maharashtra Management of Irrigation System by Farmers Act 2005* by building in such water entitlements in the Act.

Even though the laws creating WUAs have come up one after another, there has been no systematic study on how farmer irrigation rights could have been perhaps better informed and defined under these new laws by learning from previous efforts at empowering farmers under the policy and legal regimes in the first five decades of Independent India. In this sense one feels that the new laws have at best responded to a management history of irrigation in India and not to the legislative history. While the states have aimed

[22] These farmer bodies have typical functions like: (i) preparing and implementing a *warabandi* schedule for each irrigation season, (ii) preparing a plan for the maintenance, extension, improvement, renovation, and modernization of irrigation system, (iii) regulating the use of water among the various outlets under its area of operation, (iv) maintaining a register of landowners as published by the revenue department, (v) monitoring the flow of water for irrigation, (vi) resolving the disputes if any, between its members and water users in its area of operation.

[23] Mosse (2003). The author adds: The result (of this position on rights) has been that the government may have lost little control over irrigation resources, and arguably, in establishing registered WUAs has retained its rights and also acquired a new mechanism to extend its influence in rural society.

[24] Upadhyay (2010).

at creating legislative intent for PIM they have not yet decided on how to deal with existing legislative intents that run contrary to the spirit of PIM and that still continue to be part of the law of the land.[25]

State Water Resources Regulatory Authority and 'Water Entitlements'

Laws creating Water Resources Regulatory Authority Acts have been discussed in detail in this volume (see Chapter 21) and are thus not discussed in any detail in this chapter. Suffice it to say that a pioneer and precursor of these laws has been the *Maharashtra Water Resources Regulatory Authority Act, 2005* (MWRRA). Since then Arunachal Pradesh in 2006 and Uttar Pradesh in 2008 have enacted similar laws. The MWRRA, like the other state laws, defines roles, responsibilities, and powers of the Water Resources Regulatory Authority which is to be set up under the Act. It empowers the Authority *inter alia* to make a state water-use plan, assign priority for use of water, determine water allocations to various users, prevent people not allotted water allocations from using it, regulate owners of lift irrigation equipments (after five years from the date of coming in force); it also requires all drilling contractors to register, and requires prior permission before drilling new tube wells.

A popular claim that MWRRA is creating a water entitlement regime merits closer scrutiny for the present purpose. True, the Act creates a high powered State Water Resource Regulatory Authority which is to oversee the issuance and distribution of water entitlements by designated river basin agencies and, among other things, is also responsible *for fixing the criteria for trading of water entitlements or quotas on annual or seasonal basis by a water entitlement holder*. However, having explicitly equated entitlements with quotas the Act makes sure that neither the Authority nor the river basin agencies can ever be questioned on the extent of distribution of these entitlements, creating a strange fiction—a system where 'entitlements' exist without corresponding obligations to ensure that one receives them! Legally speaking, an entitlement is something that one 'has a title to', and more importantly, has this title as a matter of right, that is, a *right to demand and receive*. The new legislations in the water and irrigation sectors never as a rule create any enforceable right to water for farmers or other water users.

The Evolving Groundwater Law Regime for the Twenty-first Century

The third legislatively active area in the last decade has been groundwater.[26] Before these last ten years or so, only a few states in India had enacted specific groundwater legislation. These laws apply in restricted areas, have limited purposes and generally suffer from a low level of implementation. Most tend to include: (i) restriction of the depth of wells/bore wells/tube wells and (ii) declaration of groundwater conservation and protection zones, especially around sources of drinking water. The implementation of those provisions, including all actions to be taken under these Acts, generally rested with the district collector with no specific role therein for village/community level institutions. The 'new' laws of the decade retain all these basic features. These include *The Karnataka Ground Water (Regulation for protection of sources of drinking water) Act, 1999; The Kerala Ground Water (Control and Regulation) Act, 2002; The Andhra Pradesh Water, Land and Trees Act, 2002*; *The West Bengal Ground Water Resources (Management, Control and Regulation) Act, 2005; The Himachal Pradesh Ground Water (Regulation and*

[25] The empowering visions under the best of new legislations seeking to vest powers with the WUAs can be given legal effect only if specific pre-existing laws relating to the subject recognize the space and the mandate of these associations. This is because the new laws make clear that they are to be read in conjunction with the State Irrigation Acts and shall not 'override' them.

[26] It is pertinent to point out that in pursuance of a specific order of the Supreme Court of India, the Ministry of Environment and Forest, Government of India constituted the Central Ground Water Authority (CGWA) as an authority under the Environment (Protection) Act, 1986 to regulate over-exploitation of underground water in the country. (The Order of the Supreme Court was in *M.C. Mehta* vs. *Union of India 1997* (11) SCC 312). Specifically, the CGWA is required to regulate indiscriminate boring and withdrawal of groundwater and to issue necessary regulatory directions in this regard. The authority functions under the administrative control of the Union Ministry of Water Resources and has jurisdiction over the whole of India. In addition, the Government of India had formulated a draft model bill in the year 1970 for regulation of groundwater which was revised thrice in 1992, 1996, and in 2005. However, the proposed groundwater bill has not become law for various reasons.

Control of Development and Management) Act, 2005. One essential feature of these laws is that they create a groundwater authority at the state level.

The Himachal Pradesh Ground Water (Regulation and Control of Development and Management) Act, 2005 has some useful additional provisions as well. For example, the Act says that every user of groundwater in a notified area shall pay to the state government a royalty for extraction of groundwater at such rates and in such manner as may be prescribed. However, a user of groundwater who irrigates less than one hectare of land, whether owned or leased or both, shall be exempted from payment of royalties. Further, the Authority may, in order to improve the groundwater situation, identify the areas of groundwater recharge and issue guidelines for adoption of rain-water harvesting for groundwater recharge in such areas.

Two critical cross-cutting points from the various state groundwater laws deserve close appreciation. First, as Philippe Cullet points out, '… most of these acts avoid altogether the thorniest question which is the legal status of groundwater itself.'[27] Historically and legally, groundwater is considered an easement connected to the land.[28] Thus traditionally the owner of land had an unrestricted right to use the groundwater beneath it. However, that position has changed substantially in recent years. In fact, the Andhra High Court has made expressly clear in 2002 that 'Deep Underground Water' is the property of the state under the doctrine of Public Trust.[29] The holder of land has only a user right towards the drawing of water in tube wells. Thus neither his action nor his activity can in any way harm his neighbours and any 'such act would violate Article 21 of the Constitution.' This legal premise can be seen as the implicit basis for all the recent state groundwater laws setting up institutions that can regulate groundwater use. Thus notwithstanding the failure of the new laws to explicitly make clear the legal status of groundwater, the nature of these laws itself seems to make it clear that *Deep Underground Water is the property of the State under the doctrine of Public Trust*. This alone provides the explanation behind the power of the state in Himachal Pradesh to extract royalty from every user of groundwater in a notified area. The second obvious point from these laws is that, notwithstanding the mandate under the 73rd and the 74th Amendment to the Constitution of India (discussed above), virtually no effort has been made to vest any power—even limited management or monitoring powers—to the local rural and urban local bodies. West Bengal has a limited policy like provision requiring the State Level Authority to 'organise people's participation and involvement in planning and actual management of ground water resources' but there is nothing beyond this in the state laws. This is contrary to the buzz around 'demand orientation' and 'people orientation' more obvious in areas like rural water supply and irrigation management. In fact, in 1999 a Working Group on Legal, Institutional, and Financing Aspects constituted by the Union Ministry of Water Resources, Government of India in the context of widespread alienation with the 'Command and Control' mechanism under the Central Model Groundwater law had suggested that the best option is to introduce participatory processes in groundwater management in which the role of the state could be that of a facilitator and the role of the user organization/panchayat as that of an implementing regulatory agency.[30] In this context a famous test case on a village panchayat's efforts to regulate groundwater withdrawal that is pending today with the Supreme Court for final hearing is discussed in Box 5.1.

[27] Cullet (2009: 130).

[28] Section 4 of the Indian Easement Act, 1882 defines an easement as 'A right which the owner of occupier of certain land possesses, as such, for the beneficial enjoyment of that land, to do and continue to do something, or to prevent and continue to prevent something being done, in or upon, or in respect of certain other land not his own.'

[29] *M.P. Rambabu* v. *District Forest Officer*, AIR 2002 A.P. 256.

[30] In this context, the Working Group specifically suggests that in 'dark' and 'over-exploited areas' the gram sabha as a whole may decide on groundwater management; where villages are large, the sabha could be formed for smaller areas; the use of groundwater for irrigation and sale of groundwater should be approved by the village community; the central and state groundwater officials may be required to extend full cooperation, rendering technical service and advice to the village communities.

Box 5.1
Legal Battle over Groundwater between a Panchayat and a Soft Drink Major: Intriguing Issues in Water and Democracy

The relentless battle of a Kerala panchayat to stop a soft drink major from drawing huge quantity of local groundwater for its bottling plant reached the Supreme Court in 2005 with the court issuing notice to Coca Cola on the panchayat's plea. The panchayat appealed a decision of the Kerala High Court where the High Court had ruled that the panchayat's rejection of Coca Cola's application for renewal of license to extract groundwater was untenable in law (April 2005). While basing its verdict on scientific data provided by the court appointed multi-agency expert committee, the court concluded that the findings of the committee that the factory could safely be permitted to withdraw 5 lakh litres of water a day appears 'fair, authentic, mature and therefore acceptable'.

Notably, in pronouncing the verdict, the Division Bench of the High Court overturned a single bench ruling of the same high court on the case 14 months earlier (16 December 2003). The judge had then held that the government, holding public property of groundwater in trust, had no right to allow a private party to overexploit the resources to the detriment of the people.

The April 2005 judgement of the Division Bench of the High Court stated: The industry has the right to receive water 'without inconveniencing others'; 'We hold that ordinarily a person has the right to draw water in reasonable limits'; 'There is a need to do balancing of ecological rhythm with aspirations of the people in the locality'; and finally, the findings of the single judge 'might not be practical'. In the era of a categorical Constitutional commitment to genuine local self-governance, the moot question is who should decide what is convenient in villages, what is reasonable, what popular aspirations are, and what is practical? Further, if higher courts overrule an elected panchayat's decision, does it suggest that democratic decisions are per se not just? The case is an interesting intersection of democracy, justice, and environment and it is clear that the Supreme Court verdict, as and when it comes, has the potential to refine and settle the law on groundwater in India.

Sources: Upadhyay (2005); *Perumatty Grama Panchayat* v. *State of Kerela*, 2004(1) KLT 731; *Hindustan Coca-Cola Beverages (P) Ltd* v. *Perumatty Gram Panchayat*, 2005(2) KLT 554.

Green Tribunal to Introduce 'New' Legal Approach to Prevent Water Pollution

We now discuss a recently enacted law, that for the first time recognizes the right of the victims of environmental damage and pollution, including water pollution, to claim damages and compensation. The National Green Tribunal Act, 2010 that came into being as a law in June 2010 for the first time vests the power in a Tribunal to provide for 'relief and compensation to the victims of pollution and other environmental damage', 'for restitution of property damaged' and 'restitution of environment' (Section 15). The Schedule appended to the Act makes it clear that the National Green Tribunal shall have jurisdiction over cases and violations under the Water (Prevention and Control of Pollution) Act, 1974. Thus the Act creates an enforceable right to claim damages and compensation for all victims of water pollution. This is a sharp departure from the provisions under the existing Water (Prevention and Control of Pollution) Act, 1974 where apart from closing down a polluting industry, cutting its water and power supply, and criminal punishment for those responsible for running it there was simply no right available to the victims of water pollution. The National Green Tribunal Act, 2010 introduces such an enforceable right. The Tribunal is likely to become functional later this year and the way it shapes law and jurisprudence in this area remains to be seen.

Conclusion

To conclude, some of the points made in the chapter may be recapitulated. The judicial creation of a fundamental right to water in India has been significant but in specific cases the judicial approach can be adhoc and with fault lines embedded in it. This, and other good reasons outlined in the first part of the chapter, suggest as to why an explicitly recognized and well-defined right to water needs to find a direct entry into the Constitution of India. We need to put behind us a certain judicial ambivalence that threatens to reduce a *rights* regime to a *right without remedies* regime. The minimum core obligation of the state flowing from the right to water of every person has not yet been defined and specified in India either by the legislature or by the courts. It is felt that the time to do that is here and now.

It is also critical to reconcile the fundamental right to water with the mandate for water supply and management with the rural and urban local bodies. Amongst other things, this should make obvious the fact that municipal corporations/councils are duty-bearers who are obliged to honour the fundamental right to water of every person. Also, in the context of the fact that all the recent decentralizing' government initiatives have sought to vest powers informal village groups/ associations, the water rights regime needs to evolve conditions under which a group entity can become a true right holder so that an entity like a legally constituted VWSC or a WUA can enforce such rights. Even while a more mature group rights regime in water is imperative one feels that given the state of water laws we are still some distance and time away from it and a lot of work needs to be done. The critical emerging issues to be addressed on the way ahead (in their specific contexts) have already been explained through a review of new water laws of the last ten years or so and thus need not be restated here.

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Section II

Rural

6 Past, Present, and the Future of Canal Irrigation in India

Tushaar Shah

Introduction

At the beginning of the eighteenth century, India was the 'irrigation champion' of the world. While the colonial government initially neglected the maintenance and upkeep of the numerous but mostly small irrigation structures, it soon spotted the potential for large-scale canal irrigation as an economic enterprise and took to canal building as a business on a massive scale. In those days, there was much dissatisfaction with irrigation management among observers and investors who expected much higher financial return on irrigation investments. Yet, in retrospect, around AD 1900, canal irrigation systems in India were arguably in a far better state than today in terms of their operation and maintenance (O&M), productivity impacts, and financial returns. If we look at the situation ten years ago, around 2000, while the new welfare state had kept alive the colonial tradition of big time canal construction, the management of canal irrigation had become pathetic in terms of all the criteria on which it excelled a century ago. The dominant view about the way out is that farmer management through water user associations can restore canal irrigation to its old glory. However, this may not be the correct thinking. This chapter argues that the larger socio-technical fundamentals in which canal irrigation can thrive in a smallholder agrarian setting were all mostly present around 1900 and are all mostly absent today. The motives for irrigation building have changed, as has the politics around it as well as the nature of the Indian state and society. Most of all, the veritable and pervasive groundwater boom in Indian agriculture during recent decades raises questions about the relevance of traditional canal irrigation for Indian farmers who want on-demand irrigation, all round the year. Canal irrigation policy can chart several alternate courses in the future, of which four are explored in this chapter: (i) continue in a business-as-usual mode, keep throwing good money after bad, and decline into irrelevance; (ii) maximize the areal extent of conjunctive use of surface and groundwater by truly functioning as extensive irrigation systems as they were originally designed; (iii) reform the irrigation bureaucracies for greater professionalism, accountability, and performance orientation; (iv) reconfigure public irrigation systems as hybrid systems in which the irrigation departments are responsible for reliable bulk water deliveries and private irrigation service providers (ISPs) retail the water to irrigators. Some of (iii) and (iv) is already happening, but by sheer default, rather than by design. Public irrigation can serve the country far better if a considered strategy of reinventing the role of reservoirs and canal distribution is pursued in today's changed context. For this to happen, the first step is to establish a credible information and monitoring system to assess public irrigation performance against its design and current objectives.

Canal Irrigation in India *c.* 1900

Gravity flow irrigation is central to Indian social history. According to Alfred Deakin (*The Age*, 1891), during the late 1900s, the region had 12 million hectares (ha) of irrigated land compared with 3 million ha in the United States, 2 million ha in Egypt, 1.5 million ha in Italy, and a few hundred thousand ha each in Ceylon, France, Spain, and Victoria (Australia). Canal irrigation experienced its most rapid expansion in India during the last years of the nineteenth century.

In its big-time irrigation construction, the British irrigation enterprise revived, rehabilitated, and built upon the irrigation canals that lay in disrepair during the early decades of the Company rule. Colonial investment in canal irrigation consistently yielded 8–10 per cent return on investment right until 1945 (Whitcombe 2005). Whitcombe estimated that between 1912–13 and 1945–6, irrigation investments of the Government of British India returned a net profit, increasing from 8.3 per cent on productive works and 4.5 per cent on all major works in 1912–13 to 12.8 per cent on productive works and 7.2 per cent on all major works in 1945–6. This calculation, based only on water charges collected, did not include the higher revenue assessment on irrigated land.

The key was intensive revenue management through an elaborate but low-cost irrigation administration appropriate for large irrigation systems but useless for myriad small, community-based water harvesting and irrigation structures. For government schemes, to collect irrigation fees and manage water distribution at the village level and above, the colonial government maintained a large irrigation bureaucracy. Even with an elaborate administrative apparatus, wherever possible, the government outsourced water distribution to large land holders who received water from public systems in their private distribution canals. Private canals were a substantial source of irrigation in the irrigated area in colonial north-western India. In 1943–4, nearly 500,000 acres in British Punjab were irrigated by private canals captive to one or a few farmers. In Shahpur district, where the government encouraged construction of private canals, all the canals were owned by just two families, Noon and Tiwana (Islam 1997: 36). Apart from these super-sized farm holdings, even ordinary irrigators had much larger holdings of 50 to 540 acres (Ibid.: 83). These relatively large landholdings made irrigation management below the outlet easier than it is today.

The colonial irrigation management was thus a high-input-high-output affair. A vast authoritarian bureaucracy reaching down to the village level used forced labour to maintain canal network, managed water distribution, and undertook ruthless water fee recovery on all lands *deemed* to be irrigated. In the canal commands, the canal water 'tax had to be paid regardless of whether or not use was made of the canal in a particular year or whether or not there was a reliable supply from the canal' (Hardiman 2002: 114). This, according to Hardiman, encouraged, even forced, farmers to grow valuable commercial crops to generate cash. It also resulted in much litigation from dissatisfied *zamindars* who put pressure on canal managers to ensure water delivery and maintain canals. The amounts provided for O&M were substantial so that deferred maintenance was minimal.

A hundred years later, the finances of canal irrigation in post-colonial India stood in stark contrast as summarized in Table 6.1. Around 2006, India's Central Water Commission (CWC) reported that the water fee realized by all major and medium irrigation projects was all of 8.8 per cent of the 'working expenses' during 1993–7 and the ratio had declined further to 6.2 per cent during 1998–2002 (CWC 2006) compared to 2.5 to 3 times of water expenses around 1900. During 1961–2001, the capital outlay on major and medium irrigation schemes at 2000 prices was approximately Rs 295,000 crore (Amarasinghe and Xenarios 2009). In 2005, the World Bank estimated that some Rs 19,000 crores should be provided for maintenance of irrigation infrastructure but only Rs 2820 crore (0.1 per cent of capital cost) was spent on maintaining these public irrigation assets; water fee recovered from irrigators was all of Rs 652 crore, less than 10 per cent of the 'working expenses' of Rs 8250 crore (CWC 2006: Table A1).

As a commercial venture, the performance of canal irrigation has decidedly declined over the past 100 years. D.R. Gadgil, the pioneer of Indian economic planning, had argued that, in a poor agrarian economy like India, public irrigation investments should be judged on their social and economic returns rather than their financial returns. As if on cue, soon after Independence, irrigation charges were drastically reduced; and even these

Table 6.1 Deteriorating Finances of Indian Canal Irrigation, AD 1900 compared with AD 2000

		Major and medium systems in British India, 1902–3	*Major, medium, and multi-purpose irrigation Projects in India*		*Major and medium irrigation systems in India, 2001*
			1977–8	*1986–7*	
1	Capital investment in major and medium projects (nominal)	£ 30 million	Rs 3004 crore	Rs 26014 crore†	Rs 295,000 crore
2	Area irrigated by all government schemes (m ha)	7.4	18.75	25.33‡	18
3	Water fees collected as per cent of capital investment	10 per cent	1.43 per cent	0.3#	0.2 per cent
4	Value of crops irrigated as per cent of capital investment	87 per cent	na	Na	18.3 per cent*
5	Water fees collected as per cent of value of crops irrigated	11 per cent	Na	2 per centΨ	1.2 per cent
6	Water fee collected as per cent of Working Expenses	280 per cent	45 per cent	20 per centΩ	7.9 per cent
7	Maintenance expenditure as per cent of working expenditure	53 per cent	42 per cent	38 per cent	34 per cent
8	Maintenance expenditure as per cent of capital investment	2.6 per cent	na	Na	0.95 per cent

Source: Data for 1902–3 from Buckley (1905); for 1977–8 and 1986–7 from Government of India [GoI] (1992); for 2001 from CWG (2006).

Notes: † GoI (1992: Annexure 1.5).This includes around 215 BCM of reservoir storage, and around 80 BCM in run-off the river system plus thousands of large irrigation tanks and *ahar-pyne* systems.

‡ GoI (1992: Annexure 1.7-A).

Computed using irrigation charges collected (as in GoI 1992: Table 2.6) as percentage of capital investment (in row 3).

* Assuming 18 million ha of canal irrigated area growing crops worth Rs 30,000/ha at 2000–1 prices.

Ψ GoI (1992: 2.25). 'The Irrigation Commission had suggested that water rates should be fixed at around 5 per cent of gross income for food crops and 12 per cent for cash crops. At present, the actual gross receipts per ha of area irrigated by major and medium projects is barely 2 per cent of the estimated gross output per ha of irrigated area, and less than 4 per cent of the difference between output per ha of irrigated and unirrigated areas.'

Ω Computed from GoI (1992: Table 2.6).

remained increasingly uncollected. Around 1930, irrigation fees were the largest source of government revenue in Punjab, higher than even income tax (Islam 1997); but these declined rapidly after 1950. By 1960, the scenario throughout the country had changed drastically for the worse. In a study of Bihar, Bhatia (1991) showed that irrigation dues in 1960 were so small that it made eminent sense to relocate the 5000-strong force deployed in collection elsewhere and abolish the irrigation fees altogether. This trend continued in other states where irrigation fees remained stagnant for decades; and the proportion of total demand actually collected declined to a small fraction. Have public irrigation investments in free India delivered the irrigation—and the socio-economic returns—they were designed for as Gadgil had hoped?

Unfortunately, the answer to the question is 'No'; and there lies the heart of the problem. The financial rot was the harbinger of a much deeper crisis of stagnation and decline in public irrigation systems whose social and economic returns turned out to be far smaller than imagined. In one of the earliest reviews in the mid-1980s, Daines and Pawar (1987: 2) noted that 'most investments in existing large public surface irrigation systems have had rather low economic rates of return in the range of 4–12 per cent'. Many factors explain this decline, but four are the most important: first, all-round deterioration in planning and management of public irrigation at all levels; second, failure to anticipate and adapt to the rising tide of pump irrigation from surface and groundwater, within and outside the command areas; third, the resultant reorganization of India's irrigation economy; and fourth, the challenge of performance management of public irrigation systems in the new irrigation economy.

Decline in Public Irrigation Management Performance

Researchers writing during the 1980s noted that surface irrigation systems tended to always be perennially underutilized, and typically only a fraction of the designed command was actually irrigated soon after the completion (Daines and Pawar 1987). The key problem, many observers noted, was poor maintenance and system management, especially below the outlet. Repetto (1986: 4) foresaw the problem when he wrote that 'public irrigation systems themselves are sinking under their managerial, economic and environmental problems.' And David Seckler, another keen observer of the Indian irrigation scene, wrote: 'As the rug of irrigation development is rolled out ahead through construction of new facilities, it will roll up behind through poor maintenance and management of existing facilities' (cited in Wade 1984: 286). Without understanding the larger malaise, donors pumped in large volumes of funds in the name of 'rehabilitation and modernization' which led to throwing good money after bad. The colonial irrigation's ethos of 'build–manage–generate surpluses–maintain' gave way to a 'build–neglect–rebuild' syndrome.

The reality of an Indian irrigation system is that it never seems to conform to its design. Most were overdesigned to pass the cost–benefit test; and once constructed, anarchy followed in the command areas. Everywhere, the central problem is 'unauthorized' over-appropriation of water by head-reach farmers for growing crops that irrigation planners had never expected them to grow. Most Indian irrigation systems were mostly designed for protective irrigation over large areas; moreover, they assumed 'that farmers will stick to subsistence production of food crops, when supplementary irrigation is made available to them' (Jurriens et al. 1996). But reality never conformed to this plan. Systems designed for irrigated dry crops—as in Karnataka's Tungbhadra canal—collapsed into rice irrigation systems. As a result, the original goal of providing protective irrigation over large areas was defeated (Mollinga 2003). In the north-western systems, as in Haryana, researchers found the much-celebrated *warabandi* (rotational water supply) system—designed to minimize head–tail inequity—eroded beyond redemption; the same has been found for the Indus system in Pakistan (Jurriens et al. 1996; van Halsema 2002) and elsewhere in monsoon Asia where it has been tried (Rice 1996). There are still some regions in India, where such a system is still operational but it is increasingly being threatened. Under the *warabandi,* every farmer is supposed to get equal number of water turns, for equal time, per unit of land. Shah (2003) found high levels of flow irrigation deprivation at the tail-ends during monsoon as well as winter seasons in *warabandi* areas (Table 6.2).[1] As a result, the periphery of the design command increasingly began to rely on groundwater for irrigation.

A number of studies based on micro-level data indicate that decline in the performance of the irrigation administration, strong construction orientation and low O&M orientation of the irrigation bureaucracy, political influence on design and management, institutional vacuum below the minor canals have contributed to the decline in canal irrigation. Even more important than these is the emergence of a vast pump irrigation economy in which scavenging water from any proximate source—ground or surface—has taken precedence over orderly gravity flow irrigation.

Rise of the Water Scavenging Irrigation Economy

When canal irrigation first started in the Indo-Gangetic basin, a large number of wells fell into disuse. Dhawan

[1] The Haryana study defined flow irrigation deprivation as 50 per cent or less of canal irrigation received by the best-off farmer in a watercourse.

TABLE 6.2 Extent of Irrigation Deprivation Levels of Tail-enders in Selected Gravity Flow Irrigation Projects in India

States	*Names and type of systems studied*	*Extent of flow irrigation deprivation (FID) (per cent)*
Gujarat	Dharoi-Major; Mahi Right Bank-Major;	7–37
Haryana	Western Yamuna-Major; Bhakra-Major	56–84
Karnataka	Tungabhadra system-Major; Vanivilas, Medium; Two tanks-Minor	40–91
Maharashtra	Mula-Major; Walen tank-Minor	29–70
Orissa	Hirakud-Major	35–72
Tamilnadu	Parambikulam Aliyar-Major; Two rainfed tanks-Minor	24–55

Source: Shah (2003).

(1996: 537) called this the 'substitutional effect' of public irrigation works which caused amongst farmers, well-placed in new command areas, a 'disinclination even to maintain their own sources of irrigation of pre-canal vintage, not to mention that they drastically cut back on new investments in such means of irrigation'.

However, today, pump irrigation from groundwater wells as well as directly from canals is rampant in Indian systems, leaving surface irrigation systems reconfigured and their command areas redrawn. Where gravity flow once crowded out wells, the opposite is the case today; proliferation of irrigation wells in many canal commands has turned what were irrigation canals into recharge canals. In the course of a field visit to the *Guhai* irrigation system in North Gujarat, we found that most farmers irrigate 35–45 times in a year, but the canal releases are available only 3–4 times. The Guhai system meets only a small fraction of the direct irrigation demand; yet it is highly valued by command area farmers because it contributes more recharge than the rainfall (Shah 2010). Flow irrigation from tanks, used for centuries to grow rice, especially in southern India, is rapidly shrinking with the growing profusion of wells in tank commands. According to Selvarajan (2002), Andhra Pradesh, Tamil Nadu, Karnataka, and Orissa, which together accounted for 60 per cent of India's tank-irrigated area, lost about 37 per cent of the tank-irrigated area from 1965 to 2000.

Wells replacing tanks and *ahar-pyne* structures was understandable. But during the 1990s, they began to do the same to major and medium canal irrigation systems. In the Bhakra command in North-west India, canal irrigation at first drove out wells. However, since the 1990s, the trend has been reversed (Dharmadhikari 2005), and now, 75 per cent of all irrigated areas in Indian Punjab depend upon well and tube well irrigation (Singh 2006, citing a Government of Punjab 2005 document). This is happening at the national scale too (Selvarajan 2002; Thakkar 1999: 19). Comparing land-use statistics for India, Janakarajan and Moench (2006) noted that between 1996–7 and 2002–3, the area under canal irrigation declined by 2.4 million ha (13.8 per cent), the area under tank irrigation fell by 1.4 million ha (42.4 per cent), and the area irrigated by all other sources declined by 1 million ha (28 per cent). The only irrigation source that increased its share was groundwater wells, by 2.8 million ha (more than 9 per cent). Comparing the minor irrigation census data for 1993–4 and for 2000–1 suggests that in the seven intervening years in those states common to both the censuses,[2] surface irrigation systems lost 4.6 million ha (29.4 per cent) from their command, roughly at the rate of 0.65 million ha per year. Groundwater-irrigated areas grew during the same period by 4.35 million ha.

To reverse the deceleration in canal irrigated areas, the Government of India instituted the Accelerated Irrigation Benefits Programme to step up the investment in the last-mile projects. More than US$ 7.5 billion has been invested in these projects since 1997.

[2] Andhra Pradesh, Arunachal, Bihar and Jharkhand, Goa, Himachal Pradesh, Madhya Pradesh and Chhattisgarh, Orissa, Punjab, Rajasthan, Uttar Pradesh and Uttaranchal, West Bengal, Gujarat, and Maharashtra.

However, instead of acceleration, public irrigation command areas have continued to decelerate during this period. A recent study of 210 major and medium irrigation projects by a Delhi NGO used data from the Ministry of Agriculture to show that after investing Rs 130,000 crore, these projects delivered 2.4 million ha less irrigation during 1990–01 to 2006–7. Similar results were obtained by comparing the data from three minor irrigation censuses. The public irrigation policy seems unhelpful as governments have to invest twice as fast in canal irrigation projects every year just to keep their command areas from shrinking, as Figure 6.1 suggests.

Changing Organization of India's Irrigation Economy

All this suggests that India's irrigation economy is in the throes of a massive transformation; and public irrigation systems are losing their position of dominance in this changing playing field. Wallach, writing about the Nagarjunsagar project in Andhra Pradesh during the 1980s spoke of the Indian reality that 'dams and canals are splendid monuments, but as water distribution systems they are rarely able to deliver water to more than half of their commands'.[3]

In contrast, the pump irrigation economy is spreading faster than previously imagined, especially since 1990. Fifty years ago, rural India had a clear water-divide: most irrigated area was concentrated within canal commands and there was little irrigation outside. But that is not so any longer. An all-India National Sample Survey (NSS) survey of 78,990 farm households in 1998 showed hardly any difference in the average gross area irrigated per sample household in villages with government canals (1.8 ha) and those without government canals (1.69 ha). It found: 'a marked rise in privately owned irrigation facilities … (and that a) large part of the cultivated land today is irrigated by hiring pumpsets' (National Sample Survey Organization, NSSO 1999: 39). A 2002–3 survey of 51,770 farm households from 6638 villages around India showed that 69 per cent of the sample area irrigated

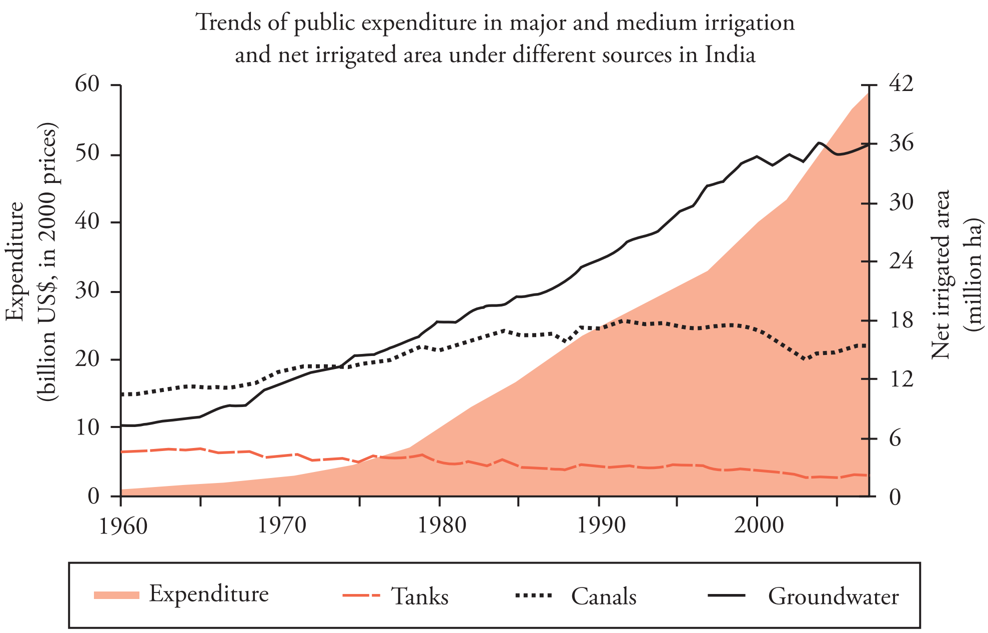

Figure 6.1 Accelerating Investment and Decelerating Irrigation Benefits

Source: IWMI (2009).

[3] http://ags.ou.edu/~bwallach/documents/Krishna%20Basin.pdf last accessed on 30 October 2009.

in *kharif* and 76.5 per cent in *rabi* was served by wells and tube wells (NSSO 2005). Yet another large-scale NSSO (2003) survey found that in 2002, 76 per cent of the 4646 villages surveyed had irrigation facilities, but mostly in the form of tube wells. Of villages that reported having irrigation facilities, 76.2 per cent were irrigated by tube wells. The CWC claims that over 30 million ha are irrigated by canals. All other sources suggest that this figure is around 15 million ha; and that the pump irrigation economy reaches supplemental irrigation to an undetermined area anywhere between 30 and 90 million ha, depending upon the data source (see Table 6.3).

Parameters for Performance Management

Finally, a major driver of the declining performance of public irrigation projects is the difficulty in assessing their performance. During colonial times, when water rates were high and vigorously collected, total irrigation fee collection and financial returns offered a robust surrogate of performance. But today, irrigation fee collection tells us nothing about the performance of the irrigation management. Land use survey data are challenged by irrigation managers on the pretext that farmers under-report canal irrigated area to avoid paying water charges. Remote sensing maps can help assess total irrigated area in a command but not by source. The difficulty of measuring the performance of public irrigation management poses a formidable obstacle in the challenge of performance improvement.

To understand the persistently poor performance of major and medium projects, the Government of India commissioned the four Indian Institutes of Management (IIMs) to undertake an in-depth study of the issues involved. The question they posed was: why is the gap between irrigation potential created and

Table 6.3 Various Estimates of Area Irrigated by Canals and Wells in India, *C.* 2000

		Data for year	*Major and Medium Schemes*	*Groundwater*	*Other sources*
1	Minor Irrigation Census, October 2005, Net area irrigated†	2000–1	10.23 m ha	30.5 m ha	5.71 m ha
2	NSSO 59th Round‡	January–December 2003			
2a	Percentage of net area sown in kharif irrigated by: Estimated kharif area irrigated by:#		7.75 per cent 8.37 m ha	28.95 per cent 31.3 m ha	5.55 per cent 5.99 m ha
2b	Percentage of net area sown in rabi irrigated by: Estimated rabi area irrigated by: Estimated gross area irrigated by:		7.68 per cent 7.83 m ha 16.2 m ha	42.86 per cent 43.7 m ha 75 m ha	5.79 5.91 m ha 11.9 m ha
3	Ministry of Agriculture, GoINet area irrigated by different sources	2001–2	15.9 m ha	35.04 m ha	7.59 m ha
4	CWC	2001–2	31.3 m ha	35 m ha	
5	IWMI global irrigated area map using remote sensing data (gross area irrigated)*	2004–5	55 m haΨ	91 m haΩ	

Notes: † From the Abstract of information from GoI (2005), Village Schedule, Table 6.1, p. 321.

‡ GoI (2005: Table 3.4.1). This survey covered 51,770 farming households from 6638 villages around India.

Kharif cropped area in 2002–3 was 108 million ha and rabi cropped area was 102 million ha. See (NSSO 2005) http://www.mospi.gov.in/press_note_nsso_31august06.htm

* Thenkabail et al. (2006).

Ψ Conjunctive use areas in command of major and medium irrigation systems.

Ω Gross area irrigated by groundwater structures, small tanks, and other sources outside the command areas of major and medium irrigation systems.

the area actually irrigated by public systems widening?[4] Regrettably, the question itself was trivial and produced a trivial answer. The question is trivial because the 'irrigation potential' is defined simply as the 'presumed' volume of water expected in the reservoir divided by a 'presumed' irrigation delta required for a 'presumed' cropping pattern, totally overlooking the ground reality of Indian canal irrigation. In no Indian irrigation system do the real values of these variables approach their presumed values which in any case are arguably the numbers chosen to justify project investment rather than honestly considered estimates. The gap between potential created and area irrigated is thus a good indicator of poor planning of irrigation projects rather than of canal irrigation performance. Researchers really interested in the performance of public irrigation projects ask different questions and, therefore, get different, often more insightful answers.

From the viewpoint of irrigators, the performance of an irrigation system is judged by the level of water control it offers to farmers within the design command (Boyce 1988). Freeman et al. (1989) define water control as the capacity to apply the proper quantity and quality of water at the optimum time to the crop root zone to meet crop consumptive needs and soil leaching requirements. The performance gap between the level of water control that command area farmers expect and what they actually receive is the sum of three component gaps:

- Gap I: Gap between the area (and farmers) designed to be served by gravity irrigation and the area (and farmers) actually served after the system begins operation;
- Gap II: Gap between the level of 'water control' promised at the planning stage and the level of 'water control' actually delivered after the beginning of the operation;
- Gap III: Gap between the level of 'water control' demanded by farmers at the present point in time and the level of 'water control' actually offered by the system.

Gap I often arises because irrigation systems are over-designed to make them appear more viable and beneficial than they can actually become. Irrigation delta assumed is lower than realistic so that a larger design command can be shown. Once the system is commissioned, the gap tends to expand because of the acts of omission and commission that subvert the objectives of system management. Acts of commission include water thefts, vandalism, violation of water distribution norms, and unauthorized diversion or lifting of water from canals by head-reach farmers. Acts of omission include farmers' own failure to cooperate in maintenance and repair, to pay irrigation charges, and so forth (Burt and Styles 1999; Pradhan 1989: 18; Oorthuizen 2003: 207).

Gap II generally arises because of inept system management as well as physical deterioration of the system and reengineering by farmers (Oorthuizen 2003). Also important are operating rules for reservoir and main system management. In multi-purpose projects, the hydro-electric plants often determine the protocol and schedule for releasing water from reservoirs without much regard for the irrigators' needs.

Gap III arises from the changing pattern of irrigation demand, mostly due to diversification of farming towards high value crops. Irrigation systems designed for rice/wheat rotations or for extensive irrigation can meet only a small fraction of the water control needs that diversified farming systems require, which impose a different irrigation schedule. Depending only on public irrigation systems would thus drastically reduce the opportunity set of farmers who then turn to groundwater irrigation to provide them the high level of water control they need for their diversified cropping patterns.

For long, poor performance was blamed on the physical deterioration of systems and poor maintenance, and numerous programmes were launched to 'rehabilitate' surface irrigation systems. But as Boyce (1988: A-9) pointed out, 'The social difficulties of achieving joint water use among many irrigators may exceed the technical difficulties of constructing large-scale systems'.

[4] Different departments measure irrigation potential created and utilized differently. The Irrigation Department estimates the ayacut by the volume of water released and an assumed duty of water. The Revenue Department estimates area irrigated based on the water cess actually collected. It also uses the previous records of localization orders issued earlier. The Agriculture Department goes by the area in which crops are raised under irrigation. All these estimates differ widely and no attempt is made for reconciliation at any stage.

As a result, evaluations repeatedly found that physical rehabilitation was not a silver bullet. Typically, a visible performance jump following the immediate physical rehabilitation enlarged the command area and improved fee collection, water flowed unimpeded to the tail-end, and users expressed satisfaction. A few years later, water fee collection would languish, and anarchy levels rise. Maintenance would be deferred; degradation of the system would begin slowly and then accelerate, causing head–tail imbalance and prompting another round of rehabilitation. In South Indian tanks, the cycle has been so short that new rehabilitation plans are afoot even before the last plan is fully implemented. Mohanty (2005) calls this the *build–neglect–rebuild* syndrome. Recent thinking about improving performance of surface systems therefore favours modernization, defined as the 'process of technical and managerial upgrading … of irrigation schemes combined with institutional reforms, with the objective to improve resource utilization … and water delivery service to farms' (Renault 1998: 8). Involving farmers in irrigation management through participatory irrigation management (PIM) is a key component of modernization. But can PIM help to close performance gaps I, II, and III?

Improving Public Irrigation Performance: Can PIM Do It?

Unfortunately, PIM—and its sibling, irrigation management transfer (IMT)—have proved ineffective in revitalizing canal and tank irrigation not only in India but in much of Asia (Mukherji et al. 2009). The idea of PIM goes back to traditional Farmer Managed Irrigation Systems (FMIS), in whose case a distinct 'irrigation culture' passed over generations of irrigation communities. However, the logic of transforming traditional 'irrigation communities' into PIM through WUAs in a government-run irrigation system has itself been questioned (Hunt 1989; Narain 2004). Coward (1983) argues that:

> The basic point is to understand that the fundamental processes of investment now being made by the State [in large irrigation projects] fail to create property relationships among the water users, and thus are unable to support the creation of a social basis for action among local people.

What is extraordinary about PIM (and IMT, which is as yet untried in South Asia) is the way it has continued to hold on the irrigation management discourse despite virtually no evidence of its having succeeded anywhere in the developing world except on an experimental basis, and only with facilitation of un-replicable quality and scale. That system managers want farmers to manage irrigation canals is not new; the British tried hard in late nineteenth century to get farmers from the Indo-Gangetic basin to participate in irrigation management but without much success, except in *warabandi* in the Indus canals (Whitcombe 2005). Since Independence, farmers' organizations for irrigation management have been regularly tried, with uniformly disappointing results. In the early 1960s, Uttar Pradesh tried *Sinchai Samitis* (irrigation committees) on irrigation tanks and reservoirs; later, Madhya Pradesh tried it on thousands of its minor irrigation tanks. Other states have been struggling to make *Pani Panchayats* (water assemblies) work. However, the Sinchai Samitis of Madhya Pradesh and Uttar Pradesh have disappeared without trace, and so have Pani Panchayats in Gujarat and elsewhere. Gujarat introduced its Joint Irrigation Management Programme in 1983, but the 17 irrigation cooperatives lost money and were disbanded. In 1991, it made another attempt, this time with assistance from local non-governmental organizations (NGOs), and 144 irrigation cooperatives were formed to cover 45,000 ha of irrigated area (Shukla 2004). However, these cooperatives never functioned, and it is difficult to see precisely how PIM areas were better off than other command areas.

In sum, it is a rare circumstance in which WUAs have improved the performance of public irrigation systems on a large scale in South Asia. And that too only when a mid-sized NGO invests years of effort and resources in organizing WUAs and using means to reduce transaction costs that farmers on their own would normally not possess. Some of the best known examples of successful PIM/IMT on large government-run surface irrigation systems in India are Ozar on Waghad project in Nashik, Maharashtra, Dharoi in North Gujarat, Pingot and a few more medium schemes in Bharuch district. The success of farmer management in all these—and its beneficial impact—is undisputed. In each of these, however, there was a level of investment of motivation, skill, time, effort, and money which is unlikely to be replicated on a large scale. In catalyzing Ozar cooperatives, Bapu Upadhye, Bharat Kawale, two popular local leaders and their NGO Samaj Pragati Kendra, and senior researchers of SOPPEKOM, a local research group, invested years of effort to make PIM work (Paranjapye et al. 2003). In Gujarat, the Aga Khan Rural Support Programme and Development Support Centre invested at least 30 professional field staff for over 10–15 years to organize say 20,000–30,000 flow irrigators into functional WUAs. However, no government agency in India has the quality and scale of human and other resources, nay the motivation levels, needed to implement an institutional intervention that can sustainably raise the productivity of the 35–40 million ha of flow irrigated area, over say 15 years.

Nevertheless, the fascination with the idea continues as governments and donors seek to rejuvenate irrigation systems with the magic wand of PIM. And the recent fad is to do it with a 'big bang'. Orissa recently passed a law that transferred all its minor irrigation systems to instantly created Pani Panchayats. And Andhra Pradesh created more than 10,000 WUAs by a stroke of its chief minister's pen. The Andhra Pradesh reform is lauded by some observers as a great example, even though dozens of institutional big bangs of this genre have quietly ended as whimpers. And if the 250,000 ha decline in surface irrigated area in Andhra Pradesh between the 1993–4 and 2000–1 minor irrigation censuses is any indication, Andhra Pradesh's reforms are already a whimper. The World Bank loan spent, field researchers in Andhra Pradesh too are beginning to wonder precisely what the WUAs are doing better than before (Jairath 2001; Reddy 2003; Madhav 2007). Chapter 9 of this *Report* discusses the effectiveness of WUAs in selected states in India.

Indeed, a primary purpose of the command area development agencies (CADAs) formed by the Government of India in the early 1980s was to involve farmers' organizations in the management of irrigation projects. However, there is no trace of CADAs or their 'beneficiary farmers' associations' (BFAs). In Kerala, thousands of such organizations were formed in 1986. An assessment by Joseph (2001) in the late 1990s suggested that even in Kerala, with strong traditions of local governance, high education, and high levels of participation in public affairs, the beneficiary farmers' associations were a damp squib. Some random excerpts from Joseph (2001) based on his study of the Malampuzha Project:

> It is the CADA officials who took the initiative in their formation and not the farmer groups. In most cases, membership fee of Rs 5 was not paid by the farmers concerned; payment was made on their behalf by prospective office bearers, or the potential contractors of field channel lining or the large farmers in the *ayacut* … 86 per cent (of the BFAs) were formed in these two years (1986 and 1987) … for making possible the utilization of funds.… Only 57 meetings were held by the 8 Canal Committees during a span of 10 years … 43 of them were held without quorum and 35 with zero attendance of non-official members … The level of knowledge … about Canal Committees … and there structure and functions is very low. …

The action of PIM is driven by the idea that WUAs can manage irrigation systems better than remote bureaucracies and that they would be better at controlling anarchy, improving water service, collecting fees, and maintaining the system. This would raise water and land productivity and improve the economic conditions of the farmers. Democratic governance aside, PIM programmes have belied many of the lesser expectations even where they are widely considered successful, as in Turkey, Mexico (Kloezen 2002; Rap 2004), and the Philippines (Oorthuizen 2003). As a result, expectations have been increasingly moderated and participatory management is now considered successful even if it just 'saves the government money, improves cost effectiveness of operation and maintenance while improving, or at least not weakening, the productivity of irrigated agriculture' (Vermillion 1996: 153). The discussion, in recent times, has been more about shifting responsibility away from governments than about improving the lot of farmers—the original goal towards which most of the public irrigation investment has been directed over the past 50 years.

The lesson learnt is that the benefits of rehabilitation and upgradation are transitory without the capacity to control anarchy, and when it comes to controlling anarchy, the idea of gravity flow irrigation itself is up against some hard questions in India.

Socio-technical Pre-conditions for Canal Irrigation

Can India's publicly managed canal irrigation systems reproduce some of the productivity, socio-economic, and financial outcomes in the twenty-first century that they demonstrated at the end of the nineteenth? A likely answer is 'no' because the socio-technical conditions in which canal irrigation can thrive were all present then and are all absent now. Table 6.4 summarizes a broad-brush selection of the socio-technical conditions prevalent during pre-colonial, colonial, and post-colonial eras in many Asian countries including Mughal and British India. Our hypothesis is that particular forms of irrigation organization that we find in these eras were in sync with the socio-technical fundamentals of those times. Irrigation communities thrived during pre-colonial times when: (a) there was no alternative to sustained collective action in developing irrigation; (b) strong local authority structures, such as zamindars

Table 6.4 Socio-technical Context of Surface Irrigation in Different Eras

	Pre-Colonial (Adaptive Irrigation)	*Colonial (Constructive Imperialism)*	*Post-Colonial (Atomistic Irrigation)*
Unit of irrigation organization	Irrigation Community	Centrally managed irrigation system	Individual farmer
Nature of the state	Strong local authority; state and people lived off the land; forced labour; maximizing land revenue chief motive for irrigation investments.	Strong local authority; land taxes key source of state income; forced labour; maximizing land revenue and export to home-markets chief motive for irrigation investments; state used irrigation for exportable crops.	Weak state and weaker local authority; land taxes insignificant; poverty reduction, food security, and donor funding key motives for irrigation investments; forced labour impossible; electoral politics interfere with orderly management.
Nature of Agrarian society	No private property in land. Subsistence farming, high taxes, and poor access to capital and market key constraints to growth; escape from farming difficult; most command area farmers grew rice.	No property rights in land. Subsistence farming and high taxes; access to capital and market key constraints to growth; escape from farming difficult; tenurial insecurity; most command area farmers grew uniform crops, majorly rice.	Ownership or secure land use rights for farmers; subsistence plus high value crops for markets; growing opportunities for off-farm livelihoods; intensive diversification of land use; command areas witness a wide variety of crops grown, with different irrigation scheduling requirements.
Demographics	abundant land going a begging for cultivation; irrigable land used by feudal lords to attract tenants	abundant land going a begging for cultivation; irrigable land used by feudal lords to attract tenants	Population explosion after 1950 and slow pace of industrialization promoted ghettoization of agriculture in South and South-east Asia and China.
State of irrigation technology	Lifting of water as well as its transport highly labour intensive and costly;*	Lifting of water as well as its transport highly labour intensive and costly;	Small mechanical pumps, cheap boring rigs, and low cost rubber/PVC pipes drastically reduce cost and difficulty of lifting and transporting water from surface and groundwater.

Source: Shah (2009).

Note: * Assuming that a pair of bullocks pulling a 100 litre leather bucket do 100 turns a day for say 100 days per year, lifting 5 km^3 of water from wells would require 10 million bullocks working on wells. This work is done today in the Ganga basin by around 300,000 five-horse power (hp) diesel pumps doing 8 hours/day for 100 days. In Gorakhpur, James Buchanan estimated that 10 men could water from a ditch 3000 to 5000 square feet/day using swing-baskets. A 1 hp pump can do this work now in less than an hour. Besides the drudgery, the financial cost was an issue, too. The cost figures for those days given by the Agriculture Commission were Rs 7–20 per ha for canal irrigation and Rs 54 per ha from a well. 'In view of such a large difference in cost, it was not surprising that wells were superseded by canals as the source of water supply in areas supplied by canals' (Randhawa 1983: 291).

in Mughal India, promoted—even coerced—collective action to enhance land revenue through irrigation; (c) exit from farming was difficult; and (d) irrigating with wells, where possible, was highly laborious, costly, and time-consuming.

Similarly, large-scale irrigation systems during colonial times kept the three performance gaps (discussed above) under control because: (a) land revenue was the chief source of income for an authoritarian government, and enhancing it was the chief motive behind irrigation investments;[5] as a result, irrigation managers had a strong stake in ensuring that the mainsystems were well managed and maintained; (b) the state had a deep agrarian presence and used its authority to extract 'irrigation surplus' and impose discipline in irrigation commands; (c) the farmers in canal commands had no practical alternatives to either subsistence farming livelihoods or to gravity flow irrigation since well irrigation remained costly and laborious; and (d) population pressure on farm lands was nowhere as severe as found today. These socio-technical conditions created an 'institutional lock-in' that ensured that public irrigation systems performed in terms of criteria relevant to their managers at those times.

Post-colonial India is confronted with a wholly new array of socio-technical conditions in which neither irrigation communities nor disciplined command areas are able to thrive. The Welfare State's revenue interests in agriculture are minimal; the prime motive for irrigation investments is food security and poverty reduction, and not maximizing government income. Governments have neither the presence and authority nor the will to collect even minimal irrigation fees that are needed to maintain the systems.[6] Also, agrarian economies are in the throes of massive change. Farmers can—and do—exit agriculture with greater ease than ever before. Growing population pressure has made small-holder farming unviable except when they can intensify land use and diversify into high-value crops for the growing urban and export markets. In any case, to sustain surface irrigation seems to require an 'optimal' population density; at very low population density, it is not worthwhile; but beyond a threshold, land becomes so valuable that using it for water storage and transport comes under severe pressure (von Oppen and Rao 1987: 36).

Finally, gravity flow irrigation systems are hit by the mass-availability of small pumps, pipes, and boring technologies that have made the 'irrigation community' redundant; these have also made the irrigator impervious to the progressive widening of the three performance gaps, and reduced his/her stake in their performance. But for the rise of pump irrigation, canal irrigators would have protested non-performance by voice; now they have the easier option of exit (Hirschman 1965).

Adapting system design and management to the phenomenal expansion in pump irrigation is arguably, by far, the most formidable challenge to government canal irrigation systems and their managers. One way to adapt, many argue, is by modernizing Indian irrigation systems to make them more demand-oriented, as in Australia or the commercial farming sector in South Africa where they cater to a small number of large users and provide each with a level of water control that the Indian small farmer seeks from his own borehole and pump. But this may be a vain hope. Moreover, such modernization will work only to the extent that it addresses the rapidly changing socio-technical fundamentals of the canal irrigation context of India. Rather than improving canal irrigation performance by 'reforms'—institutional reform (like PIM/IMT), bureaucratic reform, reform of main system management (Wade and Chambers 1980)—India may be better off 'morphing' its canal systems to fit the changing socio-technical context of its agrarian economy in transition.

[5] Land revenue constituted 60 per cent of the East India Company's total income in the 1840s (Banerjee and Iyer 2002); though its share declined somewhat, it stayed at around 50 per cent throughout the nineteenth century.

[6] As Wallach says of the Nagarjunsagar project: 'The problem is partly engineering one…; more fundamentally, however, the problem is political, for the government is unable to prevent farmers at the upper or head ends … from taking so much water that the tail ends run dry … Little has been published on the subject, perhaps because India has put so much money, professional pride, and dreams of prosperity invested in the projects. Yet, many irrigation engineers in India will admit privately that the waste of development finds is staggering', available at http://ags.ou.edu/~bwallach/documents/Krishna% 20Basin.pdf last accessed on 30 October 2009.

Future of Canal Irrigation: Reform or Morph

What is the path that canal irrigation will—or can—follow in the future, over say a 25-year time horizon? Many scenarios are possible; but four are explored below.

Business-As-Usual Scenario

This is the most likely scenario and assumes that construction and management of canal irrigation projects will continue in a 'business-as-usual' mode. This will imply, among other things, that: (i) governments at the central and state levels will continue to construct large public irrigation projects despite their poor performance track record and without understanding how to improve their performance; (ii) similarly, multi-lateral lenders will continue to find new irrigation projects as well as rehabilitation/modernization projects that are attractive for making large loans that governments are happy to receive regardless of the past experience with the performance of such loans and their future prospects; (iii) poor performance of irrigation systems will continue to be blamed on the anarchy below the outlet; and despite lack of evidence of large-scale success, PIM/IMT will continue to be peddled as blanket solutions for improving system performance; (iv) since the best sites have already been used up, new projects will be increasingly costly and unviable, like the massive lift irrigation projects under construction on the Godavari River in Andhra Pradesh whose energy cost of pumping the water itself is estimated at Rs 17500/ha; (v) to justify unviable projects, planners will continue to overestimate the design command area[7] and assume unrealistic irrigation duty; once commissioned, the head-reach farmers will make a habit of irrigating water-intensive crops ensuring that the actual area commanded is a half or a third of the original plan; (vi) political leaders will continue to score electoral brownie points in initiating and constructing grandiose projects, without paying much attention to the stringent institutional and management requirements to achieve the performance goals of these systems; irrigation projects will also be attractive to politicians for the opportunities these provide in favouring supporters with construction contracts; (vii) irrigation departments will continue to remain construction-oriented with engineers having little interest or incentive or capacity in efficient management of systems so that they achieve their full performance potential; (viii) even if bureaucracies were motivated and capacitated, canal irrigation performance is difficult to measure and monitor when land revenue and water fee collection have been trivialized; (ix) in some states, irrigation departments will continue to stagnate or even shrink in size; states like Gujarat have not hired an irrigation engineer in 20 years, and by 2015, all engineers are expected to have retired; this will leave little organization to manage these large irrigation capital assets; (x) where irrigation departments are growing, with rising government salaries and stagnant irrigation fee collection, establishment costs, as share of working expenses, will increase with little left to repair and maintain the systems; (xi) in overall terms, the low-level equilibrium in which public irrigation in India is comfortably ensconced today will continue; governments will keep throwing good money after bad; multi-lateral lenders will keep financing unviable rehabilitation projects; and overall, more and more money invested will keep giving India less and less canal irrigation as has happened since 1991; (xii) the key socio-economic benefits of such projects—often more than gravity fed irrigated areas—will be in terms of recharging the aquifers in the areas where they can reach water by gravity flow and feeding urban water supply schemes.

Expanding the Area under Conjunctive Management of Surface and Groundwater

The simplest step that canal irrigation management in India can take to significantly enhance its impact is to maximize areas under conjunctive use of ground and surface water. Presently, this is not happening because India's irrigation systems irrigate only a fraction of the area they were designed to and they can with tighter management of the main system. India's canal systems

[7] For example, the Sardar Sarovar Project (SSP) is planned to irrigate 1.8 million ha on the assumption that the project will ration canal water at a delta of 53 cm/year. If we take the total water circulating in Indian canal systems at 300 BCM and divide it by the 17 m ha that this irrigates, the storage per net ha irrigated comes to 17,640 m^3. As a project representative of Indian canal irrigation sector, then SSP cannot command more than 0.55 million ha.

are designed to mobilize and move around some 300 billion cubic metre (BCM) of water[8] in a normal year. According to the CWC, these irrigate some 30 million out of a total of 37 million ha that can be potentially irrigated. According to the land-use survey data as well as the minor irrigation census data, however, only about 14–15 million ha are irrigated by major and medium public irrigation projects. According to the CWC, the volume of storage needed to irrigate a hectare is around 10,000 m^3/ha. The Land Use Survey (LUS) data suggest that the volume of water storage often increases to 20,000 m^3/ha, a good deal of which either creates water-logging or evaporates without producing any benefit. In comparison, 230 BCM of groundwater storage gives India a gross irrigated area of 35.2 m ha. Thus, the groundwater storage that India needs to support an irrigated ha is between 4300 to 6600 m^3/ha, much lower than that required for surface irrigation.

A potentially gigantic opportunity for unlocking value out of India's canal systems is by spreading their waters on much larger areas to expand the areas under conjunctive management of surface and groundwater. Around the world, a key problem in achieving such conjunctive use is the reluctance of command area farmers to invest in groundwater irrigation structures. In Pakistan during the 1950s, the World Bank had to invest in the Salinity Control and Reclamation Programme (SCARP) tube well programme to stimulate conjunctive use. In India, this is no longer a problem since irrigation wells dot the entire landscape of the country. Many Indian systems were designed as extensive (or protective) irrigation systems to support irrigated dry crops that can be matured with relatively low delta. However, due to poor system management and political intransigence, most systems have degenerated into intensive irrigation systems where a fraction of the design command uses 10,000–15,000 m^3 of water/ha to grow water-intensive crops.

It is possible to argue that canal systems can be transformed into extensive systems as they were planned, without much investment simply by improving the management of the main system. Most rehabilitation and modernization projects aimed at doing precisely this. However, these projects ended up spending huge sums on construction and little on management improvement and capacity building. Improving the management of main systems holds the key to unlocking value in India's public irrigation (Wade and Chambers 1980). Doing this, however, requires reform and revitalization of irrigation bureaucracies more than PIM/IMT and spending billions on reconstruction.

Irrigation Agencies Reinvent Themselves

Irrigation bureaucracies can reinvent themselves provided there exist certain prerequisites in their internal and external task environment.

Unbundling of the monolithic irrigation bureaucracy is one possible way (a successful example of improvement in performance through unbundling exists in the electricity sector in some states in India, which has some parallels to the irrigation sector). There are no easy answers to this question. The idea of unbundling has already been tried in Gujarat's Sardar Sarovar Narmada Nigam Limited (SSNNL), a special purpose vehicle created outside the Irrigation Department to construct and manage the Sardar Sarovar Project. However, there seems little evidence to suggest that SSNNL has done better than the Irrigation Department as either a 'profit centre' or a 'responsibility centre'. A pre-condition for any management turnaround is reliable information about organizational performance. In canal irrigation, this precondition is not satisfied today; even on basic variables—such as, the area wetted by canals in a system—different government sources provide vastly different numbers. Because irrigation charges are hardly collected, even water fee realization is a poor indicator of area irrigated. Finally, unlike during colonial times when irrigation fees commanded one-third crop share, canal irrigation is inherently unviable as a business today. Despite these issues, the performance of irrigation agencies would improve if: (i) a reliable and transparent Management Information System were established to monitor the performance of each irrigation system; (ii) the monolithic department was unbundled into independent management units for each system with operational autonomy, freedom from political

[8] This includes around 215 BCM of reservoir storage, and around 80 BCM in run-off the river system plus thousands of large irrigation tanks and *ahar-pyne* systems.

influences, agreed management goals, and performance-based reward system; and (iii) a transfer pricing scheme were evolved to translate system performance into a performance management system for the agency.

Morphing into Hybrid Systems with Public Private Partnerships

A third scenario of where Indian canal irrigation might go in the future is for the irrigation agencies to enlist the 'water scavenging anarchy' as a partner and leverage it to enhance their reach and performance. A good example is provided by developments in the upper-Krishna basin in Maharashtra. In 1976, the Bachhawat Award allocated 560 TMC of water to Maharashtra which the state had to develop by the year 2000. Maharashtra was not in a position to build reservoirs and canal networks needed to use this water and by 1996, it had constructed only 385 TMC of storage and little had been done by way of establishing a canal network in the Krishna basin. Therefore, the government first began allowing farmers to lift water from Krishna and its tributaries. This encouraged small-scale private lift schemes most of which could not convey water to longer than 1–1.5 km distance. In 1972, only 200 private and co-operative lift schemes were operating in Maharashtra. As pressure to utilize the water mounted, the government adopted a far more proactive posture towards lift irrigation schemes. It introduced a capital cost subsidy for irrigation cooperatives and also facilitated bank finance from nationalized and cooperative banks. Most importantly, the Irrigation Department (ID) constructed a series of Kolhapur Type (KT) weirs across many tributaries of Krishna to use them as storages for lift irrigation schemes. Each scheme has to be approved by the ID, whereupon it qualifies for an electricity connection and bank finance. Each scheme also has to pay irrigation fees to the ID for the actual area irrigated; it also has to pay electricity charges to the State Electricity Board at prevailing rates for agricultural use. Between December and June each year, the ID implements a fortnightly schedule of water releases to fill up the dykes, starting with the last dyke first. This ensures that lift schemes have access to reliable water supply during the irrigation season.

A good example of the kind of partnership that Maharashtra's policies have spontaneously promoted between the ID and irrigation cooperatives is the Radhanagari project (constructed by Shahuji Maharaj in 1916) that serves 91 villages in Kolhapur district (studied by Choudhury and Kher 2006; Padhiari 2006; and Chandra and Sudhir 2010). The dam never had any canals; water is released from the dam into Bhogavati River on which the ID has constructed a series of KT weirs. The ID has three roles: (i) to approve proposals for new schemes; (ii) to release water into Bhogavati river every 15 days to fill up all the KT weirs; and (iii) to collect irrigation fees from all lift schemes based on crop and area irrigated. Water lifting, conveyance, and distribution are all done by some 500 ISPs in private and cooperative sectors.

Radhanagari's performance over the past two decades has been very good compared to surface irrigation systems anywhere in India. Against a design command of 26,560 ha, the average area irrigated by ISPs during 2001–6 was 30,341 ha. The ID managed to collect only 58 per cent of the irrigation charges that were due; however, against the annual O&M cost of Rs 79 lakh, irrigation charges collected in 2005–6 were Rs 179 lakh. In terms of the area irrigated as well as irrigation charges recovered, tail-end areas were found no worse off compared to head; the practice of filling up KT weirs last to first seems to address the head–tail inequity. An informal survey suggested that the number of irrigations the project provides is 80 to 90 per cent of the number needed and that over 80 per cent of the farmers interviewed were happy with irrigation provided by the ISPs (Choudhury and Kher 2006). In terms of offering irrigation-on-demand, Radhanagari comes close to tube well irrigation. Choudhury and Kher (2006) interviewed eight private and nine cooperative ISPs that irrigate a little over 1000 ha in Radhanagari project. These have together invested nearly Rs 22 crore in systems that include 2280 hp of pumps and 41 km of buried pipe network and employ 92 staff to manage water. Typically, every system has a rising main—sometimes, multi-stage—to a chamber from where water is conveyed by buried pipes to fields. These ISPs thus invested Rs 2.2 lakh/ha in the system, use 2.3 hp/ha of power load, employ a water manager for every 12 ha irrigated and collect an irrigation charge that is high enough to pay off debt, pay electricity charges to the Electricity Board, irrigation charges to the ID, and salary to employees, and save enough for prompt repair and maintenance.

Radhanagari is not the only exception. According to the GoI's Minor Irrigation Census III, in 2000–1, Maharashtra had some 100,000 such schemes in operation for lifting and piped distribution of surface water, mostly in the Upper Krishna basin. Over 20,000 of these were owned and operated by farmer groups and Co-operatives. These lifted water from rivers and streams and transported it mostly by buried pipelines to areas up-to 30 km from the source. Remarkably, none of these was operated by a government agency. Over 90 per cent of Maharashtra's lift schemes were constructed by farmers from their own funds and bank finance, with the present value of aggregate investment of around Rs 5000 crore. Over 90 per cent schemes used electric pumps to lift water and 70 per cent had buried pipeline networks for water distribution. Total horse power of pumps installed in these schemes was around 590,000, equivalent to 440 MW, even though all the schemes involved a sizeable lift ranging from 20 meters to 185 meters. These irrigated a gross area of some 350,000 ha (including sugar-cane area of over 100,000 ha). Maharashtra's lift irrigation schemes employed over 100,000 workers as *pankhyas* (water managers), if we count the fact that the 80,000 families operating private lift schemes had at least one family member each devoted fulltime to work on the scheme operation.

Where-ever canals offer reliable water supply, private investors have invested in turning water into an 'irrigation service' that mimics on-demand groundwater irrigation. A sample of the many ways in which farmers have modified and adapted canal systems to their needs is listed in Table 6.5. If we were to learn from this experience, a variety of management models emerge in which the irrigation agency has a new, more limited role of delivering bulk water at pre-designated points in the command area and a variety of private arrangements are allowed to provide an 'irrigation service'. Regardless of whether governments support these or not, they are emerging and playing a major role in water distribution in many systems. This is the closest that canal irrigation can come to mimicking the flexible, on-demand groundwater irrigation.

At present, such private pump and pipe systems on canals are considered illegal, However, these systems can also be integrated with canal systems as hybrid systems in which the agency promises to deliver bulk-water at, say, a minor-level along a predetermined schedule and licensed ISPs, paying a volumetric water charge assume the responsibility of distributing water to their farmer-customers through a buried pipe network. Such hybrid systems involving piped distribution have several advantages over the conventional gravity flow systems: (i) private partners take up a large part of the capital investment of a canal system by constructing the distribution system; (ii) a buried pipe distribution system faces much less 'right-of-the-way' problems that canals face; (iii) piped distribution saves land used up for sub-minors and field-channels; (iv) it minimizes water-logging that is rampant in canal-based distribution systems; (v) piped distribution is considered too costly in comparison to earthen canals but is actually quite cost-effective if the land required for canals is valued at market price; (vi) a canal network is a vast evaporation pan especially at the level of the distribution system where surface area to depth ratio of channels is low; piped distribution can save some of this non-beneficial evaporation loss; (vii) piped water delivery from canals mimics tube well irrigation and raises productivity of irrigation water applied even more so because users pay a high price for the irrigation service; (viii) done right, piped distribution can help spread canal water over a much larger area than surface canals can; (ix) it can put into a place a regime of conjunctive use of ground and surface water that may tackle the acute problem of groundwater depletion; (x) while pipelining is more energy-intensive compared to gravity canals, if managed well, it can significantly improve the overall farm energy balance of the country by spreading surface water on a larger area, reducing the need for groundwater pumping, by integrating micro-irrigation technologies, and enhancing recharge from canal waters thereby reducing the energy used for groundwater pumping; (xi) while farmer participation in canal irrigation management has been hard to come by, under such a hybrid PPP model, farmer participation in irrigation management begins at the construction stage itself.

If the Maharashtra experience is any guide, inviting farmers to participate in creating such hybrid systems is not difficult. To promote farmer investments in piped distribution in a planned and systematic manner, all that the agencies need to do is the following: (i) not only recognize and legalize but also register and incentivize lifting of water from canal systems and its

Table 6.5 Farmer Modifications and Adaptations of Canal Systems to Serve their Needs

#	*System modification and adaptation*	*Examples*	*How widespread is this in India?*	*Extent of farmer enterprise and investment*	*Precondition for farmer enterprise and investment*	*Presence of Irrigation Service institutions*
1	Classical Canal Irrigation: The system operates as designed; wells are driven out by gravity flow irrigation	Mahi command in early 1970s;[a] Bhakra command in the 1950s	Not at all	Negative		Nil
2	Main system delivers water in farm ponds (diggis) fortnightly	Indira Gandhi canal, Rajasthan[b]	Not very	Low; individual farm ponds	Regular water supply to	Nil
3	Main system delivers water in village ponds as intermediate storages; farmers irrigate by gravity or lift	Sardar Sarovar; System tanks in South India	Some	Low; individual	Tanks replenished regularly	Some presence of Irrigation Service Markets (ISMs)
4	Main system delivers water into canals; farmers/groups lift and irrigate	Mahi system;[c] Upper Krishna;[d] Sardar Sarovar command[e]	Very widespread throughout India	Substantial; private and cooperative	Perennial or full season canals at run at FSL	High to very high presence of ISMs
5	Main system delivers water to a village contractor on volumetric basis and he allocates water to farmers and collects water fees	Several systems in China[f]	This model is spreading in China	Substantial, private	Perennial or full season canals at run at FSL	High presence of ISMs
6	Main system recharges the aquifers in the command; much irrigation surplus results from tube well irrigation	Bhakra;[g] Mahi;[h] Upper Krishna basin;[i] Tamil Nadu[j]	Very, very widespread	Substantial, mostly private;	None; alluvial aquifers, unlined canals help	High to very high presence of ISMs
7	Irrigation tanks support well irrigation in their command	Tamil Nadu;[k] AP;[l] Karnataka; Eastern Rajasthan[m]	Very, very widespread	Substantial, mostly private	None	Some presence of ISMs
8	Irrigation tanks converted into percolation tanks	Much of Tamil Nadu;[n] Rayalaseema[o] in Andhra Pradesh	Not very, but gaining	Substantial, mostly private	Consensus among tank irrigators	Some, to high presence of ISMs

Notes: [a] Shah (1993); [b] Amarasinghe et al. (2008); [c] Choudhury and Shah (2005); [d] Lohar et al. (2006); Birari et al. (2003); Choudhury and Kher (2006); Padhiari (2006); [e] Talati and Shah (2004); Talati and Pandya (2007); and Singhal and Patwari (2009); [f] Shah et al. (2004); Wang et al. (2003); [g] Dharmadhikari (2005); *Down to Earth* (2005); [h] Shah (1993); Shah (2009); and Kolavalli (1986); [i] Venot (2008); Biggs et al. (2007); [j] Sivasubramaniyan (2008); [k] Palanisami and Easter (1991); Palanisami and Balasubramanian (1998); [l] Rao (2003); [m] Shah and Raju (2001); [n] Palanisami (1995, 2005); [o] Rao (2003).

piped distribution; (ii) make firm commitments—during the irrigation season each year—of weekly water deliveries in each distributary/minor according to a strict schedule, as in the Radhanagari system described above; (iii) existing tube well owners should be encouraged to convert their electricity connections to canal lift; (iv) electricity connections should be provided to approved piped distribution schemes planned by farmers, cooperatives, and producer companies; (v) institutional financial agencies should be involved in providing finance to support farmer cooperatives for their investments in pumps and pipeline systems; (vi) government should provide 25 per cent subsidy on capital costs of approved projects; (vii) each pipeline system should be registered with the Irrigation Department and be required to pay irrigation fee for all the land irrigated with canal water; (viii) the idea of 'irrigation command' should be modified to include any farming community that is willing to invest in piped distribution and pay a volumetric water charge.

Conclusion

According to Kurt Levin's force-field analysis, India's public irrigation management will begin to change for the better when drivers of change will outweigh the forces that restrain change. For the moment, the latter far outweigh the former and will make 'Business-as-Usual' (outlined above) the most likely option. Indeed, one can find hardly any notable 'driver' that would create pressure for a major change programme in the public irrigation sector. Governments and donors have been throwing good money after bad; and they will keep doing so regardless of what the past investments delivered or failed to deliver. If a battery of 'change drivers' were to be created, the work would need to begin by creating a credible information and monitoring system about how public irrigation systems are performing against their original designs, their current objectives, and vis-à-vis each other. In business, measuring performance is generally considered essential to managing it. This seems nowhere more true than in the public irrigation business in India today.

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7 Groundwater Irrigation in India

Growth, Challenges, and Risks

Vasant P. Gandhi and Vaibhav Bhamoriya[†]

Introduction

Groundwater has rapidly emerged to occupy a dominant place in India's agriculture and food security in recent years. Over the past three decades it has become the main source of growth in irrigated areas, and now accounts for over 60 per cent of the irrigated area in the country. It is estimated that over 70 per cent of India's food grain production now comes from irrigated agriculture in which groundwater plays a dominant role. Since the growth in groundwater irrigation has not been largely government or policy driven and has happened mainly through highly decentralized private activity, the groundwater revolution has gone by and large unnoticed.

However, despite its huge significance and importance, groundwater irrigation is heading for a crisis and needs urgent attention and understanding in India. The number of irrigation blocks labelled as overexploited is increasing at an alarming rate of 5.5 per cent per year. The number of blocks in which officially the creation of wells must completely stop is scaling new heights every year. Yet, the sinking of new wells continues rapidly, at enormous private, public, and environmental costs. The way India will manage its groundwater resource will clearly have serious implications for the future growth and development of the water resources, agriculture, and food sectors in India, as well as the alleviation of poverty.

Size and Profile of India's Groundwater Resource and its Development

How much groundwater is available? The estimated total replenishable groundwater resource in India is 433.02 billion cubic metres (BCM) per year (see Table 7.1). The groundwater available for irrigation is estimated to be about 93 per cent of this or 403.85 BCM (after allowing about 7 per cent for domestic, industrial, and other uses). Out of this the utilizable groundwater resource for irrigation is 381.16 BCM, or 88 per cent. The annual net draft is estimated to be about 212.51 BCM so far. Thus, groundwater development is about 58 per cent of the potential in the aggregate, which may not appear so alarming. However, this number does not reveal the true picture of geographic variation, which is rather extreme.

What is the geographic distribution by river basin? Table 7.2, which gives the river basin-wise groundwater potential in the country shows that out of the total replenishable groundwater resource of 431.42 BCM, the Ganga basin alone accounts for nearly 40 per cent. Thus, the resource is highly concentrated and none of the other basins even cross 10 per cent. The basins with more than 5 per cent of the total replenishable potential are Godavari (9.42 per cent), Brahmaputra (6.15

† The authors gratefully acknowledge the contribution of N.V. Namboodiri.

Table 7.1 Dynamic Groundwater Resources of India, 2004 (in BCM per year)

1. Total replenishable groundwater resources	433.02
2. Provision for domestic, industrial, and other uses	29.17
3. Available groundwater resources for irrigation in net terms	403.85
4. (3) as per cent of (1)	93.26
5. Utilizable groundwater resources for irrigation in net terms	381.16
6. Gross draft estimated on prorate basis	230.62
7. Net draft	212.51
8. Balance groundwater resources for future use in net terms	162.29
9. Level of groundwater development	58 %

Source: Central Ground Water Board (2006).

Table 7.2 River Basin-wise Groundwater Potential of the Country

S. No.	*Name of basin*	*Total replenishable groundwater resources (BCM)*	*Percentage*
1	Ganga	170.99	39.63
2	Godavari	40.65	9.42
3	Brahmaputra	26.55	6.15
4	Indus	26.49	6.14
5	Krishna	26.41	6.12
6	North-east composite	18.84	4.37
7	Madras and South Tamil Nadu	18.22	4.22
8	Western Ghat	17.69	4.10
9	Mahanadi	16.46	3.82
10	Cauvery	12.3	2.85
11	Kutch & Saurashtra composite	11.23	2.60
12	Narmada	10.83	2.51
13	Meghna	8.52	1.97
14	Tapi	8.27	1.92
15	Cambay composite	7.19	1.67
16	Pennar	4.93	1.14
17	Brahmai with Baitarni	4.05	0.94
18	Subarnrekha	1.82	0.42
	Total Resources in BCM	431.42	100

Source: Ministry of Water Resources (2007).

per cent), Indus (6.14 per cent), and Krishna (6.12 per cent). This shows that the distribution of groundwater is highly skewed, and averages and aggregates may hide the real picture on the ground in various areas.

What is the state-wise profile of irrigation and groundwater potential? Table 7.3 shows that the estimated ultimate irrigation potential of the country is about 140 million hectare of irrigated area. Of this the potential for groundwater is estimated to be 64 million hectare, or 45.8 per cent. The proportion of groundwater in the irrigation potential varies substantially from state to state. It ranges from over 50 per cent in states, such as Uttar Pradesh, Madhya Pradesh, Jammu and Kashmir, Manipur, and Tamil Nadu, to around 33 per cent (one-third) in the case of Rajasthan, Kerala, Haryana, and Assam, and is negligible in many other states.

What is the level of development of the groundwater across different states? Table 7.4 gives the state-wise profile of the total replenishable groundwater resource, its availability for irrigation, the existing net draft, and therefore the percentage level of groundwater development. The states are arranged in descending order of the per cent of groundwater development.

Table 7.4 brings out the alarming picture of groundwater development in many states. The level of groundwater development is already as high as 141 per cent in Punjab, 111 per cent in Rajasthan, and 105 per cent in Haryana. This is followed by Tamil Nadu at 81 per cent, Gujarat at 70 per cent, and Uttar Pradesh/Uttarakhand at 65 per cent. There are large differences across the states. Further, these figures hide the highly skewed intra-state distribution, as is known in states, such as Gujarat and Rajasthan.

What is the prevalence of well irrigation across states in India? The prevalence of irrigation and well irrigation across states by village frequencies is shown in Table 7.5, which shows that over 63 per cent of the villages in India had tube wells by 2002. Given the growth of groundwater irrigation in India in the last decade this prevalence may have increased significantly by now. The states where the proportion of villages having tube well irrigation is above the national average are Punjab, Himachal Pradesh, Uttar Pradesh, Haryana and Bihar.

In states, such as Maharashtra, Gujarat, Rajasthan, and Madhya Pradesh, a large percentage of villages show the presence of other wells. However, the frequency of tube wells is also very high in Gujarat, Rajasthan, and Madhya Pradesh. These figures indicate the predominance of tube well irrigation across a large number of states in the country.

Growth of Groundwater Irrigation in India

What has been the pace of growth of irrigated area and its composition by source/method over the years? The growth in irrigated area and the rising contribution of groundwater can be seen from the data and analysis given in Table 7.6. The net irrigated area tripled from 21 million hectares in 1950–1 to 63 million hectares in 2008–9; the share of groundwater irrigation through wells rose substantially from 28 per cent to 61 per cent. The main contribution in this came from rapid growth in tube well irrigation, the share of which rose from zero in 1950–1 to over 41 per cent by 2008–9. This shows that groundwater irrigation, and within that tube well irrigation technology, has made a huge contribution to irrigation growth in India.

Overall, the green revolution technology has been a central driving force. Beginning in the mid-1960s, the green revolution was a major turning point for India's agriculture. The adoption of new high yielding variety seeds and the accompanying use of fertilizers provided great benefits, and the gains were the best with irrigation. Huge investments were undertaken for surface water irrigation projects to provide irrigation water over vast areas to larger numbers of farmers. Besides, many other significant changes also took place in the late 1960s and 1970s (Briscoe and Malik 2006). Electricity supply expanded in rural areas making pumping of groundwater easy and economical. New modular well and pumping technologies became widely available. In the surface irrigated and flood-prone areas, water-logging and/or salinity were problems, and it was realized that encouragement of groundwater pumping provided a good mechanism for lowering the groundwater table and reducing the severity of the problems. Farmers realized that groundwater was abundant in many areas, especially in the large alluvial basins. The reach of institutional credit expanded making credit more widely available. Farmers realized that they could develop and apply water 'just in time' from groundwater sources, something which was not possible in the institutionally-complex and poorly managed canal systems.

Table 7.3 State-wise Ultimate Groundwater Irrigation Potential, 2001–2

	Total irrigation potential ('000 ha)	*Groundwater potential ('000 ha)*	*Share of groundwater in total ultimate irrigation potential*
Manipur	604	369	61.1
Uttar Pradesh*	30,499	16,799	55.1
Madhya Pradesh*	17,932	9,732	54.3
Jammu & Kashmir	1,358	708	52.1
Tamil Nadu	5,532	2,832	51.2
Punjab	5,967	2,917	48.9
West Bengal	6,918	3,318	48.0
Orissa	8,803	4,203	47.7
India	139,893	64,050	45.8
Gujarat	6,103	2,756	45.2
Karnataka	5,974	2,574	43.1
Maharashtra	8,952	3,652	40.8
Meghalaya	168	63	37.5
Bihar*	13,347	4,947	37.1
Andhra Pradesh	11,260	3,960	35.2
Rajasthan	5,128	1,778	34.7
Kerala	2,679	879	32.8
Haryana	4,512	1,462	32.4
Assam	2,870	900	31.4
Tripura	281	81	28.8
Goa	116	29	25.0
Himachal Pradesh	353	68	19.3
Arunachal Pradesh	168	18	10.7
UTs	144	5	3.5
Mizoram	70	0	0.0
Nagaland	85	0	0.0
Sikkim	70	0	0.0

Source: Ministry of Water Resources (2007); Ministry of Statistics and Programme Implementation (2010).
Note: * Figures include the Ultimate Irrigation Potential (UIP) for Jharkhand, Chhattisgarh, and Uttaranchal in the UIP of Bihar, Madhya Pradesh, and Uttar Pradesh respectively.

The result was a revolution, in which groundwater irrigation developed at a very rapid rate (Briscoe and Malik 2006), while tank irrigation declined and surface water irrigation grew much more slowly (see Figure 7.1).

Briscoe and Malik (2006) report that cheap and un-metered electricity, slow development of surface irrigation, and poor management of canal systems further encouraged groundwater development. Over

Table 7.4 State-wise Groundwater Resource and its Development in India

Sl. No.	*States*	*Total replenishable groundwater resource BCM/yr*	*Available groundwater resources for irrigation BCM/yr*	*Net draft BCM/yr*	*Level of groundwater development [%]*
1	Punjab	23.78	21.44	30.34	141.51
2	Rajasthan	11.56	10.38	11.60	111.75
3	Haryana	9.31	8.63	9.10	105.45
4	Tamil Nadu	23.07	20.76	16.77	80.79
5	Gujarat	15.81	15.02	10.49	69.84
7	Uttar Pradesh	76.35	70.18	45.36	64.63
8	Uttaranchal	2.27	2.10	1.34	63.80
9	Karnataka	15.93	15.30	9.75	63.72
10	All-India	433.02	399.25	212.51	53.22
11	Maharashtra	32.96	31.21	14.24	45.62
12	Madhya Pradesh	37.19	35.33	16.08	45.51
13	Andhra Pradesh	36.50	32.95	13.88	42.12
14	West Bengal	30.36	27.46	10.84	39.47
15	Bihar	29.19	27.42	9.39	34.25
16	Kerala	6.84	6.23	1.82	29.21
17	Himachal Pradesh	0.43	0.39	0.09	23.08
18	Assam	27.23	24.89	4.85	19.49
20	Chhattisgarh	14.93	13.68	2.31	16.89
21	Goa	0.28	0.27	0.04	14.81
22	Orissa	23.09	21.01	3.01	14.33
23	Jharkhand	5.58	5.25	0.70	13.33
25	Jammu & Kashmir	2.70	2.43	0.10	4.12
26	Tripura	2.19	1.97	0.08	4.06
27	Arunachal Pradesh	2.56	2.30	Neg.	Neg.
28	Meghalaya	1.15	1.04	Neg.	Neg.
29	Manipur	0.38	0.34	Neg.	Neg.
30	Nagaland	0.36	0.32	Neg.	Neg.

Source: Central Ground Water Board (2006); Ministry of Water Resources (2007).
Note: Estimates for 2004; BCM = Billion Cubic Metres.

the last two decades, 84 per cent of the total addition to net irrigated area has come from groundwater, and only 16 per cent from canals. Thus, at present the net area irrigated by private tube wells is about double the area irrigated by canals.

Historically, in the early phase of groundwater development in the 1950s, groundwater extraction was dominated by traditional dug wells with depths generally not exceeding 30 feet. Labour or animal devices, such as Persian wheels were often used to lift the water,

TABLE 7.5 State-wise Frequency of Villages having Irrigation Facility per 1,000 Villages, and their Distribution by Type of Such Facility in India (July–December 2002)

Sr. No.	*States/UTs*	*Number of villages having irrigation facility per 1,000 villages*	*Per cent of villages having tube well irrigation*	*Per cent of villages having other well irrigation*
1	Punjab	976	92.2	2.4
2	Himachal Pradesh	382	83.5	0.0
3	Uttar Pradesh	987	82.1	2.2
4	Haryana	979	81.4	1.3
5	Bihar	895	68.6	0.4
6	India	762	63.1	21.3
7	Karnataka	829	59.3	11.7
8	Rajasthan	893	54.3	34.6
9	Gujarat	891	50.6	47.3
10	Chhattisgarh	652	44.6	11.3
11	West Bengal	845	43.9	7.3
12	Andhra Pradesh	796	43.8	7.8
13	Madhya Pradesh	925	40.6	39.6
14	Tripura	685	38.5	2.2
15	Uttaranchal	391	36.8	0.0
16	Orissa	281	31.3	0.0
17	Puducherry	1,000	24.4	0.0
18	Mizoram	188	22.3	68.1
19	Dadra & Nagar Haveli	573	22.3	22.3
20	Daman & Diu	749	19.2	36.0
21	Tamil Nadu	879	13.9	39.6
22	Maharashtra	804	9.5	72.1
23	Kerala	840	7.0	28.8
24	Arunachal Pradesh	355	6.2	0.0
25	Jammu & Kashmir	708	4.4	0.0
26	Sikkim	618	0.2	8.4

Source: Ministry of Water Resources (2007).

constituting over 60 per cent of the irrigation devices. Sometimes, there was conjunctive use and hydrological nexus between well irrigation and tank irrigation (Jeet 2005). With this and the crop choice, the balance between demand and supply of water could be maintained except during years of very low rainfall, and therefore, water use was generally sustainable.

The second phase starting in the 1970s saw considerable growth of dug-cum-bore wells (Jeet 2005; Singh 2003). The depth of the wells increased to about 50 to 100 feet and the use of centrifugal pumps became common. More water could be lifted leading to increase in irrigated area and growing crops which required more water. With the easy availability of institutional

Table 7.6 Sources of Irrigation in India, 1950–1 to 2008–9 ('000 hectares)

Year	*Canal*	*Tanks*	*Tube wells*	*Other wells*	*Total wells*	*Other sources*	*Total net irrigated area*
1950–1	8,295	3,613	0	5,978	5,978	2,967	20,853
1960–1	10,370	4,561	135	7,155	7,290	2,440	24,661
1970–1	12,838	4,112	4,461	7,426	11,887	2,266	31,103
1980–1	15,292	3,182	9,531	8,164	17,695	2,551	38,720
1990–1	17,453	2,944	14,257	10,437	24,694	2,932	48,023
1995–6	17,120	3,118	17,894	11,803	29,697	3,467	53,402
2000–1	15,710	2,518	22,324	11,451	33,775	2,831	54,833
2005–6	16,644	2,088	23,849	12,235	36,084	5,974	60,790
2006–7	16,954	2,083	24,764	12,897	37,661	6,003	62,702
2007–8	16,690	1,968	26,328	12,033	38,361	6,080	63,099
2008–9	16,597	1,979	26,004	12,563	38,567	6,053	63,196
Percentage Share of Various Sources							
1950–1	39.78	17.33	0.00	28.67	28.67	14.23	100
1960–1	42.05	18.49	0.55	29.01	29.56	9.89	100
1970–1	41.28	13.22	14.34	23.88	38.22	7.29	100
1980–1	39.49	8.22	24.62	21.08	45.70	6.59	100
1990–1	36.34	6.13	29.69	21.73	51.42	6.11	100
1995–6	32.06	5.84	33.51	22.10	55.61	6.49	100
2000–1	28.65	4.59	40.71	20.88	61.60	5.16	100
2005–6	27.38	3.43	39.23	20.13	59.36	9.83	100
2006–7	27.04	3.32	39.49	20.57	60.06	11.39	100
2007–8	26.45	3.12	41.72	19.07	60.79	9.63	100
2008–9	26.26	3.13	41.15	19.88	61.03	9.58	100

Source: Gandhi and Namboodiri (2002); Ministry of Agriculture (2010).

credit for the construction of wells in the mid-1970s, the number of wells had increased substantially by late 1970. On the other hand, most of the tanks became unusable for irrigation due to poor maintenance and this resulted in even greater dependence on groundwater.

During the third phase beginning from the mid-1980s, the extraction technology started changing towards submersible pumps and the depth of wells increased to beyond 400 feet in many areas. Water extraction increased rapidly under the influence of subsidies on electricity, lack of metering, credit availability, and the commercialization of agriculture (Singh 2003). This led to rapid decline in the water table, decline in the quality of water, increased frequency of well failure, and rapidly rising costs of well investments and operations. This expansion of groundwater use resulted in a speedy decline in the groundwater table in several parts of the country (Bhatia 1992; Dhawan 1995; Moench 1992; and Dubash 2002).

The number of shallow wells doubled roughly every 3.7 years between 1951 and 1991 (Moench 2003), the total crossing 18.5 million wells nationwide and accounting for over 50 per cent of the irrigated area. By 2008–9, groundwater now provided for over 60

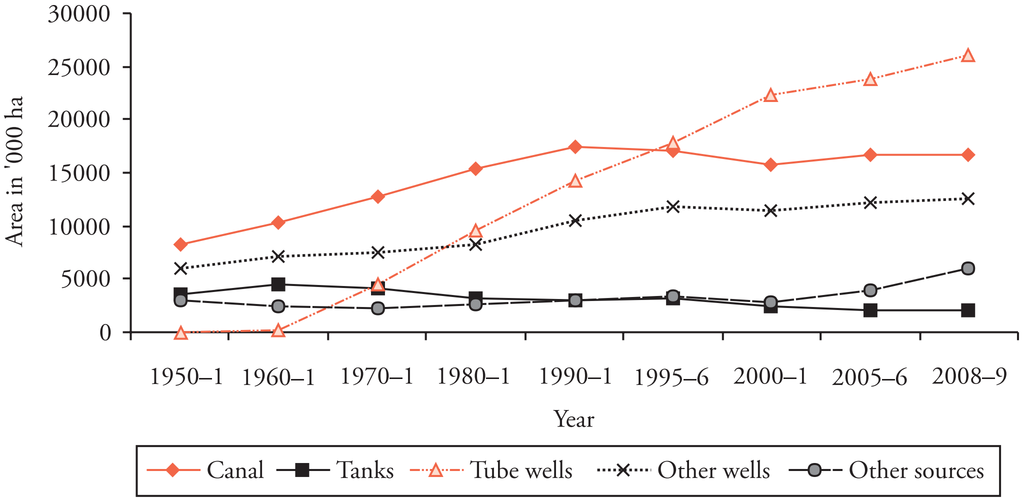

FIGURE 7.1 Sources of Irrigation in India

Source: Ministry of Agriculture (2010).

per cent of the irrigated area, and about 80 per cent of the domestic water supply year. The rapid expansion has resulted in steep declines in the groundwater table, low productivity of wells, intrusion of sea water in many areas, and deterioration in the groundwater quality. In arid regions, such as Rajasthan and Gujarat, ingress of naturally occurring brackish groundwater has become a matter of great concern. According to IWMI, the withdrawal rate in India is twice the recharge rate (Moench 2003). Thus, even though groundwater is a powerful tool for agriculture and poverty reduction, developing and managing this resource in a sustainable way is a tremendous challenge. Attempts to regulate groundwater through restrictions on credit and electric connections have had very little effect so far.

The Relative Efficacy, Efficiency, and Equity of Groundwater versus Surface Water

Efficacy and Efficiency

How does groundwater compare with surface water? Important work on this has been done by Moench (2003), and this section draws substantially on this research. Irrigation plays a major role in green revolution technologies and within this, groundwater irrigation is the best (Moench 2003). This is documented in a number of studies (see Meinzen-Dick 1996; Shah 1993). Farmers owning wells generally achieve the highest yields while those purchasing water from well owners achieve yields higher than those dependent on canal irrigation alone manage but not as high as the yields achieved by well owners (see Tables 7.7 and 7.8 based on these studies). Well irrigation is also associated with higher cropping intensity, higher cash input expenditure, and higher gross income per acre.

Other research indicates that yields in groundwater irrigated areas are higher by one-third to one-half as compared to those from areas irrigated by surface sources (Dhawan 1995). A wholly irrigated acre of land may become equivalent to 8 to 10 acres of dry land in production and income terms (Dhawan 1993). Some estimates suggest that as much as 70–80 per cent of India's agricultural output may be groundwater based (Dains and Pawar 1987). It is also found that well owners and those purchasing water tend to make more complementary investments in fertilizers, labour, and other inputs (Kahnert and Levine 1989). This increases the demand for these inputs and helps rural development (Moench 2003).

Shah (2003) indicates that numerous micro-level studies based on sample surveys show that pump-irrigated farms perform much better compared to those irrigated by any other source in terms of cropping intensity, input use, and yields (also see Dhawan 1985). By common observation, the difference between areas

Table 7.7 Average Yields of Major Crops by Water Source

Crop	*Canal only*	*Public tube well*	*Purchased from tube well*	*Own tube well*
Yield (kg/acre)				
Wheat	672	747	784	896
Rice	522	709	784	859
Cotton	261	299	373	485

Source: Moench (2003); Meinzen-Dick (1996); and Freeman et al. (1978).

Table 7.8 Input Use and Agriculture Productivity by Water Source

	Canal water only	*Tube well water buyers*	*Tube well owners*
Gross crop income (Rs/acre)	3,018	3,475	4,659
Canal Water use/acre (acre minutes)	26.3	26.2	25.2
Tube well water use (acre minutes)	0.0	14.2	31.4
Cash input expenditure (Rs/acre)	309	385	388
Labour use (man-days/acre)	73.8	76.2	75.5
Cropping intensity (per cent)	160	168	184
Per cent water consumptive crops	35	36	45

Source: Moench (2003); Meinzen-Dick (1996); and Renfro (1982).

irrigated by private tube wells and those irrigated by gravity flow canals is explained by superior quality in terms of reliability, timeliness, and the adequacy of irrigation that tube wells offer as compared to other sources (Chambers et al. 1987; Shah 1993).

Groundwater offers control and reliability of water in irrigation which proves very important. Experiments indicate that water control alone can bridge the gap between potential and actual yields by about 20 per cent (Herdt and Wickham 1978). In Spain, irrigation uses 80 per cent of all water and 20 per cent of water that comes from under the ground. But the 20 per cent produces more than 40 per cent of the cumulative economic value of Spanish crops (Barraque 1997). The contribution of groundwater is not just through higher yields. In arid regions, the stabilization effect of groundwater development may be substantial and have more than twice the benefit value of increase in water supply (Tsur 1990). In southern California, the stabilization value in agriculture is, in some cases, as much as 50 per cent of the total value of groundwater (Tsur 1993). The economic impact of droughts in California in the early 1990s was minimal largely because farmers were able to shift from unreliable surface supplies to groundwater (Gleick and Nash 1991).

In the Indian context, some insight on this can be gained through examining the impact of different droughts (Moench 2003). In the 1960s groundwater irrigation was relatively insignificant, particularly in eastern India. In 1965–6, when the monsoon rainfall was 20 per cent below normal, the food grain production declined by 19 per cent at the all-India level over the 1964–5 production level (Prasad and Sharma 1991). In 1987–8 when groundwater had been considerably developed, the rainfall dropped by 17.5 per cent below normal, and yet food grain production declined by only 2.14 per cent from the previous year. (Note: the droughts are not strictly comparable.) This appears to indicate the contribution of groundwater in improving the reliability of production.

Another way is comparing the standard deviation in the growth rates of irrigated and unirrigated agriculture for the period after the advent of new technology in the late 1960s. An analysis carried out for 11 major states for the period 1971–84, reveals that the degree of instability in irrigated agriculture was less than half of that in unirrigated agriculture (Rao et al. 1988) (see Table 7.9). The stability impact of irrigation was found to be much greater in low rainfall states, especially those served by assured sources of irrigation including tube wells (Haryana and Punjab), than in high rainfall areas, indicating an impact of groundwater irrigation. Bihar and Madhya Pradesh were the only states that exhibited higher fluctuation in irrigated agriculture as compared to unirrigated agriculture.

Equity

What is the nature and pattern in ownership and equity in groundwater irrigation? The Third Minor Irrigation Census conducted in 33 states and union territories during 2000–1 enumerated 18.5 million groundwater units. These comprised of 9.62 million dug wells, 8.35 million shallow tube wells, and 5.30 million deep tube wells. The distribution of well irrigation units by their ownership (Table 7.10) shows that 81 per cent of dug wells were owned by individual farmers, 16.8 per cent by groups of farmers, and very few by others. In shallow tube wells, 94.6 per cent were owned by individuals, 4 per cent by groups of farmers, and very few by others. In deep tube wells too, 61.8 per cent were owned by individuals, 27.6 per cent by groups of farmers, and about 10 per cent by the government/cooperatives/panchayats. On the other hand, the ownership of surface irrigation schemes was dominated by the government. Thus, the ownership of tube wells and dug wells for irrigation was largely with private individual farmers. Only in the case of deep tube wells, groups of farmers and the government showed some ownership, but individual farmers still dominated.

What is the ownership pattern by landholding size? Results from the same survey given in Table 7.11 indicate that over 67 per cent of the dug wells and shallow tube wells were owned by small and marginal farmers—those having operational holdings below 2 hectares. In the case of deep tube wells, about 60 per cent were owned by medium and large farmers. In the

Table 7.9 The Impact of Irrigation on Variability in Agricultural Output

State	*Irrigated agricultural output (1)*	*Unirrigated agricultural output (2)*	*Unirrigated to irrigated ratio (3=2/1)*
Standard Deviation in Annual Growth Rates, 1971–84			
Andhra Pradesh	13.6	18.8	1.38
Bihar	22.0	17.9	0.81
Gujarat	23.8	86.3	3.63
Haryana	9.3	54.8	5.89
Karnataka	16.7	31.4	1.88
Madhya Pradesh	24.5	23.0	0.94
Maharashtra	17.9	43.8	2.45
Punjab	4.9	19.3	3.94
Rajasthan	11.3	46.9	4.15
Tamil Nadu	19.2	41.6	2.17
Uttar Pradesh	12.0	40.0	3.33
Average	7.3	19.0	2.60

Source: Moench (2003), adapted from Rao et al. (1988).

TABLE 7.10 Distribution of Wells According to their Ownership, 2000–1

	Dug wells	*Shallow tube wells*	*Deep tube wells*	*Total*	*Surface flow*
Distribution According to Ownership (Number: 1,000)					
Government	172.0	47.8	50.3	270.2	264.8
Coop. societies	9.7	7.2	1.9	18.8	2.5
Panchayat	14.4	18.9	3.5	36.8	45.7
Groups of farmers	1,611.4	334.8	146.5	2,092.8	98.2
Individual farmers	7,784.5	7,901.7	0.0	15,686.2	217.0
Others	25.2	45.4	328.0	398.5	13.9
Total	9,617.4	8,355.7	530.2	18,503.2	642.0
Distribution According to Ownership (Percentage)					
Government	1.79	0.57	9.49	1.46	41.24
Coop. societies	0.10	0.09	0.36	0.10	0.38
Panchayat	0.15	0.23	0.66	0.20	7.11
Group of farmers	16.76	4.01	27.64	11.31	15.29
Individual farmers	80.94	94.57	0.00	84.78	33.80
Others	0.26	0.54	61.86	2.15	2.17
Total	100.00	100.00	100.00	100.00	100.00

Source: Ministry of Water Resources (2002a).

case of surface water, small and marginal farmers had a 72 per cent share. Thus, groundwater irrigation was less equitable than surface irrigation by landholding size, and deep tube wells were even less equitable. However, over two-third of dug wells and shallow tube wells were owned by small and marginal farmers.

Small and marginal farmers operated 36 per cent of the land whereas medium and large farmers operated 64 per cent of the land (see Table 7.11). Of all the wells, 66 per cent were owned by small and marginal farmers, and 34 per cent by medium and large farmers. This indicates that compared to land ownership, the distribution of ownership of wells was more equitable and was skewed in favour of small and marginal farmers. However, surface irrigation was more favourably distributed, with 72 per cent access with small and marginal farmers.

The distribution of crop season-wise irrigation by groundwater indicates that more area is irrigated by groundwater in the rabi season—about 50 per cent. About 35–38 per cent is irrigated in the kharif season, and about 8–10 per cent in perennial crops (Table 7.12). Thus, the rabi season, when rainfall is low, takes a major share of groundwater, yet the share of the kharif season, when the rainfall is high, is also substantial.

Moench (2003) states that the equity impacts of groundwater development for irrigation are not positive in every aspect. Modern tube well drilling and technology tend to be capital intensive. As a result, large farmers have an advantage. Early exploiters of groundwater have typically been large farmers who produce surpluses for the market. The World Bank (1999b) indicates that tying water rights to land rights has implications for access to groundwater and has *de facto* led to rights at the field level where due to the characteristics of groundwater as a common property resource, larger farmers with higher pumping capacity and deeper tube wells have a disproportionate claim over the resource than others.

Table 7.11 Distribution of Wells According to Farm Holding Size, 2000–1

Operational holding size	*Dug wells*	*Shallow tube wells*	*Deep tube wells*	*Total*	*Surface flow*	*Number of operational holdings (1995 in '000)*	*Area operated (1995 in '000)*
Distribution According to Farm Holding Size (Number: 1,000)							
Marginal (0–1 ha)	3,222.5	2,731.5	24.7	5,978.7	111.7	71,179	28,121
Small (1–2 ha)	2,924.9	2,890.5	35.7	5,851.1	114.2	21,643	30,722
Medium (2–10 ha)	3,007.9	2,273.6	68.5	5,350.0	65.5	21,353	80,351
Large (>10 ha)	240.7	340.9	17.6	599.2	23.8	1,403	24,163
Total	9,396.0	8,236.5	146.5	17,779.0	315.2	115,580	163,357
Distribution According to Farm Holding Size (Percentage)							
Marginal (0–1 ha)	34.30	33.16	16.85	33.63	35.45	61.59	17.21
Small (1–2 ha)	31.13	35.09	24.38	32.91	36.22	18.73	18.81
Medium (2–10 ha)	32.01	27.60	46.75	30.09	20.77	18.47	49.19
Large (>10 ha)	2.56	4.14	12.02	3.37	7.56	1.21	14.79
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Source: Ministry of Water Resources (2002a).

Table 7.12 Crop Season-wise Area Irrigated by Groundwater, 2000–1

	Dug wells	*Shallow tube wells*	*Deep tube wells*	*Total*
Crop Season-wise Area Irrigated by Groundwater (1,000 ha)				
Kharif	4,745.0	10,676.6	1,415.2	16,836.7
Rabi	6,988.1	13,284.7	2,000.0	22,272.7
Perennial	1,098.3	2,259.0	408.5	3,765.7
Others	391.9	1,452.7	262.4	2,107.0
Total	13,223.2	27,673.0	4,086.0	44,982.2
(Percentage)				
Kharif	35.88	38.58	34.63	37.43
Rabi	52.85	48.01	48.95	49.51
Perennial	8.31	8.16	10.00	8.37
Others	2.96	5.25	6.42	4.68
Total	100.00	100.00	100.00	100.00

Source: Ministry of Water Resources (2002a).

Singh (2003) indicates that this can be partly solved by water markets, which can mitigate the inequalities in access to groundwater. Farmers who do not have their own wells can have access to groundwater irrigation through water markets.

Groundwater can also be a key resource for poverty alleviation and economic development. Evidence indicate that improved water supply can generate many positive externalities in the overall household micro-economy. In areas dependent on irrigated agriculture, the reliability of groundwater and the resulting higher crop yield generally achieved, often enables farmers with small holdings to considerably increase their incomes (Moench 2003). The positive impact of well irrigation goes beyond those who own them as it also increases and stabilizes the demand for associated inputs, including labour. The expansion of well irrigation, therefore, can have a ripple effect in the rural areas including creating more employment.

In this context of inequality, CSE 1991 indicates that there are compelling reasons for stimulating rapid development of groundwater resources in eastern India. Eastern India has a bulk of India's poverty. It is largely rural, predominantly agricultural, and has a high population density. It has been argued that the green revolution in Punjab, Haryana, and western Uttar Pradesh was fueled more by the private tube well revolution, rather than only surface water, and why it has not progressed eastward to eastern India is explained by the slow pace of groundwater development in the east (Dhawan 1982). Besides, increased density of wells can increase the welfare of the people in the eastern region through the powerful positive externality that they produce by working against water-logging and flood-proneness. The CSE (1991) states:

> …that active development of groundwater reservoirs by extensive irrigation pumping during dry season can provide substantial capacity to store flood as well as the drainage waters during the wet season. Preliminary calculations made in USA indicate that full development of conjunctive use in the Ganga basin can lead to as much as 50 per cent reduction in the monsoon flows of rivers. Thus, groundwater utilization can not only contribute to full realization of the agricultural potential of the region but would also be effective in reducing and preventing water logging conditions which have come to be an imminent threat in considerable tracts of North Bihar [as indeed much of Eastern India]. The measure could considerably alleviate the flood problem of the region through provision of underground storage of monsoon flows. However, the desired development of groundwater in this area has been inhibited by the preponderance of marginal farmers who cannot afford the investment required in installation of tube wells….

The Role of Land Tenure, Water Rights, and Groundwater Markets in Influencing Equity and Efficiency

As per the law, groundwater is under private regime in India and the rights to groundwater belong to the owner of the land (Jeet 2005). The right to groundwater is transferred to anyone to whom the land is transferred. There is no limitation on how much groundwater a particular landowner can draw. Therefore, a landowner can legally abstract any amount of water unless the geo-hydrology or technology limits it. The consequence of such a legal framework is that only the landowners can own groundwater in India. The landless households or tribes who may have community rights over land have no private rights. The legal framework also implies that rich landlords can be water lords and indulge openly in extraction and selling of as much water as they wish (Singh 1991). The lack of well-defined property rights, the invisibility, and the complex flow characteristics of groundwater makes it very difficult to monitor its use (Singh 1995).

For wider access and control it is necessary to separate water rights from land rights, but no such provisions have been made so far in the national groundwater law (Jeet 2005). In Gujarat, the government tried to regulate water extraction and marketing by restricting the depth of tube wells and by introducing licensing procedures, but there has been little success. Since the groundwater situation in different parts of the country varies with factors, such as geology, hydrology, ecology, soil, climate, pattern of usage, and water quality, the nature of regulations for groundwater utilization may need to vary from area to area.

Water markets and trading can partly mitigate the inequalities in access to groundwater resources due to lack of ownership of land (Jeet 2005). They could work on the principle of profitability, and overexploitation could be checked through this. Though water markets exist, they are by and large limited to localized water trading between adjacent farmers. Water trading remains informal in the sense that there are often no formal methods or agreements. This hinders the reallocation of water for more productive use. In recent years it has become apparent that informal water markets have become widespread. One of the more complex and better operated of these informal markets is in Gujarat (The World Bank 1999b). Expanding the role of markets into a formal mechanism for water allocation necessitates a reform of the water rights framework, and the development of effective management institutions. The introduction of more formal water markets, where feasible, could further provide an opportunity for efficient reallocation using market mechanisms (The World Bank 1999a).

Who participates in the water market is an important indicator of the nature of water markets. Past studies show that the well owners with less holdings have a higher extent of participation than those who own larger holdings (Shah and Raju 1988). But a study done in Rajasthan (Singh 2003) does not support this hypothesis (see Table 7.13). This study shows that among the sellers only one-third belonged to the small and semi-medium size categories and two-third belonged to the medium and large farm size categories. On the other hand, a majority of the buyers belonged to the small and semi-medium size groups.

The same study finds that the main reasons given by self-users for non-participation in water markets were: lack of surplus water due to low discharge, followed by no buyers available, and water quality (see Table 7.14). On the other hand, the reasons for participation in the water market given by sellers were: having surplus water, earning profits, and power policy (particularly flat pricing). The major reasons given for participation in the water markets by the buyers were: owning land but no well, and limited and unreliable water supply.

Apart from the water markets, an important grassroots initiative on improving groundwater availability has been the check dam movement in the Saurashtra region of Gujarat. This involves the formation of

Table 7.13 Farm Size-wise Distribution of Households Participating in Water Markets (*per cent*)

Category	*Size of farms*					*Sample Size (No.)*
	Marginal	*Small*	*Semi-medium*	*Medium*	*Large*	
Kukanwali						
Self-users	0	0	15	77	8	13
Seller	0	11	21	42	26	19
Buyers	25	13	50	12	0	8
Overall	5	8	25	42	15	40
Srichandpura						
Self-users	17	50	33	0	0	6
Seller	33	33	34	0	0	6
Buyers	70	15	15	0	0	13
Overall	48	28	24	0	0	25
Overall						
Self-users	5	16	21	53	5	19
Seller	8	16	24	32	20	25
Buyers	52	14	29	5	0	21
Overall	22	15	25	29	9	65

Source: Singh (2003).

TABLE 7.14 Reasons for Participation or Non-participation in Water Markets (*per cent*)

Particulars	*Kukanwali*	*Srichandpura*	*All*
Self-users' reasons for not participating			
• No surplus water	46	83	58
• No buyers	38	17	32
• Water quality	16	0	10
Sellers' reasons for participating			
• Surplus water	74	83	76
• Profit earning	26	50	32
• Power policy	26	17	24
Buyer's reasons for participating			
• Owned land but no well	88	46	66
• Limited and fluctuating water supply	12	54	34

Source: Singh (2003).

village level local institutions in hundreds of villages to undertake the planning, financing, and construction of a system of check dams in and around the villages to collect and hold rainwater so as to recharge the underground aquifers and thereby recharge the dug wells. The movement appears to have had a huge impact on water availability and agricultural incomes in the area. The results of a study of these institutions by Gandhi and Sharma (2009), given in Table 7.15, indicates a large positive impact on water availability, irrigated area, participation-empowerment, village development, and on the environment.

Overextraction, Costs, and Externality Implications

Extraction of groundwater in excess of its replenishment is a serious problem and leads to significant declines in the groundwater table. Information on the broad official assessment of this is analysed in Table 7.16, which shows the distribution of different talukas/blocks in India into overexploited/dark/critical with respect to the status of groundwater. The situation may not look serious at the national level since the number of such blocks is below 20 per cent overall, and is lower in many states. However, the condition seems to be very precarious in states, such as Punjab, Haryana, and Rajasthan. In these locations the incidence of overexploitation is very high and the situation is becoming critical.

The assessment in Table 7.16 indicates that over 80 per cent of the blocks/assessment units were overexploited, dark, or critical in Rajasthan, which was closely followed by Punjab at 78.8 per cent, and Delhi at 77.8 per cent. In Haryana, Tamil Nadu, and Karnataka too the percentages were very high at 58.4, 45.5, and 38.9 respectively. Andhra Pradesh and Gujarat were also above the national average of 18.5 per cent.

Groundwater extraction has increased dramatically in India over the six decades since independence. Official statistics and projections indicate rapid growth in the area irrigated from groundwater, the number of wells, and the number of energized pump sets (The World Bank 1998). Data from the groundwater component of the World Bank–Government of India water sector strategy review (The World Bank 1998) clearly show the rapid rates of growth.

What factors contribute to this situation of overexploitation? In the interest of food security and inclusive growth, the government's policies have made subsidies and credit extensively available to farmers (Singh 2003). These have influenced power pricing and technology use which have strong linkages with groundwater development and use. These policies have

Table 7.15 Impact of Rainwater Harvesting and Groundwater Recharge by Check Dam Groups of Saurashtra Region in Gujarat—Members' Response

Per cent

Questions on the impact on: scarcity and efficiency equity empowerment development and environment	*Highly positive*	*Positive*	*No impact*	*Negative*	*Highly negative*
Timely water availability	44	56	0	0	0
Adequate water availability	56	44	0	0	0
Increase in irrigated area	45	55	0	0	0
Equitable distribution of water	0	0	100	0	0
Empowerment of farmers to manage irrigation systems	42	58	0	0	0
Beginning of a sense of ownership by farmers	61	39	0	0	0
Active involvement of all classes	30	70	0	0	0
Village as a whole	91	9	0	0	0
Environment and natural resources	83	17	0	0	0

Source: Gandhi and Sharma (2009).
Note: N=100.

fostered intensive groundwater utilization and a sharp increase in groundwater use has been recorded, leading to overexploitation. The expansion of groundwater use has resulted in a speedy decline in the groundwater table in several parts of the country (Bhatia 1992; Dhawan 1995; Moench 1992; and Dubash 2002). The evidence indicates that the fall in the water table is quite rapid in water scarce regions. In Rajasthan this decline is recorded at the rate of 1 to 5 metres per year in different conditions. If this trend continues then there will be irreparable loss, and socio-economic and environmental challenges will emerge. Immediate attention needs to be given to this.

The World Bank (1999b) indicates that there is no charge on groundwater itself and the present groundwater pricing structure provides minimal incentives for efficient and sustainable groundwater utilization. For electric pump sets, throughout almost the whole of India, charges are levied on a flat rate basis in proportion to the size/horse-power of the pump set. Such non-volumetric charging has only a very indirectly weak impact on actual water use (The World Bank 1999b). Moreover, in most areas power is supplied to the rural areas with a heavy subsidy element.

Moench (2003) maintains that much has been written on groundwater overextraction and water quality concerns in India but their real dimensions are difficult to evaluate objectively. Despite the apparent widespread nature of groundwater mining and pollution problems, the real extent may not be recognized since official statistics on the number of blocks where extraction is approaching or exceeding recharge may be misleading. There is great uncertainty over these estimates (Moench 2003). The average figure of water availability shows that the annual replenishable groundwater resources in India amount to about 430 BCM, and that the net withdrawal amounts to about 160 BCM per year. Based on these numbers and averages, this does not seem to be a grave problem. But averages are deceptive and most water issues are largely local issues. At the local level a huge number of productive localities are already under severe groundwater stress.

Perceptions of widespread overextraction stem from two pieces of strongly suggestive data:

- The rapid growth in the number of pumps and power consumption related to agricultural irrigation.
- Clear evidence of substantial water level declines in selected areas along with data suggesting that such areas are increasing rapidly.

Table 7.16 Categorization of Blocks/Talukas/Watersheds as Overexploited and Dark/Critical

		Number of districts	Number of assessed units (districts/blocks/taluka/mandal)	Overexploited		Dark/Critical	
				Number	Per cent	Number	Per cent
1	Andhra Pradesh	22	1231	219	17.79	77	6.25
2	Arunachal Pradesh	3	3	0	0.0	0	0.0
3	Assam	23	134	0	0.0	0	0.0
4	Bihar	42	515	0	0.0	0	0.0
5	Chhattisgarh	16	146	0	0.0	0	0.0
6	Delhi	9	9	7	77.78	0	0.0
7	Goa	3	11	0	0.0	0	0.0
8	Gujarat	20	223	31	13.90	12	5.19
9	Haryana	17	113	55	48.67	11	9.73
10	Himachal Pradesh	12	5	0	0.0	0	0.0
11	Jammu & Kashmir	14	8	0	0.0	0	0.0
12	Jharkhand	13	208	0	0.0	0	0.0
13	Karnataka	19	175	65	37.14	3	1.71
14	Kerala	14	151	5	3.31	15	9.93
15	Madhya Pradesh	45	312	24	7.69	5	1.60
16	Maharashtra	29	318	7	2.20	1	0.31
17	Manipur	6	7	0	0.0	0	0.0
18	Meghalaya	5	7	0	0.0	0	0.0
19	Mizoram	3	22	0	0.0	0	0.0
20	Nagaland	7	7	0	0.0	0	0.0
21	Orissa	30	314	0	0.0	0	0.0
22	Punjab	17	137	103	75.18	5	3.65
23	Rajasthan	32	237	140	5.91	50	21.10
24	Sikkim	4	1	0	0.0	0	0.0
25	Tamil Nadu	27	385	142	36.88	33	8.57
26	Tripura	3	38	0	0.0	0	0.0
27	Uttar Pradesh & Uttaranchal	74	820	39	4.76	13	1.59
28	West Bengal	16	269	0	0.0	1	0.37
29	UTs		18	2	11.11	0	0.0
	All-India	516	5723	830	14.50	226	3.95

Source: Central Ground Water Board (2006).
Note: Central Ground Water Board (2006). Unit of assessment: Mandals—Andhra Pradesh; talukas—Maharashtra, Gujarat, Karnataka, and Goa; districts—Arunachal Pradesh, Assam, Meghalaya, and Nagaland; state—Sikkim; districts (Valley)—Jammu and Kashmir and Himachal Pradesh and; islands—Lakshadweep. Rest of the states—blocks.
Overexploited: >100%; Dark: >85%—<100%

The situation on the ground indicates that official figures are probably underestimates (Moench 2003). The number of energized pumps, for example, is estimated based on loan and subsidy applications through NABARD. Loans and subsidies are not given in areas that have been declared 'dark' due to groundwater overextraction. However, well drilling continues based on private sources of finance—such wells are often not captured in official statistics and the numbers may be large. In Mehsana district of Gujarat, for example, estimates indicate that some 2,000 wells may be being drilled annually despite the region having been 'dark' for more than a decade (Moench and Kumar 1995). Further, until recently, there was substantial political pressure at the local level to ensure that regions were not declared overexploited or critical. Subsidies and votes tend to go together in all parts of the world and in India too this may have had an impact on estimates of groundwater extraction (Moench 1994)

For India as a whole, over 14 per cent of all blocks (referred to in Table 7.16) are either overexploited or critical, a number of which is expected to reach 60 per cent in just 25 years time, according to Briscoe (1996). A major problem of water table depletion is the deterioration in quality which has a large impact on the health of large sections of the population which heavily depends on groundwater. In Gujarat, groundwater provides most domestic and more than three-quarter of the irrigation water. Overextraction has caused the water table to fall by as much as 40 to 60 metres in many places, the yield of wells has decreased, cost of water pumping has increased, and in many cases wells are being abandoned. Groundwater mining in Gujarat and Rajasthan has resulted in fluoride contamination particularly endangering the poor in these areas.

Most discussions on groundwater overdraft emphasize the distinction between economic depletion (that is, falling water levels make further extraction uneconomic) and the actual dewatering of the aquifers (Moench 1992). Aquifers are depleted in an economic sense long before there is any real threat of their being dewatered. The Gangetic basin may have 20,000 feet of saturated sediment but from an agricultural perspective only the top few hundred feet are economically accessible for irrigation. Particularly, wells owned by small/marginal farmers are often shallow—only a few tens of feet deep. Putting this in the context of poverty and famine, falling water tables will first exclude the poor—those who cannot afford the cost of deepening wells. This may happen long before they affect the availability of water to wealthy farmers and other affluent users (Moench 1992).

Moench (2003) indicates that the impact of this would tend to be particularly pronounced during drought periods when a large number of small/marginal farmers could simultaneously lose access to groundwater when their wells dry up. During non-drought periods, water-level declines would undermine the economic position of small/marginal farmers forcing them onto already saturated unskilled agricultural and urban labour markets. The food security crisis in both these situations may be through the economic route rather than because of food grain availability per se.

A region where one of the most extensive overextraction of groundwater has taken place in the country is north Gujarat. Tube well depths have often crossed 1,000 feet in this area. Results from a recent study by Gandhi and Roy (2009), indicate that hardly any institutional change has taken place so far to deal with the situation. Cooperatives and partnerships of farmers exist and these do make an assessment of the quantity of water available and do contribute to more equitable distribution of the water among members. However, no attempt has been made to price the water according to its scarcity value and use. The members are aware that the activity of the institution is depleting groundwater in the village, but no effort is made by the institution to monitor or control the depletion and environmental harm. Equity is being looked at but scarcity and environmental harm/depletion are not being addressed.

Groundwater Quality Problems

Sharma and Kumar (2005) indicate that problems of water quality are emerging even in areas, such as the water-rich Krishna delta in Andhra Pradesh, a highly productive area known for its high crop yields. Due to insufficient supply of canal water, farmers' dependence on groundwater for irrigating crops has increased manifold during the last decade. The existing groundwater salinity problem has worsened as a result of unplanned groundwater development and extraction. An in-depth analysis of the hydro-geologic conditions was done through a two-dimensional cross-sectional model, and the simulations showed that the increase in groundwater salinity in the region (except close to the coast) was not due to saltwater intrusion from the sea but because of saline water intrusion from existing saline zones into freshwater zones, because of groundwater extraction.

Babaria et al. (2005), examined the quality of irrigation groundwater in the water scarce Saurashtra region of Gujarat. A survey of irrigation water in the seven districts of Saurashtra was undertaken and 169 underground well/tube well water samples were collected from the cultivate fields. Survey data indicated a range of Electrical Conductivity (EC) from 0.5 dS m^{-1} to 23 dS m^{-1}. Overall mean value (5.87 dS m^{-1}) was considerably higher than the critical value, and this was indicative of potential development of saline soils in these districts. By district, the highest mean value of pH 9.8 was recorded in Amreli and the lowest mean value of pH 6.7 was recorded in Junagadh. The overall mean value of SAR was 10.13.

The Efficacy of Water Institutions (Laws and Policies) in Managing Groundwater Challenges

According to the Indian Constitution and laws, groundwater is in the private regime in India, and the rights to groundwater are vested with the landowner. When a sale or purchase of land takes place, these rights are transferred with the rights to land from one owner to another. Besides this, under the Constitution water is a 'state subject' in India and is therefore under the jurisdiction and control of state laws and policies, with very little control of the federal/central government, except in the case of inter-state water disputes which are referred to it.

The Ministry of Water Resources, Government of India had proposed a new bill on groundwater control and regulation in 1970 which was revalidated in 1992 and circulated to all state governments. Some of the major elements of this included powers to notify specific areas for control and regulation of groundwater development, requiring grant permissions to extract and use groundwater in the notified areas, registration of existing users in the notified areas, prohibition of carrying on sinking wells in the notified areas, and so on. But it failed to get accepted and take off. There was no clause for involving users or user groups in the management structure.

Given this status of groundwater in the country, the Government of India recently brought out a National Water Policy in 2002 (Ministry of Water Resources 2002b: 4) which also covers groundwater resources. A few provisions of the policy are:

- There should be a periodical reassessment of the groundwater potential on a scientific basis, taking into consideration the quality of water available and economic viability of its extraction.
- Exploitation of groundwater resources should be so regulated as not to exceed the recharging possibilities, as also to ensure social equity. The detrimental environmental consequences of overexploitation of groundwater needs to be effectively prevented by the central and state governments. Groundwater recharge projects should be developed and implemented for improving both the quality and availability of groundwater resources.
- Integrated and coordinated development of surface water and groundwater resources and their conjunctive use should be envisaged right from the project planning stage and should form an integral part of project implementation.
- Overexploitation of groundwater should be avoided especially near the coast to prevent ingress of seawater into sweet water aquifers.

However, the National Water Policy as well as other such policy statements have largely remained on paper and not been translated into action (Jeet 2005). This appears to be primarily because the policies are not supported by the required institutional framework of laws, structures, and operational mechanisms. As indicated earlier, the legal and absolute right to groundwater rests with the landowner. Transferability of ownership independent of land is not defined. Tying water rights to land rights has major implications for access to groundwater and the distribution of benefits of water use, and it also constrains the potential for intersectoral allocation. The regulation of groundwater extraction suffers from major gaps (Briscoe and Malik 2006). Apart from a limited Act for the Chennai metropolitan area, 1987, a Bill in Gujarat, 2001, and the one passed by Maharashtra for protecting rural water supply, 1993, none of the states in India have addressed groundwater rights. However, indirect attempts have been made for controlling groundwater extraction.

These are, for example, through credit rationing by NABARD based on the degree of aquifer development, curbing new power connections to bore wells, and time restrictions on electric power supply. The present environmental legislations and regulations are also weak in addressing the environmental impact of groundwater utilization (Briscoe and Malik 2006).

The Central Ground Water Board (CGWB) has prepared a model legislation for groundwater regulation. This has been circulated to state governments and has undergone many revisions. The present version mainly emphasizes regulation, including management and overdraft regulations. These versions, however, contain no provision for ensuring the participation of the local population in the management or in the regulation (Jeet 2005).

A major institutional reform would be establishing tradable private property rights in groundwater. This could also empower communities to have rights over the groundwater that they manage, and address issues, such as efficiency, equity, and sustainability (Kumar 2003). However, bringing about such reforms in water rights would be a complex process because such rights may not always be mutually exclusive (Saleth 1996). If appropriate legal, institutional, and policy regimes exist, local user groups/organizations can emerge in problem areas with support from external agencies, such as NGOs (see Boxes 7.1 and 7.2 for some insights into independent initiatives). Some of them can help recognize the rights of individuals and communities over groundwater, and establish tradable private property rights. The present institutional arrangements in

Box 7.1
Groundwater Recharge in Khopala

Village Khopala is located in the Bhavnagar district of Saurashtra in Gujarat. It is a medium sized village with about 1,200 households and a population of approximately 6,500. The village community comprises of a mix of caste groups, including Patel, Bharwad, Harijan, Rajput, Khumbhar, Brahmin, Muslim, Vaghri, Koli, and a few others.

The village regularly faced acute water shortage due to low and erratic rainfall. Recently it received only 7 inches of rainfall. In the adjoining district of Rajkot, village Rajsamadiyala had dramatically improved its water availability by building check dams. Impressed by this, in 1998 Mathurbhai Savani, who belonged to Khopala village but was now a businessman in Surat, decided to motivate the villagers about the usefulness of water conservation methods, including the construction of check-dams. Savani spent a great deal of time with the villagers and convinced them about the importance of water conservation for easing the availability of water. He took a group of 50 villagers to Rajsamadiyala village at his cost and showed them the benefits of check dams. This motivated them greatly. The villagers realized the importance of water conservation and formed a village committee (*samiti*) for water conservation. The committee had broad representation and included many different caste groups.

Committee members surveyed the entire village area and identified about 200 locations suitable for constructing check dams. They also identified 16 sites for development for the purpose of farm ponds. There was also a big pond site on the government land, which could be developed and converted into a much better pond. After the survey, the committee had a meeting and took important decisions including:

- Construction of 200 check dams
- Construction of 16 farm ponds
- Collecting a contribution from each farmers @ Rs 1,200 per hectare
- Purchasing 5 acres of land from farmers in and around the big village pond for development
- One person from each family in the age group of 20 to 40 years should contribute labour for development work for 60 days
- Nobody should lift water from the village pond for irrigation purposes
- No tree felling in the village, and if anybody violated this, he/she should pay a penalty of Rs 1,000
- Bullock cart roads were earmarked for accumulation and channelization of water towards the check dams
- They decided to take 3 metre wide patches of land from both sides of these roads to expand the channel to provide room for water accumulation and shift the road to the side
- Any tube well of depth greater than 90 feet would not be allowed to function in the entire village area including the farms

(*contd.*)

Box 7.1 (*contd.*)

Later they also came to know about a government scheme supporting construction of check dams. Under this the government contributes 90 per cent of the total cost and the rest is to be borne by the villagers. The government's share is routed through NGOs. Since the construction of check dams was not planned with the help of an NGO nor had they made any application to the government, this would take time. After extensive deliberations, the samiti decided to go ahead with the construction of check dams without the help of the government and through their own contributions. They decided to do this before the 1999 monsoon season. At this juncture, Savani came up with the proposal of a 75:25 scheme, in which the villagers would have to raise only 25 per cent and he would make arrangements for 75 per cent of the costs through donations. The samiti agreed to his suggestion and began collecting the required funds at the rate of Rs 1,200 per hectare from each and every farmer. About 95 per cent of the farmers contributed (900 farmers) their share (*lokfalo*) accumulated to approximately Rs 36 lakh (1 lakh=100,000). And as promised, Savani raised a contribution of Rs 79 lakh. Thus the total fund available for the construction of check dams reached Rs 115 lakh.

On 19 December, 1998 the samiti started the construction of check dams and repair work of the ponds. Before the 1999 monsoon season (June), they had constructed 200 check dams. Besides, they had enlarged and repaired the village pond, increasing its size from 5 to 10 acres. They had also made 16 new farm ponds in the village, ranging in area from 0.5 bigha to 5 bigha (4 bigha=1 ha). Among the 200 check dams, 80 were of about 5 metres in length, 100 were of 5 to10 metres, 17 were of 10 to 20 metres, and 3 dams had a length of more than 20 metres. The total cost incurred for all these was Rs 135 lakh. So the samiti ended with a deficit of Rs 20 lakh. However, they were not deterred by the deficit in completing the work. They borrowed this amount from well-to-do farmers and traders.

In the meantime they came to know about a scheme of the Forest Department for the construction of check dams. The samiti approached Forest Department officials, and explained their current position of a deficit of Rs 20 lakh. The officials inspected the check dams made by the villagers, and out of 200 check dams, they offered help for 30–35 check dams which amounted to Rs 20 lakh. This was paid in August-September, 1999. Thus, the samiti could meet all the costs and clear the debts.

After the check dams were completed in June1999, the monsoon started. Immediately after the onset of the monsoon the results started becoming visible. Before the check dams were constructed all the open wells (about 450) in the village had been dry. In the 4 tube wells, water was available only at a depth of 200 feet or more. Immediately after rains the open wells were seen starting getting recharged. There were about 40 open wells which had been completely abandoned. They were cleaned. These wells were also recharged. By the end of 1999 all the open wells in the village had been recharged fully. Water became available at a depth of only about 40 feet. By the end of 2003 over 60 open wells had been newly constructed. The owners of the 4 tube wells discontinued their use and began to depend only on their open wells. If anyone wanted to sink a tube well even for drinking purposes, they were allowed to go only up to a depth of 90 feet. It was estimated that there was an almost 4-fold increase in the availability of water for irrigation. The samiti also distributed 10 tree saplings to each farmer in 1999 to grow on their farm boundaries. In 2003, Savani inspected the tree saplings, and those farmers who had grown the maximum number of sapling were given rewards.

India which involve central, state, and local institutions, and both formal and informal structures, are unable to bring about water allocation, planning, and management on a comprehensive or scientific basis.

Bold steps have been taken by many countries in the face of similar challenges that India is facing concerning groundwater ownership. In the early 1980s the legislatures of the American arid states of Arizona and New Mexico replaced the common law/rule of absolute ownership of groundwater, with a government-administered permit system of groundwater extraction (The World Bank 1999b). The legislature of the Australian state of Victoria did the same thing with the 1989 Water Act. In England and Wales, government-administered licensing requirements were superimposed on the existing riparian rights in groundwater under the 1963 Water Act. The Spanish legislature passed legislation in 1985 whereby all hitherto private groundwater resources became the public property of the state. Italy's parliament passed legislation in 1994 vesting all private water resources, including, in particular, groundwater in the state. These legislations effectively curtailed the significant attributes of land ownership, such as the right to sink a well, and the right to extract any amount of groundwater from beneath one's own land (The World Bank 1999b).

Box 7.2
Sodhala Tube Well Partnership and Water Markets in Kansa Village

The concept of partnership in tube well irrigation system came into existence in Kansa village in 1962. The declining water table, high cost of construction of the tube wells at the individual level, and their low life-span were the major reasons behind the start of this innovation in irrigation. Kansa village is in Visnagar taluka of Mehsana district in Gujarat. It is a large village of about 2,300 households and a population of about 12,000. The village community has many caste groups, including Patel, Thakor, Rajput, Brahmin, Vaghri, Raval, and Harijan. Agriculture and dairying are the major economic activities and the major crops are wheat, mustard, cotton, and castor. The minor crops are *jeera* (cumin), *variyali* (fennel), *methi* (fennugreek), *sava*, chichory, *isobgul*, *bajri* (pearl millet), *guar*, *moong* (green gram), sesamum, paddy, *jowar* (sorghum), *banti,* and fodder crops.

Five farmers of Kansa village—Ramanbhai Patel, Keshavlal Patel, Ishwarbhai Amthibhai Patel, Senthabhai Madhavlal Patel, and Babubhai Keshavlal Patel —got together to form a tube well partnership called the Shodhala Tube-Well Partnership. They invested in and constructed a tube well of 180 feet depth and installed a 30 HP electric pump in it. The partners shared the capital investment and also the operating cost and income from the sale of water equally. Apart from their own use, they earned a profit by selling water to fellow farmers. In the early 1960s they got power supply for 20 to 22 hours in a day. From the late 1960s, the power supply became erratic and it was available for only 10 to 14 hours a day. As a result, the water pumped was not sufficient to irrigate their lands as well as the land of other farmers. In the early years the average profit was about Rs 50,000 per year. But over the years, with the power supply problem and declining water discharge from the well, the profits declined.

Ultimately the tube well enterprise failed in 1975, and the partnership then constructed a new tube well. This time the necessary well depth increased to 300 feet and it was operated with a 45 HP pump. They also increased the number of partners from five to 25. The partnership share varied from 1 to 5 per cent. This tube well remained operational until 1990 when 40 farmers were made partners with partnership shares ranging from 1 to 5 per cent. The partners were from the Patel and Thakore communities. They constructed another tube well whose depth was 480 feet and it had a 75 HP pump. This tube well was in good working condition until recent times. In last few years the enterprise and the farmers have faced acute power supply problems. The power supply is available only for 6 to 7 hours a day and there are high voltage fluctuations. The supply timings are also very irregular. Because of this erratic nature of power supply, the pump needs repair 2 to 6 time a year. Each time the repair costs come to around Rs 10,000. In recent years, the partnership has been able to provide irrigation to only about for 85 bighas of land (4 bighas = 1 ha).

Though, the Shodhala Tube well Partnership is an informal unregistered partnership, it has evolved an institutional structure. It has a general body of partner members, which meets every year. Decisions, such as the share of water to be made available to each member in the forthcoming season are taken in this meeting. This water share is based on various factors, including the contribution share of the member in the partnership, the expected power supply availability situation, and the expected available water discharge from the tube well. Typically, each partner is expected to use a minimum of Rs 500 worth of water, and even if he does not use it, he is required to pay Rs 500 to the partnership. This compulsory collection helps to meet fixed costs, including the fixed electricity charges for the pump. Ramanbhai Keshavlal Patel is the founder member of this partnership and is its leader. He has managed the partnership for many years. For his role and work he is paid Rs 20,000 per year. The partnership has to pay a fixed flat rate electricity charge @ Rs 500 per HP of the pump per year and the electricity bill is received every six months.

The enterprise has evolved a system of charging partners and other farmers for the water. The water output of the tube well gets divided into three equal parts and comes out in three separate outlet pipes. The output of each pipe is called one unit output flow, and locally it is called one '*reila* or 'stream'. The basis of pricing is per reila per hour and the present price is Rs 35 per reila per hour in cash. If the discharge from the well is good then all the three reila are brought out and used to irrigate separate fields or else fewer 'reila' are brought out. From 'reila', it typically takes 8 to 9 hours to irrigate one bigha of land for the first irrigation. Subsequent irrigations may require only 6 hours. As mentioned earlier, the charge is Rs 35 per reila per hour in cash, or alternatively, in kind per bigha irrigated for some crops. The current crop-wise pricing is given in the Table 7.17. For payments in kind, the produce is collected at the end of the season. The general body identifies a trader during its meeting and the produce is sold through him. The produce may also be stored for some time to get a better price. The profit/loss is calculated at the end of the year and this is divided among the partners based on their share in the partnership.

Table 7.17 Pricing of Water: Crop-wise Charges and General Irrigation Needs

Item/Crop	*Mustard*	*Cumin and fennel*	*Wheat*	*Castor*
Water charges in cash (Rs 35 per reila per hour) or in kind	80 kg mustard per bigha	Rs 35 per reila per hour	240 kg wheat per bigha	Rs 35 per reila per hour
Number of irrigations typically required by the crop	4	4	6	5 to 8

The partnership faces many problems. A major problem is the limited power supply, often for only a few hours a day. Another problem is the fluctuation in power supply which damages the motor and increases maintenance costs. A serious problem is the decline in the water table and therefore decreasing outputs from the wells. The capital cost of the construction of wells is increasing because of the increasing water table depth as well as the increase in construction and equipment costs. Some rough figures reported by the farmers are given in the table below. Besides, there is an increasing risk since the outcome of the drilling of tube wells is uncertain, adding to the cost as well as the risk. Further, operating costs are rising and the wells often fail early—they have a shorter life-span. With rising costs, risks, and scarcity, getting the involvement, contribution, and cooperation of the farmers is becoming more difficult and challenging.

Table 7.18 Approximate Depth of the Water Level, Wells, and Well Cost Over the Years

Year	*Water level (ft)*	*Well depth (ft)*	*Cost (Rs)*
1963	40	100	50,000
1970	90–100	250	1,00,000
1980	250		
1990	350	700–800	
2000	400		
2003	500	1,000	10,00,000

Conclusions and Policy Implications

Groundwater has grown in importance to occupy a dominant place in India's agriculture, food security and water supply. It has become the main source of growth in irrigated area and is now critical to food security. Groundwater management is, however, heading for a crisis in India and needs urgent attention and understanding.

It is clearly established that having irrigation water improves agriculture, and further, in-depth research finds groundwater to be a superior source of irrigation compared to surface water. It is associated with better yields, input use and profitability. This is mainly because it offers better control over water availability and use to the farmers. Researchers find that farmers owning wells generally achieve the highest yields, while those purchasing water from well owners achieve yields higher than those dependent on canal irrigation alone. Yields in groundwater irrigated areas are found to be higher by one-third to one-half as compared to those from areas irrigated by surface sources. Well irrigation is also associated with higher cropping intensity, higher cash input expenditure and higher gross income per acre. Increase in groundwater irrigation is also closely associated with a reduction in the risk and variation in production.

Assessments show that India has a huge groundwater resource but its availability and status vary substantially between basins, states, and areas. 40 per cent of the groundwater resource is in the Ganga basin alone, and no other basins even crosses 10 per cent. Given this variation, the management of groundwater would need to be different in different areas. Overall, groundwater extraction has increased dramatically in the six decades all over India since independence. Official Indian statistics and projections all indicate rapid growth in the area irrigated from groundwater, the number of wells, and the number of energized pump sets, and data from the World Bank-GOI reviews also show the same.

The state-wise profiles bring out an alarming picture. The level of groundwater development is already as high as 141 per cent in Punjab, 111 per cent in Rajasthan and 105 per cent in Haryana. This is followed by Tamil Nadu at 81 per cent, Gujarat at 70 per cent, and Uttar Pradesh/Uttarakhand at 65 per cent. Further, these figures hide the highly skewed intra-state distribution. Assessment by talukas/blocks/assessment units indicates that in Rajasthan, over 80 per cent of the blocks/assessment units are overexploited, dark or critical, closely followed by Punjab at 78.8 per cent, Delhi at 77.8 per cent, as well as Haryana, Tamil Nadu and Karnataka at 58.4, 45.5 and 38.9 respectively, and Andhra Pradesh and Gujarat are above the national average in overexploitation.

There is rapid growth in pump numbers and power consumption related to irrigation and clear evidence of substantial water level declines. Information suggests that declines are increasing rapidly even in the areas declared 'dark'. There is also often substantial political pressure at the local level to ensure that regions are not declared overexploited or critical. This could be affecting the groundwater status statistics and the official figures may be underestimates.

There is an urgent need to tackle overexploitation of groundwater in the country. The measures may range in nature from informal to formal, individual to institutional/legal, and voluntary to compulsory. At an informal level, awareness about groundwater overexploitation and its consequences needs to be greatly increased through extension and publicity campaigns. Groups or associations of farmers may be formed to monitor and manage groundwater. These may be built over existing water users groups/associations/cooperatives or farmer bodies of other kinds. A government department initiative to measure the groundwater level/situation (already existing in some areas) on a monthly or quarterly basis extensively across blocks/villages is required along with reporting and dissemination of this information through the above mentioned means and bodies. Since electric pumps are extensively used to pump the water, controlling the availability of electricity supply for operating pumps can go a long way in reducing overexploitation. This has been successfully tried in parts of Gujarat. Metering and charging of electricity at the real economic price also needs to be implemented.

Other direct measures would include restricting the number of tube-wells through licensing or through imposing institutional credit restrictions. Pumping of water can also be restricted through installation of water meters on tube-wells as done in many developed countries. Overall, new legislation is required to control groundwater exploitation, and a constitutional amendment separating the right to groundwater from the right to land would help provide the necessary foundation for stronger laws and institutional controls.

Since agriculture is the largest user of water, accounting for over 80 per cent of the water use, improvement in the efficiency of water use in agriculture can go a long way in alleviating the supply-demand imbalance and tackling the overexploitation of groundwater. Frequent flooding of fields to irrigate is extremely inefficient especially when no proper assessment of the soil moisture and the crop water need is done, and the fields are poorly leveled. Promotion of alternatives such as irrigation through furrows, drip irrigation, and sprinkler irrigation can greatly improve water use efficiency and even these should be done after assessment of soil moisture and critical stages of crop water need. Good land leveling can also go a long way in reducing farm water need. Other conservation measures such as mulching can also help.

To signal the scarcity of water, formal and informal controls and proper pricing of water is a must. If water is expensive, farmers will use it more efficiently. Pricing should be done by crop, and high water charges should be there for high water using crops such as sugarcane, rice and banana. Restrictions on the dates of planting for crops such as rice can also help, as has been done in Punjab. Avoiding the extremely hot weather in May-June for planting rice can greatly reduce water need and improve water use efficiency. This would be helped by developing and recommending the appropriate crop varieties. On these lines, the development of varieties which are drought resistant and have better water use efficiency would also help substantially.

Aquifers are depleted in an economic sense long before they are dewatered. Often only the top few hundred feet are economically accessible for irrigation. Further, wells affordable to small/marginal farmers are often shallow and falling water tables will first exclude the poor long before they affect availability of water to wealthy farmers and other affluent users. This effect would to be particularly pronounced during drought periods when huge number of small/marginal farmers would simultaneously lose access to groundwater as their wells dry up. Depleted access forces them onto already saturated unskilled agricultural and urban labour markets. Thus both the poverty and the food security situation would be aggravated in these conditions through the economic as well as the food grain production route.

Institutional development such as the setting-up of elected and empowered water user associations is extremely important to improve the efficiency and equity in groundwater management. However, the ability of such institutions to implement control would be substantially enhanced by the separation of water rights from land rights, and putting water rights on a strong, separate and equitable basis. Apart from reducing overexploitation, increasing the recharge of groundwater through harvesting of rain and surface flows would prevent the dewatering of aquifers, and also greatly improve equity by making water available in the wells affordable to small and marginal farmers.

Deteriorating quality of the groundwater is another major problem and is substantially related to overexploitation in many areas—particularly with salinity, fluoride and other chemical toxicity problems which usually increase with water depth. However, other contaminations also need to be addressed. Regular testing of all sources of water which are being used for human consumption is a must in improving awareness, alertness and control. Creating alternative sources of water is a must where quality problems exist.

As indicated earlier, different approaches are required in different areas and so state governments and state policies need to play a very important role. In Eastern India, for example, which is in the Gangetic basin, there is a case for development of groundwater resources. Eastern India has the bulk of India's poverty and is largely rural, agricultural, flood-prone, with a high population density, and has had a slow pace of groundwater development. Increased density of wells can increase the welfare of the people through irrigation as well as through the powerful positive externality of working against water-logging and flood-proneness. Research indicates that pumping out of groundwater for irrigation in the dry season can create substantial capacity in aquifers to store flood and drainage water underground during the wet season, and this can mitigate floods by leading to as much as 50 per cent reduction in the monsoon flow of rivers. Thus, groundwater development can contribute to full realization of the agricultural potential of the eastern region and also be effective in reducing and preventing flood and water-logging conditions which are major threats in eastern India. However, safeguards are a must to foster planned development and prevent overextraction.

Legally, water is a state subject in India and groundwater is under the private regime. The rights to groundwater belong to the landowner. The rights to groundwater are transferred to anyone to whom the land is transferred. There is no limitation on how much groundwater a particular landowner can draw. This leads to a concentration of water ownership with the land and capital owners in India and a lack of control over the extraction of water. Legally separating land and water rights would be a fundamental step in better managing groundwater.

The present institutional arrangements in India involving central, state, and local institutions, and both formal and informal structures, are unable to bring about water allocation, planning and management on a comprehensive or scientific basis. Apart from immediate controls, a major institutional reform required is the establishment of specific private and community property right in groundwater preferably tradable property rights. This would also empower communities to manage groundwater better and address issues such as efficiency, equity and sustainability. Bringing about such reforms would be a complex process. But if appropriate legal, institutional and policy regimes exist, local user groups/organizations can emerge in problem areas with support from external agencies such as the government and NGOs, bringing better control and efficient use.

Many countries facing similar challenges have taken bold steps. The legislatures of the American arid states of Arizona and New Mexico replaced the common law/rule of absolute private ownership of groundwater, with a government-administered permit system of groundwater extraction. The legislature of the Australian state of Victoria has also recently made a similar change replacing the law/rule of absolute private ownership of groundwater, with an administered permit system of groundwater extraction. In England and Wales, a government-administered licensing requirement has been superimposed on the existing riparian rights in groundwater. In Spain, in 1985, all hitherto private groundwater resources became the public property of the state. In Italy legislation was passed in 1994 vesting in the state all private water resources, including, groundwater. These changes are leading to far better management of the groundwater resources in these countries. Similar changes are urgently required in India.

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8 Rainwater Harvesting for Irrigation in India

Potential, Action, and Performance

Vasant P. Gandhi and Vaibhav Bhamoriya†

Introduction

Rapid expansion of groundwater use in India in the last three decades has resulted in a steep decline in the groundwater table in vast areas of the country. This has led to drying up of a huge number of wells, low well productivity, rapid rise in well and pumping depths, deteriorating groundwater quality, and also salinity ingressin many areas, see discussion in Chapter 7 of this *Report*. Shallow wells are running dry and the depth of tube wells is increasing every year. Some estimates indicate that the withdrawal rate of groundwater in India is twice the recharge rate (International Water Management Institute 2002).

In response to this situation, rainwater harvesting offers a critical and promising solution to replenish and recharge the groundwater (in areas where geologic conditions are conducive). In a typical setting, much of the rainwater is lost to surface flows. Rainwater harvesting for agriculture generally involves the creation of structures such as check dams, ponds, and percolation tanks to slow the flow of water, and to collect and hold limited quantities at a planned set of places along the flow path. The primary objective is to increase the percolation of the rainwater into the ground to recharge the groundwater table. This leads to a rise in the water table levels, increased supply of water in wells, and a longer period of availability of water. In this chapter, we outline the case for small decentralized water harvesting structures and institutions in contrast with the conventional, centralized river basin wide planning and development model of water resource management. We review policy initiatives on watershed development (WSD). We also present the results of a survey where respondents were beneficiaries of check dams in the Saurashtra region of Gujarat and draw policy implications from the same.

Background

What is the amount of water available through rainwater in India annually? The normal annual rainfall precipitation in the country is estimated to be 400 million hectare-metres (Mha-m) of water (Majumdar 2002) (see Figure 8.1). Out of this, 115 Mha-m enters surface flows, 215 Mha-m enters the ground, and 70 Mha-m is lost to evaporation. Only 25 Mha-m is finally used

† The authors are grateful to Suresh Sharma and Ashutosh Roy (Indian Institute of Management, Ahmedabad) for their contributions to parts of this research.

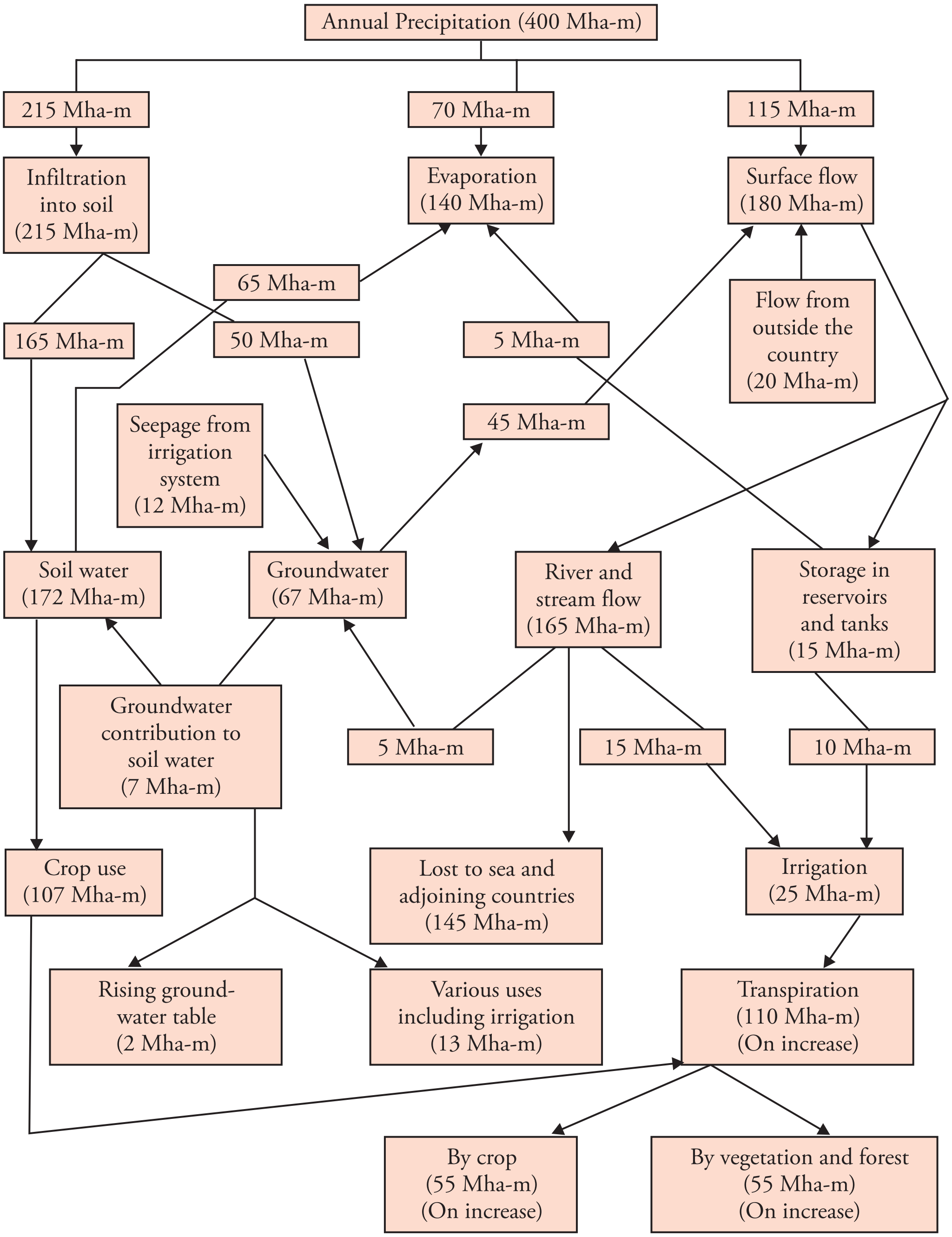

FIGURE 8.1 Water Resource Wealth of India

Source: Majumdar (2002).

through surface irrigation which constitutes a mere 6 per cent of the total water available through rain and from flows from outside the country (20 Mha-m). The figure also indicates that out of the 215 Mha-m infiltrating into the soil, only 13 Mha-m is utilized for groundwater irrigation and other uses. This again constitutes a mere 6 per cent of the annual precipitation infiltrating into the soil, indicating the substantial potential for rainwater harvesting.

One of the reasons for the poor utilization of rainwater in India is the high concentration of rainfall over a few months. As Table 8.1 shows, about 74 per cent of the rainfall is received during the south-west monsoon period of June to September. Even this does not fully reveal the concentration of big spells of rains. As a result, the soil saturates, and much of the water flows away if no structures are made to check this flow. The uneven distribution also creates a situation of long dry periods when cropping is difficult if water is not retained or made available in some other way.

Besides this, the distribution of rainfall is also geographically highly uneven (see Table 8.2). Only 8 per cent of the country receives very high/assured rainfall of above 2000 mm, and another 20 per cent receives high rainfall of 1150 to 2000 mm. The rest of the country, that is, 72 per cent, is in the low, dry, or medium rainfall range of less than 1150 mm, with 30 per cent area particularly dry at below 750 mm. Thus, in vast areas, unless wells are present, groundwater is not available with adequate rainwater recharge. In the absence of a proper surface irrigation scheme, crop production becomes difficult. Athavale (2003) indicates that about 50 per cent of irrigation water, 85 per cent of the drinking water, and about 33 per cent of the domestic water in cities comes from tapping of groundwater through dug wells or tube wells. By 2008–9, groundwater accounted for about 61 per cent of the irrigated area in the country (Ministry of Agriculture 2010).

Table 8.1 Distribution of Annual Rainfall by Seasons in India

Rainfall	*Duration*	*Approx. percentage of annual rainfall*
Pre-monsoon	March–May	10.4
South-west monsoon	June–September	73.7
Post-monsoon	October–December	13.3
Winter or north-east monsoon	January–February	2.6
Total	Annual	100.0

Source: Meteorological Department of India, Pune, cited in Fertilizer Association of India (2007).

Table 8.2 Distribution of Area by Annual Rainfall in India

Rainfall classification	*Amount of rainfall (mm)*	*Approx. percentage of area receiving rainfall*
Low/Dry	Less than 750	30.0
Medium	750 to 1150	42.0
High	1150 to 2000	20.0
Very high/Assured	Above 2000	8.0
Total		100.0

Source: Meteorological Department of India, Pune, cited in Fertilizer Association of India (2007).

The situation of acute drops in the water tables is highlighted by Table 8.3. Water table falls of over four metres per year are seen in a large number of districts. The situation seems to be particularly acute in the states of Madhya Pradesh, Rajasthan, Gujarat, Maharashtra, Uttar Pradesh, Andhra Pradesh, and Tamil Nadu where sharp drops are common. There appears to be a widespread need to explore the possibilities of rainwater harvesting to alleviate the decline in water tables.

As pointed out in Chapter 7, 'Groundwater Irrigation in India: Growth, Challenges, and Risks' in this *Report*, the level of groundwater development is already as high as 141 per cent in Punjab, 111 per cent in Rajasthan, and 105 per cent in Haryana. This is followed by Tamil Nadu at 81 per cent, Gujarat at 70 per cent, and Uttar Pradesh/Uttarakhand at 65 per cent. Further, these figures hide the highly skewed intra-state distribution.

Importance of Rainwater Harvesting

Verma et al. (2008) indicate that decentralized small water harvesting structures present a major alternative to the conventional river basin water resource development models. An excellent example is the decentralized, large-scale, check dam rainwater harvesting movement in Saurashtra, Gujarat. This is also brought out by studies conducted by the Central Soil and Water Conservation Research and Training Institute, Dehradun (reported by Khurana 2003).The studies show a clear relationship between the size of catchment and amount of run-off that can be captured. Increasing

Table 8.3 Observed Annual Fall in Water Table Levels, District Frequency, May 1999 to May 2001

States	*May 1999 to May 2000*		*May 2000 to May 2001*	
	Fall in water table level			
	2 to 4 metres	*More than 4 metres*	*2 to 4 metres*	*More than 4 metres*
	Number of Districts			
Andhra Pradesh	8	6	5	3
Maharashtra	11	6	12	3
Madhya Pradesh	3	2	23	11
Rajasthan	All except 5	14	NA	NA
Punjab	2	1	6	0
Haryana	3	2	3	1
Uttar Pradesh	6	4	11	6
Bihar	4	–	NA	NA
West Bengal	3	2	NA	NA
Orissa	2	1	NA	NA
Assam	4	–	5	1
Gujarat	All except 4	9	NA	NA
Karnataka	8	3	4	2
Tamil Nadu	13	6	16	10

Source: Ministry of Water Resources (2001).
Note: NA–data not available.

the size of the catchment from 1 hectare (ha) to about 2 ha reduces the water yield per hectare by as much as 20 per cent. Thus, in a drought prone area where water is scarce, 10 tiny dams with a catchment of 1 ha each will collect more water than one larger dam with a catchment of 10 ha. Khurana (2003) indicates that the drought proofing benefits from small rainwater harvesting structures can very effectively distribute the available water when there is no drought or a limited drought. Moench and Kumar (1993) say that smaller structures help in conditions of high inter-year rainfall variability and low reliability.

Rockstrom et al. (2009) discuss that rainwater harvesting structures can be very useful for semi-arid and dry, sub-humid regions especially as water scarcity is caused by extreme variability of rainfall rather than the amount of rainfall. Under such conditions, with high rainfall intensities, few rain events, and poor spatial and temporal distribution of rainfall, even if total rainfall is adequate, water losses are very high, thus leading to scarcity. Given that the frequency of dry spells and droughts is expected to increase with climate change (Intergovernmental Panel on Climate Change 2007), they suggest rainwater harvesting structures as extremely important for mitigating the impact on agriculture and increasing agricultural productivity. Rockstrom et al. (2009) argue for the need to downscale water resource management from the river basin scale to the catchment scale (about 1000 km^3). Indicating these important benefits, Oweis (1997) finds that bridging critical dry spells through supplemental irrigation of about 50 to 200 mm through groundwater and rainwater harvesting can stabilize yields in dry, sub-humid regions; and up to 400 per cent increase in yields have been reported in the arid regions of Syria.

Kateja (2003) discusses the importance of groundwater in arid states such as Rajasthan and the need for different techniques of groundwater recharge. Seventy per cent of the population in Rajasthan depends on groundwater for drinking and irrigation purposes and the scanty rainfall cannot recharge the groundwater without the adoption of water harvesting techniques. The techniques may include recharge structures such as *Talabs, Nadi, Tanka, Bawari, Jhalara,* and *Khadin* to suit the local geological and climate conditions. Groundwater extraction is also leading to significant water quality problems and health hazards and over 16,000 habitations (that is, about 13 per cent of the total habitations in the state) may be fluoride affected.

With respect to the usefulness of tanks for collecting rainwater and recharging groundwater, Shah and Raju (2001)—who studied the socio-ecology of tanks and water harvesting in Rajasthan—report that there are multiple benefits from tanks. Tanks lead to substantial rainwater harvesting at the local level, and the associated distribution system leads to water availability in large areas and to larger numbers of farmers. A significant benefit of percolation of rainwater is groundwater recharge and higher water table in the area. Other benefits include low cost flow irrigation, reduction in intensity of flash floods, concentration of silt and minerals to fertilize the soil in the command area, and reduction in soil erosion.

Kishore et al. (2005) find that even when the rainfall shows no decline, there are growing scarcities at many locations, as use is increasingly exceeding the availability. They say that the only recourse in such locations is to close the demand–supply gap by conserving water through rainwater harvesting. This may include building a core wall on the upstream side of ponds to prevent them from pulling out groundwater from upstream lands.

Tilala and Shiyani (2005) undertook a study of the impact of water harvesting structures on the Raj Samadhiyala village of Saurashtra near Rajkot. This is a highly admired rainwater harvesting experiment and the study sought to evaluate the impacts through a comparison of beneficiaries and non-beneficiaries (see Table 8.4). The authors found that the water harvesting structures had a substantial positive impact on the cropping patterns of farmers (for example, could grow vegetables in summer), crop yields (42 per cent , 45 per cent, and 31 per cent increase for groundnut, cotton and wheat, respectively comparing beneficiary and non-beneficiary farmers) and farmer incomes (76 per cent, 95 per cent, and 77 per cent higher farm business income for beneficiaries vis-à-vis non-beneficiaries in these crops). They also report benefits of higher water use efficiency, reduction in cost of production, and higher labour productivity.

Sikarwar et al. (2005), evaluated the impact of 5 small check dams and 5 marginal check dams constructed in Saurashtra, Gujarat in the Ladudi Watershed between 2002 and 2004 by the Gujarat State Land Development Corporation (GSLDC). They found that the total hours of irrigation from the wells increased by 32 per cent and that there was a rise of 6 to 7 metres in the water table depth observed in the wells. There was also improvement in the cropping pattern, net revenues, as well as the socio-economic status of farmers as a result of the check dams.

The National Water Policy 2002 recommends the development of water harvesting systems to increase the utilizable water resources. In line with this, the Tenth Five Year Plan set targets and budgets for artificial recharge of groundwater and rainwater harvesting (see Table 8.5).

Table 8.4 Yield and Returns per Hectare of Different Crops

Items	*Unit*	*Groundnut*			*Cotton*			*Wheat*		
		Beneficiaries	*Non-beneficiaries*	*per cent change*	*Beneficiaries*	*Non-beneficiaries*	*per cent change*	*Beneficiaries*	*Non-beneficiaries*	*per cent change*
Yield	Q	21.01	14.75	42.44	14.50	10.03	44.56	33.97	25.91	31.11
Gross Return	Rs	28610	20370	40.45	28086	19318	45.38	27642	21097	31.02
Farm Business Income	Rs	12810	7248	76.74	8335	4267	95.33	16138	11242	43.55

Source: Tilala and Shiyani (2005).

Table 8.5 Targets and Budget for Recharge Structures Under the Scheme 'Artificial Recharge of Groundwater and Rainwater Harvesting' of the Tenth Plan

States/UTs	*Number of recharge structures*	*Cost (Rs in Lakh)*
Andhra Pradesh	185	1350
Bihar & Jharkhand	205	750
Chhattisgarh	104	500
Delhi	235	300
Goa	30	150
Gujarat	240	1350
Haryana	260	350
Himachal Pradesh	64	350
Jammu & Kashmir	40	350
Karnataka	373	1350
Kerala	95	350
Madhya Pradesh	232	1100
Maharashtra	212	1100
North-Eastern States	165	600
Orissa	100	800
Punjab	425	500
Rajasthan	196	1350
Sikkim	170	150
Tamil Nadu	184	1350
Uttar Pradesh & Uttaranchal	770	1500
West Bengal	236	900
Andaman & Nicobar Islands	77	100
Chandigarh	100	100
Lakshadweep	100	100
Dadra & Nagar Haveli	140	100
Daman & Diu	110	100
Puducherry	38	100
Eastern Coastal States	1	200
Western Coastal States	1	200
India	5088	17500

Source: Ministry of Water Resources (2002).

WSD Programmes

A major national initiative in India in which rainwater harvesting is a significant component is the WSD programme, taken up under different schemes/programmes of the Government of India and the state governments (See Table 8.6). Raising productivity and incomes in rain-fed areas is a major challenge in India and a key to achieving this is to improve the use of natural resources—particularly land and water which are major constraints in these areas. Since about 50–60 per cent of the country's population depends directly or indirectly on agriculture for income and livelihood (including the majority of the poor), and poverty is particularly acute in the rain-fed areas, WSD programmes are given huge importance. They are seen as a significant measure for mitigating drought impact and reducing the vulnerability of the large poor populations in dry regions.

For WSD programmes, scientists and engineers have developed a variety of technologies which offer solutions to difficult watershed conditions. The solutions include interventions ranging from simple check dams to large percolation and irrigation tanks, from vegetative barriers to contour bunds, and changes in agricultural practices for example, in-situ soil and moisture conservation, agro-forestry, pasture development, horticulture, and silvipasture. A hierarchy of institutional arrangements of the government and other agencies undertakes the planning and implementation of WSD. An example of an institutional arrangement is shown in Figure 8.2. A watershed is considered a geo-hydrological unit or an area that drains to a common point. Practical definitions have varied over the years but for government projects and budgeting purposes, a watershed has been typically identified as an area of approximate 500 ha in a village. This is being expanded in the recent years.

The history and concept of WSD in India can be traced back to the Famine Commission of 1880 in British India which first indicated its importance. It was identified again in 1928 by the Royal Commission of Agriculture. After independence, Government of India-supported WSD programmes started during the 1950s. The first step towards a systematic effort to tackle the problem of drought and desertification through WSD was the establishment of a special centre at Jodhpur in 1952 with the major focus of carrying out research on core needs of desert area development. In 1959, the entire responsibility for research on dry land/desert

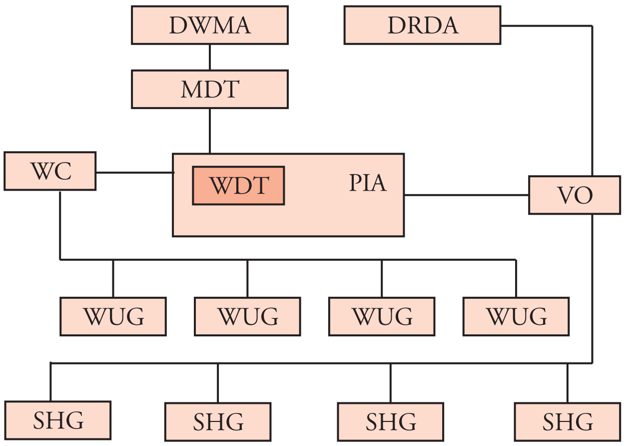

Figure 8.2 An Example of the Institutional Arrangement for Water Development

Source: Authors' own.
Note: DWMA—District Water Management Agency; DRDA—District Rural Development Agency; MDT—Multi Disciplinary Team; PIA—Program Implementation Agency; SHG—Self-help group; VO—Village Organization; WC—Watershed Committee; WUG—Water User Group; WDT—Watershed Development Team.

areas was entrusted to the above centre which was then designated the Central Arid Zone Research Institute (CAZRI). The first large-scale government supported watershed programme was launched in 1962–3; a major purpose was to check siltation of multi-purpose reservoirs through soil conservation works in the catchments of river valley projects.

During the Second and Third Five Year Plans, the problems of drought-affected areas were mainly sought to be solved by launching Dry Farming Projects, which were initially taken up in a few areas and emphasized moisture and water conservation measures. The Fourth Plan continued to place major emphasis on dryland farming technology, and for this purpose, the All India Coordinated Research Project for Dryland Agriculture was started, later based at the Central Research Institute for Dryland Agriculture (CRIDA). Under its aegis, 24 pilot projects were started to serve as training-cum-demonstration centres for application of technology relating to soil management, water harvesting, improved agronomic practices, drought resistant crops, and more.

The origin of the Drought Prone Areas Programme (DPAP) can be traced to the Rural Works Programme launched in 1970–1 with the objective of creating assets designed to reduce the severity of drought in the affected areas. The programme spelt out a long-term strategy in the context of the conditions and potentials of identified drought prone districts. In all, 54 districts as well as parts of 18 other districts contiguous to them were identified in the country as drought-prone for purposes of the programme (See Table 8.7). The programme grew to cover 12 per cent of the country's population and nearly one-fifth of the area. Labour-intensive activities such as medium and minor irrigation projects, road construction, soil conservation, and afforestation projects were taken up under the programme. The success of these activities prompted the government to take up a mega sized project named the Drought Prone Areas Programme in 1972–3, with the principal objective of mitigating the impact of droughts in vulnerable areas.

In the Fifth Five Year Plan, the DPAP adopted the strategy and approach of integrated area development laid down by the Task Force constituted by the Planning Commission. On the suggestion of the National Commission on Agriculture, 1974, a specific programme was initiated in 1977–8 for hot desert areas, consisting mainly of afforestation and livestock development—the Desert Development Programme (DDP) (See Table 8.8). The DPAP and DDP were reviewed periodically by the Ministry of Rural Development, which recommended modifications in the nature and coverage of these programmes from time to time. The major emphasis was on productive agriculture, dryland as well as irrigated, and vegetation cover. In 1980, the Ministry of Agriculture also started a new scheme called the Integrated Watershed Management in the Catchments of Flood Prone Rivers (FPR).

The DPAP was withdrawn from areas covered under DDP as both programmes had similar objectives. The main thrust of DPAP/DDP was on activities relating to soil conservation, land shaping and development, water resource conservation and development, afforestation, and pasture development.

With experience gained from the different approaches, the concept of integrated WSD was first formalized in the early 1990s, and in 1990, the National Watershed Project for Rain-fed Areas (NWDPRA) was launched in 99 selected watersheds to enhance crop productivity in arable rain-fed areas. By 1994, it covered 2554 micro watersheds. In 1993, the Government of India constituted a technical committee headed by C.H. Hanumantha Rao to review these programmes. The committee indicated that:

> the programmes have been implemented in a fragmented manner by different departments through rigid guidelines without any well-designed plans prepared on watershed basis by involving the inhabitants. In many areas the achievements have been dismal. Ecological degradation has been proceeding unabated in many of these areas with reduced forest cover, reducing water table and a shortage of drinking water, fuel and fodder (Ministry of Rural Development 1994 and 2006.)

The Committee, therefore, proposed a revamp of the strategy of implementation of these programmes, drawing upon the 'the outstanding successes' of some

Table 8.6 Number of WSD Projects, Area Covered, and Funds Released under Different WSD Programmes in India, 1995–6 to 2007–8

Name of programme	*Number of projects sanctioned*	*Area covered in lakh ha*	*Total funds released by the central government (Rs Million)*
DPAP	27,439 (60.9)	130.20 (41.2)	28,378 (36.7)
DDP	15,746 (34.9)	78.73 (24.9)	21,032 (27.2)
IWDP	1877 (33.9)	107.00 (33.9)	27,976 (36.1)
Total	45,062 (100.0)	322.93 (100.0)	77,386 (100.0)

Source: Ministry of Rural Development (2010).
Note: Figures in parenthesis are percentages.

Table 8.7 Area Treated Under DPAP

Year	*Area treated in lakh hectares*
1995–6	5.95
1996–7	5.50
1997–8	4.54
1998–9	3.65
1999–2000	3.66
2000–1	7.50
2001–2	5.44
2002–3	6.56
2003–4	7.35
2004–5	7.49
2005–6	8.10
Total	65.74

Source: Ministry of Rural Development (2010).

Table 8.8 Area Treated Under DDP Since its Inception

Year	*Area treated in lakh hectares*
From inception till 31 March 1995	5.15
1995–6	2.02
1996–7	1.31
1997–8	1.40
1998–9	1.60
1999–2000	2.00
2000–1	3.41
2001–2	3.56
2002–3	4.39
2003–4	4.72
2004–5	4.89
2005–6	6.01
Total	40.46

Source: Ministry of Rural Development (2010).

ongoing watershed projects. It recommended that sanctioning of works should be on the basis of action plans prepared on a watershed basis instead of a fixed amount being allocated per block as was the practice at the time. It called for the introduction of participatory modes of implementation, through involvement of beneficiaries of the programme and non-government organizations (NGOs). Based on its recommendations a new set of guidelines was formulated and came into effect from 1 April 1995 and applied to all the watershed projects of the Ministry of Rural Development. At the time, the Department of Land Resources of the Ministry of Rural Development administered three area-based watershed programmes for development of dry, rain-fed wastelands and degraded lands namely DPAP, DDP, and Integrated Wastelands Development Programme (IWDP). The Common Guidelines of 1994 were revised by the Ministry of Rural Development in 2001 and then again modified and reissued as 'Guidelines for *Hariyali*' in April 2003.

The watershed programme has become the centrepiece of rural development in India. The Ministry of Environment and Forests and bilateral funding agencies are involved in implementation of watershed projects in India. The new initiative of the Department of Land Resources called 'Hariyali' had the objective of empowering *Panchayati Raj* Institutions (PRIs) both financially and administratively in the implementation of WSD Programmes. Under this initiative, all new area development programmes under IWDP, DPAP, and DDP were to be implemented through the PRIs in accordance with the guidelines for Hariyali from 1 April 2003. In November 2006, an apex body called the National Rain-fed Area Authority (NRAA) was set up. It brought out new 'Common Guidelines for Watershed Development Projects' in 2008 in order to have a unified approach by all ministries, leading to the Integrated Watershed Management Programme (IWMP). These guidelines are now applicable to all WSD projects of all departments/ministries of the Government of India concerned with WSD projects.

Rainwater Harvesting: Institutional Effectiveness in Gujarat

Community based rainwater harvesting is perhaps more important today than ever before. An outstanding grassroots level initiative for rainwater harvesting is seen in the check dam movement in the dry Saurashtra region of Gujarat state. This was a grassroots level movement that witnessed the formation of hundreds of village level institutions for organizing rainwater harvesting through planning, funding, and construction of a series of check dams as well as other rainwater harvesting structures in and around each village (see Gandhi and Sharma 2009). The purpose was to collect and hold rainwater for a short time and recharge the underground aquifers, thereby bringing water to the open wells, most of which had run dry. From the late 1990s, such institutions have been formed in hundreds of villages in the region and the movement is reported to have had a significant impact on water availability and agricultural incomes.

Check dams are small low barriers built across the pathways of rainwater surface flows. The pathways could be natural or manmade, small or large, and may include gullies, old village roads, streams, and shallow rivers. In the rainy season, the check dams help retain surface water overflows so that water percolates and recharges the water table below (Gandhi and Sharma 2009). A series of check dams is usually planned along a water flow path so that water overflowing one structure is captured by the next, and so on. In this manner, the benefits of groundwater recharge are spread over a large area and potentially impact a large number of wells. Check dams do not require much technical know-how to construct and the capital investment is generally modest. Construction is often labour intensive which facilitates participation by most of the villagers. The involvement of the local people in planning and implementation, through these institutions, is reported to be crucial in making these interventions possible and successful.

The rainwater harvesting movement in the Saurashtra area of Gujarat was inspired primarily by the success in a village called Raj Samadhiyala near Rajkot. Commencing initially as a local initiative, the check dam concept and development has benefited substantially from private voluntary support organized through several organizations such as the Jal Dhara Trust. The Trust pooled funds from expatriate village residents who had migrated to the city of Surat, and done well in diamond cutting businesses and who were willing to offer help/philanthropy to their community of origin. The Trust not only helped organize funds but also supported the initiative with technical know-how and, in some cases, earth-moving equipment. The movement also benefited from active government support. During the year 2000, the Government of Gujarat launched the Sardar Patel Participatory Water Conservation Programme to aid in the construction of check dams. As part of this programme a scheme was devised whereby 60 per cent of the cost of a check dam would be met by the state on the proviso that villagers contributed the remaining 40 per cent, primarily in the form of labour. However, the village institutions eager for speedy implementation before the rainy season often did not always wait for government paperwork clearance and went ahead through their own contributions and those sourced from private/trust sources; the government funds often followed. According to some reports, 15,000 check dams had been constructed in the state by year 2002 (*Times of India* 2002), and according to government statistics given in Table 8.9, over 90,000 check dams had been completed by 2007 (Government of Gujarat 2007).

Of 5600 villages in Saurashtra, 3000 have small and medium check dams while there are 300 large check dams in the region (*DNA Newspaper* 2008). The outcome has been profound as evidenced by this comment from Maldebhai Bodar, a farmer from Sevantara village with 35 check dams: 'Earlier it was very difficult getting water for even one crop in a year. Now we have three crops' (Ibid.).

The research described below has examined the performance of a sample of village institutions which were organized for rainwater harvesting work and which were critical to its successful implementation. The examination uses the framework of features based on new institutional economics and management theories of governance developed in Gandhi et al. (2009).

Sample and Respondent Profile

A Study of Rainwater Harvesting in Gujarat

Seven village rainwater harvesting institutions were selected from three districts in the Saurashtra region of Gujarat, namely Amreli, Bhavnagar, and Rajkot. A total sample of 100 beneficiaries affiliated with check dam institutions was surveyed. The study used both institutional questionnaires and household questionnaires to collect information (Gandhi and Sharma 2009).

Table 8.9 Number of Check Dams Constructed in Various Districts in Gujarat, June 2007

	District	*Number of check dams*
1	Ahmedabad	629
2	Amreli	4822
3	Anand/Kheda	367
4	Banaskantha	2766
5	Bharuch	685
6	Bhavnagar	7290
7	Dahod	5468
8	Dang	1678
9	Gandhinagar	328
10	Jamnagar	7871
11	Junagadh	5080
12	Kuchchh	5804
13	Mehsana	832
14	Narmada	1302
15	Navsari	1234
16	Panchmahal	7856
17	Patan	1587
18	Porbandar	902
19	Rajkot	14192
20	Sabarkantha	8228
21	Surat	2174
22	Surendranagar	2493
23	Vadodara	2684
24	Valsad	4477
	Total	90648

Source: Government of Gujarat (2007).

Table 8.10 Respondent Profile

Education	
Education	Per cent
Illiterate	7
Std1–4	36
Std5–9	51
Std10–12	6
Below graduation	0
Graduation	0
Above graduation	0
Total	100
Sources of irrigation	
Sources	Per cent
River	0
Open well	100
Tube well	0
Canal	0
Tank	0
Lift from tank	0
Total	100
Reliance on the institution	
Reliance	Per cent
Very substantial	19
Substantial	81
Some	0
Very little	0
None	0
Total	100

Source: Gandhi and Sharma (2009).

The educational profile of respondents (see Table 8.10) shows that education was limited: 93 per cent of households had some education, but very few had education beyond the 9th grade, and none had college education. The only source of irrigation for the households was open wells and reliance on the water institution for water access was reported as very high, with 81 per cent indicating it as substantial and 19 per cent as very substantial.

Governance

The data in Table 8.11 show that the Chairman, Managing Committee, and the Secretary are reported to be active by about half the respondents and very active by the other half, indicating some variation. Government officials are also indicated as having an active part in the institutional arrangements. The local government, including the panchayat and sarpanch, shows active involvement but not as much as some others.

Table 8.11 Role in Running the Institutions

Role of:	*Very active*	*Active*	*Passive*	*None*
1. Chairman	48	52	0	0
2. Managing committee	53	46	0	1
3. Members	7	8	85	0
4. Secretary	48	52	0	0
5. Government officials	38	62	0	0
6. Panchayat	14	86	0	0
7. Sarpanch	7	93	0	0
8. Other local institutions	0	0	0	100

Source: Gandhi and Sharma (2009).

Measuring Institutional Performance

The overall performance rating for check dam institutions is reported in Table 8.12. About 56 per cent of the respondents considered the institution to be very successful whereas 44 per cent considered it to be successful. Thus, the satisfaction with the institution and its results seems very high.

Table 8.12 Performance of the Institution

Performance	*Rating*	*No. of farmers*
Very successful	4	56
Successful	3	44
Satisfactory	2	0
Poor	1	0
Total		100

Source: Gandhi and Sharma (2009).

Table 8.13 presents results on the broader perceived impacts of the institution, including the effects on equity. The data indicate that the institution was perceived as having facilitated empowerment and a sense of ownership among the farmers. Moreover, active involvement of all classes was reported. The institution was also perceived as having a substantial positive impact on the whole village, including small/marginal farmers and labourers. Even the impact on the environment was reported to be positive, presumably because local groundwater recharge was conceptualized as benefiting the environment.

Multivariate Analysis

The TOBIT regression model is used and the caveats of potential multicollinearity apply. The results on overall institutional performance are given in Table 8.14. The model indicates that if the objectives are clear to the

Table 8.13 Impact of the Institution on the Village, Different Communities, and the Environment

	Highly positive	*Positive*	*No impact*	*Negative*	*Highly negative*
Empowerment of farmers to manage irrigation	42	58	0	0	0
Beginning of a sense of ownership by farmers	61	39	0	0	0
Active involvement of all classes	30	70	0	0	0
Impact on:					
Village as a whole	91	9	0	0	0
Women	71	29	0	0	0
Large/medium farmers	61	38	1	0	0
Small/marginal farmers	67	33	0	0	0
Labour/wage earners	25	74	0	0	1
Environment and natural resources	83	17	0	0	0

members, management has sound expertise, and management has the authority to adapt the rules and systems, institutional performance is better. In addition, superior performance is promoted when the institution uses its powers to bring about compliance. Where the government has played an active part in the derivation of rules there would appear to be better performance. In addition, good interaction between the members and capable leadership to facilitate interaction helped improve the performance. Thus, many factors are associated with good performance, particularly objectives being clear to members, management's expertise, management adapting the rules, and compliance.

Conclusions and Policy Implications

Extraction of groundwater has resulted in large declines in the groundwater tables in many areas of the country. This has resulted in low productivity of wells, deterioration of groundwater quality, and intrusion of sea water in coastal areas. In response to this, rainwater harvesting offers a very promising solution. Estimates indicate that there is a huge potential and only about 6 per cent of the available surface and groundwater is being used. Most of the rainwater which falls, is lost to surface flows. Rainwater harvesting for agriculture generally involves creation of structures such as check-dams, ponds, and percolation tanks at a planned set of places along the flow path. This increases the percolation of the water into the ground and recharges the groundwater table. It increases the supply of water in the wells and the duration of availability.

Decentralized small harvesting structures present a major alternative to conventional river basin water resource development. Decentralized water harvesting can capture five times more water. The drought proofing benefits from small rainwater harvesting structures can be well distributed especially when the drought is limited and not severe. Rainwater harvesting can be very useful in semi-arid and dry sub-humid regions where the problem is not the amount of rain but the extreme variability. Given that with climate change the frequency of dry spells and droughts are expected to increase, rainwater harvesting can be extremely important to mitigate the impact on agriculture and increase agricultural productivity. Bridging critical dry spells by irrigation through rainwater harvesting can stabilise and increase yields.

The National Water Policy and the Tenth Five Year Plan set targets and budgets for artificial recharge

Table 8.14 TOBIT Regression: Dependent Variable–Overall Performance/Success

Parameter	*Estimate*	*t value*	*Approx Pr > |t|*
Intercept	–4.68	–1.04	0.3001
Managing committee active	–0.08	–0.44	0.6598
Secretary active	–0.22	–1.07	0.2831
Management has the expertise	0.20***	2.72	0.0066
Government helped determine the rules	1.06***	4.24	<.0001
The objectives are clear to the members	0.76***	3.10	0.0019
The institution regularly plans for achievement of objectives	0.01	0.07	0.9469
There is good interaction between the members	0.46**	2.19	0.0282
There is good leadership to facilitate interaction	0.41*	1.78	0.0746
There are clear mechanisms for changing the rules	0.21	1.14	0.2545
The management has authority to adapt the rules and systems	0.60***	2.77	0.0056
The institution uses its powers to bring compliance	0.78***	2.91	0.0036

Notes: *significant at 10 per cent; ** significant at 5 per cent; *** significant at 1 per cent.

of groundwater and rainwater harvesting. Besides, rainwater harvesting is pursued in India through WSD programme of the Government of India and the state governments. Since poverty is particularly acute in the rain-fed areas, WSD programmes are given huge support by the government, and are looked upon for mitigating drought impact and reducing vulnerability of the large poor populations in the dry regions. Under the DPAP, DDP, and IWDP watershed development programmes of the government, huge funds of over Rs 77300 million have been released, and an area of 32.29 million hectares has been treated between 1995–6 and 2007–8.

A huge grassroots initiative on rainwater harvesting has taken place in the Saurashtra region of Gujarat and has received substantial support from the state government. The movement works through the formation of local village institutions for organizing the planning, finance, and implementation of village-wide rainwater harvesting through construction of check dams and other water conservation structures. It is reported that since the late 1990s, over 90,000 such structures have been created in the state and evidence indicates that these initiatives have had a huge impact on water availability and agricultural incomes. Study and multivariate analysis of the performance of these rainwater harvesting institutions indicates that success is determined by a number of factors including appropriate scale, clarity of objectives, good interaction, management having expertise, adaptiveness, and compliance.

There is an urgent need for strong policies and programmes to promote rainwater harvesting in India. These should target areas that are water scarce, those that have become highly dependent on groundwater, and where rapid declines in groundwater levels are taking place. Substantial funding is required for the creation of rainwater harvesting structures and given the costs and externalities involved, it calls for public support. However, it is very important that this is accompanied by the development/creation of appropriate institutional structures for planning and implementation. Experience indicates that given the substantial variation in the geologic, hydrological, and social settings, bringing together the formal/scientific with the local and informal is a major challenge and clearly requires a participative approach for success. Conditions of institutional success such as clear objectives, good interaction, adaptiveness, appropriate scale, and compliance need to be addressed by the policies and programmes to ensure good performance. The activities need to be preceded by area based planning and formulation of regular action plans. The check dam movement in Gujarat shows that community involvement in rainwater harvesting projects and activities is extremely important for success. It also shows that creating effective village institutions with active participation can go a long way in improving results. The potential for raising donation support and other funding is also demonstrated in such an approach.

Other experiences indicate that to improve the impact of rainwater harvesting, it is necessary to go beyond natural resource management to add productivity enhancement activities. These may include measures to improve water use efficiency such as drip and sprinkler irrigation, and promotion of appropriate crops, varieties, and modern inputs to enhance physical productivity and economic returns. Further, to extend the benefits to landless and weaker sections in rain-fed areas, it is important to include an enterprise promotion component. This would assist in the development of small business enterprises of these people with the involvement of women and SHGs. This would help the landless and weaker sections to capture some benefits from the rise in incomes and demand of the farming community. Rainwater harvesting and WSD undertaken with such a comprehensive policy approach would lead to more inclusive and sustainable water resource development and management in water scarce areas.

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9 Water Management Institutions for Enhancing Water and Food Security

Designing for Better Adaptiveness

Vaibhav Bhamoriya and Vasant P. Gandhi[†]

Introduction

Water resources and its management are becoming crucial as the demand for water is increasing in all the sectors to unsustainable levels with demand in the agriculture sector being the largest. India has a vast population and therefore there is a huge demand for food. The variability in the availability of water poses a significant threat not only for water security but also for farmers due to their access and distribution of water. This poses a threat not just for agriculture but also for all farm-related livelihood activities. While technical solutions have been tried to improve the access and distribution of water, an oft ignored but critical aspect is the development of good institutions to manage and distribute available water among users.

This chapter examines the performance of water management institutions through a framework, which relates their structures, processes, and governance features to their performance on stated objectives. The motivation behind the work is to understand what makes some water institutions perform better than others and can those features of the better performing institutions be incorporated in the design of water management institutions through policies or other suitable mechanisms. The next section provides the contextual setting of the irrigation sector and participatory irrigation management (PIM) in the states studied. The section that follows presents a brief literature review on the subject, which is followed by an introduction of the framework that has been used to evaluate the performance of water management institutions. The next section briefly describes the empirical analysis and discusses the results of the study that covers water institutions in Andhra Pradesh (AP), Maharashtra, and Gujarat. The concluding part summarizes the design principles for developing better performing and more sustainable water management institutions based on the research findings.

Institutions in Water Resource Management

Historically, before government investment in irrigation became a common practice in India, many emperors and local chiefs had devised ways of storing water in ponds and tanks (Singh 1991). Some excavated inundation

[†] The authors gratefully acknowledge the contribution of Lin Crase (Professor, La Trobe University) and Ashutosh Roy (formerly Doctoral student at IIMA) for parts of this research.

canals and 'anicuts' to draw water from rivers. Another type of water harvesting structures were formed in hilly terrains of Himachal Pradesh that closely mimicked the Warabandi system of Northern Plains (See Box 9.1). Though most such efforts were initiated by the wealthy and influential people of the time, the responsibility for maintaining the irrigation works and the distribution of water often remained with the farmers. Since agriculture was critical for human survival, communities developed norms and social systems for managing irrigation. Beneficiaries undertook responsibilities with regard to supervision and repairs of the system, sometimes with the help of paid staff, and sought an equitable distribution of water. Some old works that still survive bear testimony to the potential of farmers for their initiative and strength in sustaining organized human efforts (Gandhi and Namboodiri 2002; Singh 1991).

Box 9.1
Traditional Water Management Practices in the Himalayan Valley of Lahaul

Reforms in irrigation sector are increasingly focusing upon devolving the management power to the communities and world over such models of community irrigation management practices are being tested. While the basic tasks associated with an irrigation system remain the same, like construction, operation, and maintenance of the physical structure, the organizational forms which have evolved to do so vary considerably. One such system which has existed in the Himalayan valleys for a very long time is the *Bari* (turn) system comprising of water channels called *kuhls*.

Kuhls and the Bari System

In the high reaches of the Himalayas, the near unavailability of water in winters and agricultural practices in summers, explains the importance and dependence on water, the source of which is melted snow. Various water management institutions have evolved to overcome the challenges posed by this difficult terrain. Since irrigation requires the maximum input of water, there has emerged a unique water management system comprising the water channels called kuhls. These are cemented or semi-cemented structures built along the hill gradient, based upon the natural gravitational flow and bring water from the stream source to the fields. The water is then diverted through smaller channels to each land holding. These are a time-tested, community-made water channels for sharing the glacial water and ensuring irrigation in otherwise dry and porous soils. The need for equitable distribution and efficient management of water from the kuhls, has led to the emergence of an institution locally known as the Bari system. This institution gives rights of water use to the owners of land, allots time to use the resource, and ensures their equal participation in the management of the kuhls. In this system bari refers to the turn each farmer gets for irrigating the fields. The whole community is divided on the basis of number of farm families, and one family gets one full day to irrigate their fields turn wise. For example, if there are 20 farm families in a village, the bari comes after every 20 days. But two families, on mutual understanding may decide to share the water for half a day and get their next turn after 10 days instead of 20. The amount of water and time allocated are both dependent on the size of the land holdings.

As part of the exploratory study carried out to develop an understanding towards the water management regime of the region, four villages in the Keylong district of Lahaul valley of Himachal Pradesh, with different socio-cultural patterns were studied. This region faces difficult challenges posed primarily due to the unbending terrain, limiting the access of people to natural resources like water. Even within a village, differential needs of the people have led to varied dependence on this resource. While in such a scenario, conflicts related to resource sharing seem inevitable, the Lahaul valley offers a unique sustainable system based on mutual understanding and cooperation. Melting of snow in late March marks the beginning of the agricultural season in the valley. In all the villages under study, irrigation water is allocated based on the bari system and the kuhl has special religious and social significance. Water distribution is mainly handled by the villagers so they prefer internal settlement of disputes amongst themselves, or involving the village Panchayat, which ensures that they remain together and bound in the community practices.

The bari system offers an interesting case exemplifying the evolution of institutions mediated by the scarcity of resources and a traditional self-organized institutional emerging in response to the constraints set by the terrain. Community-managed common property structures like kuhls, not only serve the purpose of irrigation but are also an important instrument for bringing the community together through collective action, thus, serving a greater ecological and social purpose. These associations have traditionally utilized the networks of interdependence which is important in reducing vulnerability to environmental

(*cond*)

Box 9.1 (*cond*)

change. Such an irrigation management approach is being followed at the grassroots successfully without any political interventions.

Challenges and Recommendations

One of the key challenges is the rapidly changing socio-economic scenario putting such traditional institutions under threat from market expansion, migration, population pressures, and technological change. Increasing non-farm employment is also providing an incentive to the people of the valley to opt out of the community managed systems. With mechanization and the advent of technology, the locals are switching over to newer systems of irrigation and growing crops, not just for subsistence but for large monetary benefits. New methods such as sprinkler irrigation are being introduced to meet the concomitant demand of the water and fertilizer intensive crops. Although gravity water schemes have low operation and maintenance costs than lift schemes, they are still being discouraged in the policy discourse and many schemes for lift irrigation are in the pipeline for this region. Such infrastructure interventions must keep into account the local geographical constraints, socio-economic characteristics, and cost effectiveness in order to determine the suitable intervention. Efforts must also be made to study these community managed systems to improve efficiency in the water delivery mechanism. Measures like snow harvesting need to be adopted, and conservation of local knowledge, produce, agro-biodiversity must be promoted.

Traditional systems are also affected by social structures and caste and clan networks. A social threat to such systems is when these dynamics come into play in some societies where a large land-holder or an affluent class is given more resources and privileges in the society. In addition, these systems also face the impacts of environmental change that has a direct bearing on the resources and livelihoods. Increased average temperatures have led to decrease in snow cover on mountain tops that feed and shifting of vegetation belts upwards. Under such a scenario, it is most important to consider the experiences of these vulnerable communities and the degrees to which their lives are being affected and integrate them while designing effective water and climate policies.

—Medhavi Sharma and Vasundhara Dash

During British rule in India, the state started intervening in harnessing irrigation resources on a large scale. Some large barrages and reservoirs were built to store rainwater in order to sustain agriculture in times of drought and lean rainfall. At the time of independence, India had 22.5 million ha of land under irrigation. With the huge government initiative since then a total potential irrigated area of 68.0 million ha had been created by 1985. However, irrigation management, particularly in the delivery and utilization of water at the farm level, was unsatisfactory. The Irrigation Commission, 1972, the National Commission on Agriculture, 1976, and a number of high powered committees set up by the Government of India viewed the state of affairs with serious concern (Singh 1991).

Starting in 1973, a coordinated approach to the development of irrigated agriculture was sought to be implemented through Command Area Development Authorities (CAD). Most states created multi-departmental project organizations headed by senior officers of the government to implement the CAD programme. On-farm development (OFD), which involved the construction of irrigation channels and drains and land levelling and shaping, were the most important activities pursued by CAD authorities. But strangely, the farmers did not participate with any great enthusiasm. CAD continued to be seen as a government programme imposed from the top (Singh 1991). There were innumerable cases of farmers wilfully destroying irrigation structures and measuring devises built to facilitate the distribution of water. They did not adopt CAD as a programme meant to benefit them or being worthy of support. Some project administrators argued that the implementation and water utilization would improve if farmers were given the responsibility for irrigation management.

Though initially many administrators were not enthusiastic about farmers' participation, some took the initiative to involve them in executing OFD works and irrigation management. Farmers receiving water from an outlet point were consulted and institutions called water users associations were formed, each having a chairman and a management committee (Singh 1991). This was the beginning of the government policy of PIM. The experience over the last few decades shows that if farmers actively participate in irrigation management there is marked improvement in water utilization. Uphoff (1986) highlighted some of the important benefits from farmers' participation drawing upon international studies. There was an increase in the area under irrigation and also in the number of farmers gaining access to irrigation. In India, several states have modified the old irrigation acts to accommodate group management by farmers. Many have instituted enabling frameworks so that farmers can form water cooperatives and charge for water by volume as against the usual crop acre rate (Gandhi and Namboodiri 2002).

Participatory Irrigation Management (PIM)

Technology alone cannot provide the solutions for water resource management; institutional arrangements are crucial. An analysis of the shortcomings of the conventional irrigation management points substantially to the lack of meaningful involvement of farmers in decision-making and in various physical activities (Sivamohan and Scott 1994). This realization led to the policy and growing emphasis on PIM. Vaidyanathan (1999) found that the design of appropriate institutions, given the peculiarities of water and the variations in environment, agrarian structures, and other related aspects was crucial.

PIM implies the involvement of water users in different aspects and levels in the management of water, including planning, design, construction, maintenance, and distribution as well as financing. The primary objective of PIM is typically to achieve better availability and utilization of water through a participatory process that gives farmers a significant role in management decisions about water in their hydraulic units (Salman 1997). These participatory irrigation management bodies are often called water users' associations (WUA) but may also have other names, such as irrigation cooperatives or partnerships. Many WUAs are created covering a hydraulic unit such as the area irrigated by a minor or a branch of a canal minor. The command area may extend from less than a village to about two villages or even larger. Generally all farmers who own land within the command area may be members of the WUA. The membership of a WUA may vary from a few to a few thousand farmers and the command area may vary from a few ha to a few thousand ha. WUAs are not limited to surface water irrigation. In Gujarat and Maharashtra informal tube well cooperatives/partnerships, check dam user groups, and lift irrigation cooperatives also exist. These WUAs may be formally registered or be informal associations, but their distinguishing feature is the participation of farmers in the management of water. Under PIM, it is felt that users have a stronger incentive to manage water more productively, and can respond more quickly to management problems in the system, particularly at the farm level (Brewer et al. 1999; Groenfeldt and Svendsen 1997; Subramanian et al. 1997).

Legal Framework for PIM

The model for the legal framework to support water institutions is the Model Act formulated by the Government of India. Constitutionally, water is a state subject in India and the states can adopt the Model Act by amending their existing irrigation acts, or enact new acts for PIMs. So far eight state governments have framed legal frameworks for PIMs with Andhra Pradesh, Gujarat, and Maharashtra being at the forefront. The status of the acts in various states is given in Table 9.1.

The Study States of Andhra Pradesh, Maharashtra, and Gujarat

The Andhra Pradesh Legislative Assembly approved a special act, the Farmers Management of Irrigation Systems Act on 27 March 1997. It changed the role of the irrigation department from a 'doer' to a 'facilitator' by shifting the responsibility of planning and implementing water distribution, maintenance, and improvement of irrigation systems to WUAs. Under the Act, over 10,000 WUAs and 174 distributory committees were to be created for the irrigation management of about 5 million ha (Brewer et al. 1999).

Andhra Pradesh followed a top-down, big-bang approach like Mexico to enable fast upscaling and implementation but lacked substantially in generating meaningful participation and management by the users themselves. The Act gives local water rights and control of the system mainly to WUAs which are backed by legal rights and obligations. It offers functional and administrative autonomy and WUAs can take their own decisions. The Act makes the irrigation department

Table 9.1 Enactment/Amendment of Irrigation Act: Position by State

Sl. No.	*Name of State*	*Position*
1	Andhra Pradesh	Enacted in 1997
2	Assam	Enacted in 2004
3	Bihar	Enacted in 2003
4	Chhattisgarh	Enacted in 2006
5	Goa	Enacted in 2007
6	Gujarat	Enacted in 2007
7	Karnataka	Promulgated an ordinance on 7 June 2000 for amending the existing Karnataka Irrigation Act, 1957
8	Kerala	Enacted in 2003
9	Madhya Pradesh	Enacted in 1999
10	Maharashtra	Enacted in 2005
11	Orissa	Enacted in 2002
12	Rajasthan	Passed in 2000
13	Sikkim	Enacted in 2008
14	Tamil Nadu	Enacted in 2000
15	Uttar Pradesh	Enacted in 2009

Source: Ministry of Water Resources (2010).

accountable to the WUAs and a 3-tier farmers' organization is envisaged (Gandhi and Namboodiri 2009). A WUA, at the primary level may cover a minor in a village or a group of minors in a well-defined hydraulic unit. All the WUAs along a distributory/distributaries may be federated into the distributory committee (DC) and all the DCs in one irrigation system may form a project committee (PC) as the other tiers. A single tier system is proposed for minor irrigation projects, two tiers for medium irrigation projects, and three tiers for major projects. As of 2005 about 10,292 WUAs and 174 DCs had been formed on paper covering a command area of 4.80 million ha. This set up is explained in Figure 9.1.

Elections held for WUAs twice in 1997 and 2008 have activated them as institutions in the local socio-political space of the villages. The requirements of the users are conveyed to political leaders by WUA's elected representatives. Gradually the WUAs are becoming a platform for local politics and as such gaining more importance in the life scape of the villagers. In order to create funds for the DC, a few of the DC presidents have been able to influence their own WUAs for collection of some fees on the records.

Like Andhra Pradesh, Maharashtra also passed a new Act, the Maharashtra Management of Irrigation Systems by Farmers Act in 2005 and formulated policies to transfer irrigation management to the farmers. Unlike AP, the Maharashtra Act creates WUAs at the minor canal level (average command of 500 ha) and seeks to transfer operations and maintenance (O&M) responsibilities for the minor and smaller channels to WUAs, allocate water to them through a 5-year agreement, and charge them for water on the basis of the volume actually taken. The government has encouraged NGOs and

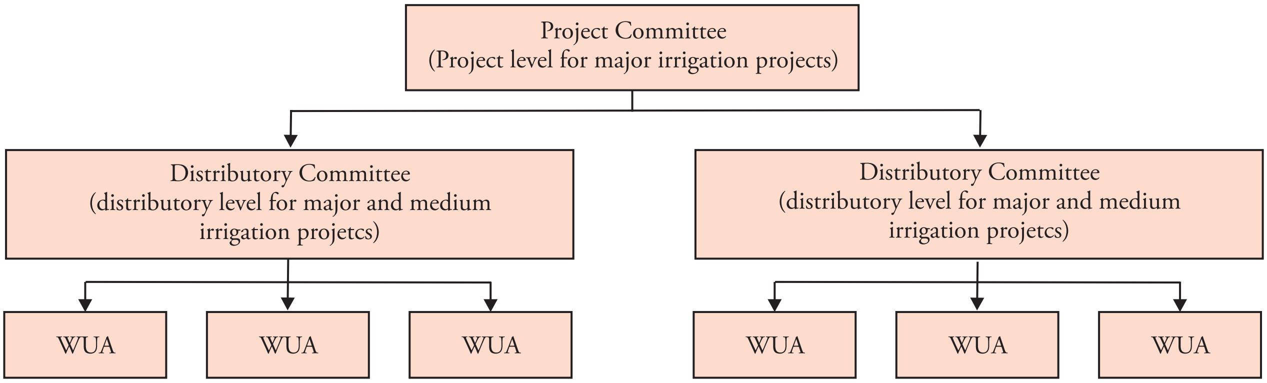

Figure 9.1 Institutional Structure Planned for PIM in Andhra Pradesh

Source: Authors' own.

irrigation department officials to help farmers in creating WUAs. Unlike AP, Maharashtra also offers various incentives to the farmers, such as support for channel repairs, rebates for prompt payment of irrigation fees, volumetric fees lower than crop-area fees, and maintenance grants. Recently the Maharashtra government was able to procure World Bank funding to rehabilitate existing canal irrigation projects with an eye on increasing efficiency by reducing channel losses. The project was approved in March 2005 and the implementation started in 2007. The progress of formation of WUAs in Maharashtra is given in Table 9.2.

In 1995 the Government of Gujarat intiated policy resolutions for implementing PIM in the state through a state level working group for implementing 13 pilot projects. Like AP, a large number of WUAs were formed on a hydraulic basis. It was proposed to form about 5,230 WUAs. However, some WUAs are yet to be made operational. The Sardar Sarovar Project aims to scale-up PIM efforts in Gujarat to cover an area of about 18 lakh ha of the irrigated area. Unlike other states, the Gujarat Water Resource Development Corporation (GWRDC) has been motivating farmers to form WUAs for tube well irrigation. By 2004–5, 2,192 tube wells out of those used for irrigation had been transferred to irrigation cooperatives. Ranking by the number of irrigation tube wells managed by cooperatives, Banaskantha district is followed by Mehsana, Anand, and Patan districts.

Water Institutions Across the States

Based on official statistics, the number of WUAs and the area covered by them are given in Table 9.3. This data appears to be incomplete and seems to exclude many like unregistered WUAs, informal associations, partnerships, and groups which are very common in some states. As per this data, AP and Orissa have the largest number of WUAs and area coverage.

Adaptiveness in Water Institutions: Conceptual Underpinnings

According to North (1991), institutions are humanly devised constraints that shape human interaction. Using different approaches like transaction costs and property rights to understand the performance of institutions, the new institutional economics assesses the real costs of economic activities, including transformation and transaction costs (Drobak and Nye 1997; North 1997). When the transaction costs are large and they are ignored, they substantially reduce the efficiency and effectiveness of economic activities (Gandhi et al. 2009). Good institutions are known to often reduce transaction costs. According to North (1997), the major challenge is to evolve institutions in which: (i) the transaction costs are minimized and, (ii) the incentives favour cooperative solutions, in which cumulative experiences and collective learning are best utilized.

New institutional economics identifies formal institutions based on laws and structures of organized society, as well as informal institutions which often develop spontaneously to address specific issues and problems in society (Olson and Kahkonen 2000; Picciotto 1995; Williamson 2000). It identifies macro level institutions: humanly devised rules or 'rules of the game' that structure interactions (formal rules, such as constitutions, property rights, and informal rules, such as traditions and codes of conduct), and micro level institutions, such as institutions of governance, including markets

Table 9.2 Progress of WUAs Formation in Maharashtra

Particulars	*As of September 1996*		*As of July 2005*	
	Number	*Area controlled (ha)*	*Number*	*Area controlled (ha)*
Water user associations functioning	100	43,684	774	250,521
Agreement signed, yet to hand over	34	9,894	426	151,936
Registered, yet to sign agreement	180	60,372	1,201	433,410
Proposed	143	55,211	1,650	704,948
Total	457	169,105	4,051	1,540,815

Source: Gandhi and Namboodiri (2011).

Table 9.3 State-wise Number of WUAs and the Area Covered by them

Sl.No.	*State*	*Number of WUAs formed*	*Area covered ('000 ha)*
1	Andhra Pradesh	10,800	4,169.00
2	Arunachal Pradesh	39	9.02
3	Assam	720	47.04
4	Bihar	67	182.36
5	Chhattisgarh	1,324	1,244.56
6	Goa	57	7.01
7	Gujarat	576	96.68
8	Haryana	2,800	200.00
9	Himachal Pradesh	876	35.00
10	Jammu & Kashmir	39	2.758
11	Jharkhand	0	0
12	Karnataka	2,557	1,318.93
13	Kerala	4,163	174.89
14	Madhya Pradesh	1,687	1,691.88
15	Maharashtra	1,539	667.00
16	Manipur	73	49.27
17	Meghalya	123	16.45
18	Mizoram	110	14.00
19	Nagaland	23	3.15
20	Orissa	16,196	1,537.92
21	Punjab	957	116.95
22	Rajasthan	506	619.65
23	Sikkim	0	0
24	Tamil Nadu	1,457	1,176.21
25	Tripura	0	0
26	Uttar Pradesh	245	121.21
27	Uttaranchal	0	0
28	West Bengal	10,000	37.00
	Total	56,934	13,537.94

Source: Ministry of Water Resources (2010).

or other modes of managing activities/transactions and seeing activities/economic activities through. WUAs may be considered micro level institutions in water resource management (Gandhi et al. 2009).

Based on these foundations of new institutional economics, and the study of empirical literature (for example, Ostrom 1992; Crase et al. 2002; Herath 2002). Pagan (2003) has suggested important characteristics that may be expected in effective water resource institutions (see Gandhi et al. 2009 for a discussion). These include:

- Clear objectives
- Good interaction
- Adaptiveness
- Appropriateness of scale
- Compliance ability

The importance of adaptiveness is stressed in these studies. Apart from these characteristics, another set of relevant constructs emerge from the management theory of organizational design. This states that good governance in organizations/institutions comprises of addressing three important rationalities (see Gandhi et al. 2009 for a discussion):

- Technical rationality
- Organizational rationality
- Political rationality

Adaptiveness can be viewed as a process of learning, an innovation, a vehicle of change, or a way of managing transaction costs. Adaptiveness can also be viewed as the balancing between continuity and change to ensure the sustainability of an institution. Adaptiveness is viewed as a response to factors that stress the institution and contribute to its long term sustenance. Significant institutional change is brought about by adaptiveness and it needs to be a continuing feature (Axelrod 1984; Klitgaard 1995).

Besides the role of institutions, researchers have also examined the reasons for the evolution of institutions. Carrol et al. (1988) indicates that a political, social, cultural, and institutional context can account for persisting organizational forms. It is posited that inertia in environmental control and structure lead to organizational forms that lack adaptive change (Aldrich 1979; Dess and Beard 1984). Another stream of literature led by Pennings (1982) suggests that organizations can acquire maximum control by manoeuvring in their environmental space and can also shift the disposition as per environmental conditions. Scott (1995) concludes that explicit attention to the evolution of institutions and organizations is required.

Picciotto (1995) highlights that different types of institutions require different institutional structures for their management. Management of common pool goods is especially difficult due to lack of exclusion while being amenable to subtractions. Ostrom (1989) indicates that institutional arrangements for managing common pool resources can turn to the tragedy of commons unless effective participatory institutions are in place and support technological innovations and management changes that are required. Williamson (1967) adds a decrease in the span of control with an increase in the size of the firm leading to limiting the size of every structure. Structure therefore seems to be an important component of institutions.

As the rate of change in organizations' problems and the environment continue to become more rapid, Shimizu and Hitt (2004) suggest that strategic flexibility is needed to respond appropriately. It is the ability to halt and reverse existing unsuccessful resource commitments followed by quickly recognizing changes and committing resources to the new course of action. New perspectives or processes to overcome such barriers are often facilitated by a change in leadership.

Organizations can respond either with incremental innovation or radical transformations to change due to competition (Torlak 2004). Autopoietic systems have innovative use of feedback in forming laws, rules, and norms, and show structural change to keep surviving by continual learning (Varela et al. 1974). Constant learning is a feature of developmental organizations. The processes of an organization also determine the ability and optimal rate of institutional change (Poirot Jr. 2002) and routinization of new activities (Williamson 1967). Processes also lead to the establishing of legitimacy and authority of organizations (Hannan and Carrol 1995). Williamson (1967) indicates that management of a firm is expected to show some adaptiveness to the new circumstances from within the routine process of the firm. According to Hannan and Carrol (1995) there is a dearth of research on how organizational and population level processes facilitate adapting to diminishing organizational mortality.

Institutional change is 'induced' by economic forces through rising costs associated with increasingly inefficient and outdated institutional arrangements (Binswanger and Ruttan 1978). Shimizu and Hitt (2004) highlight neo-classical contingencies that create barriers to strategic flexibility. According to North (1981) the real puzzle is in explaining efficiency-enhancing institutional change in the backdrop of a redistributive struggle.

Institutionalists look at institutional change as a necessary process to survive and excel. The survival of every organization depends on maintaining an equilibrium in a dynamic environment and this requires internal readjustment in the organization. Governance structures therefore differ in their capacities to respond and are contingent on the set of transactions to be effected (Williamson 1985).

North (1981) indicates that improvements in institutional design and performance are intimately linked to improvements in human welfare. Models of successful institutional change therefore play an important role. The recognition that existing arrangements leave potential gains uncaptured is one of the reasons for a demand for change in institutional arrangements. The demand for institutional change can arise for reasons apart from redistribution. Property rights, especially new forms, which are examples of demand for institutional change, can enhance efficiency by creating new production opportunities.

The Conceptual Framework for the Study of Adaptiveness in Water Institutions

Based on literature and field observations, we developed a framework, which focuses on the issues of adaptiveness in water management institutions. The framework conceptually distinguishes between the 'demand' for and 'supply' of adaptiveness. It proposes that elements of the external environment create stress, which leads to demand for adaptiveness in institutions. Internal institutional features, including the structure, processes, and governance determine institutional response and generate a supply of adaptiveness. Different aspects, such as the presence of different structural components, their functionality/changeability, membership rules, and independence from government are involved in the supply of adaptiveness. This interplay would affect the performance of an institution resulting in a changed state of the water resource and outcomes, such as water availability, irrigation efficiency, and crop yields (for details see Bhamoriya 2010).

The performance of an institution and the resulting state of the water resource can be considered as the outcome or impact of adaptiveness.The performance of water management institutions has many dimensions, such as water availability, equity, and farm profits. The framework given in Figure 9.2 can help in studying the relationship between specific features of adaptiveness and different dimensions of performance.

Data and Empirical Analysis

A mix of qualitative and quantitative methods, including case studies, interviews, and a questionnaire based survey were used to study the adaptiveness of water institutions in the three states. The grassroots water institutions studied were of various forms, such as the WUAs, irrigation cooperatives, tube well partnerships, life irrigation user associations, tank irrigation user groups, and informal groups like check dam user groups and more. Canal cooperatives included institutions in projects of different scales: major irrigation projects, medium irrigation projects, and minor irrigation projects. This was helpful in drawing results that are valid across the various forms of institutions across

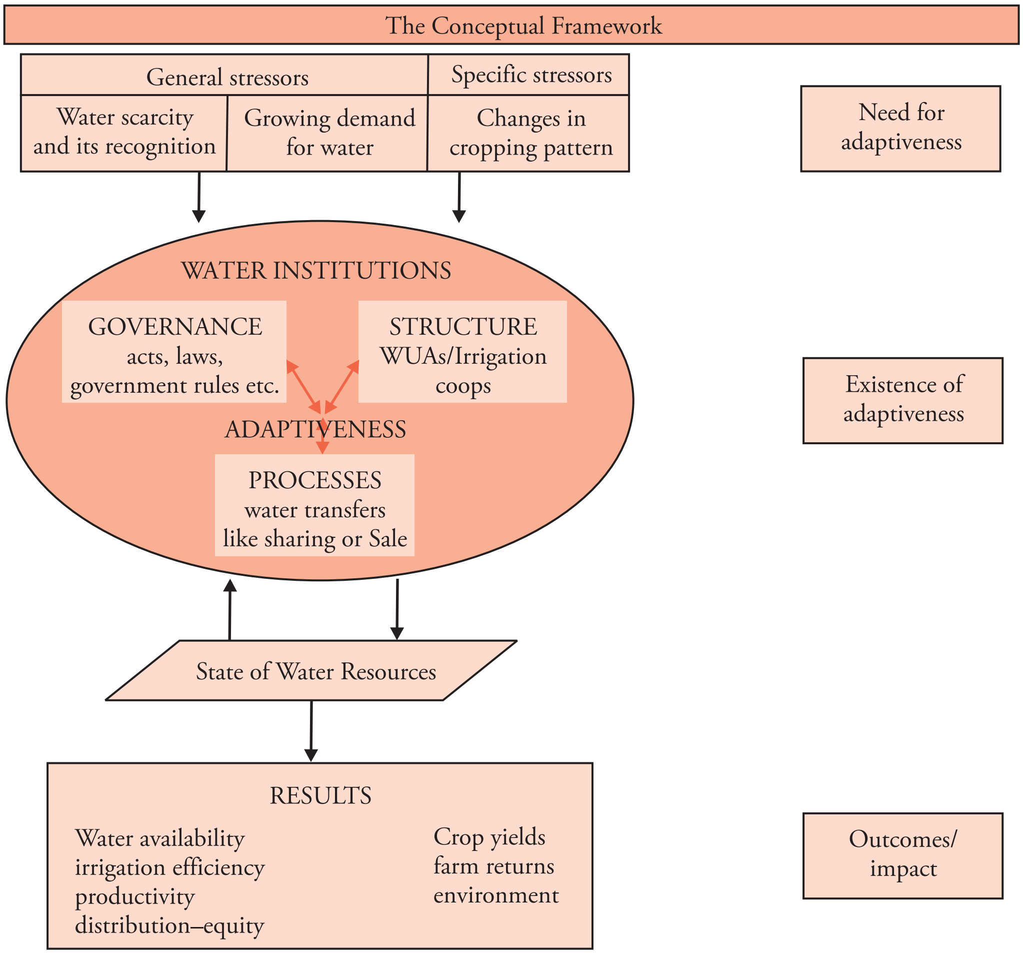

Figure 9.2 The Conceptual Framework for Studying Adaptiveness in Water Institutions

Source: Bhamoriya (2010).

different sizes and types (for details see Bhamoriya 2010).

The conceptual framework given in Figure 9.2 was used as a base for developing the questionnaire and pre-testing was done rigorously. The survey covered 22 different water institutions. Table 9.4 provides the distribution of the sample by institution type and states. A total of 464 farmer respondents spread over three states, five districts, and five types of institutions were surveyed for data.

Information was collected on different aspects, including characteristics of the village, water institution, agricultural and water resource setting, basic profile of farmers and farms, sources of irrigation/irrigation structures, and relationship with the water institution. The specific focus of the survey was on institutional features—structure, processes, and governance related to adaptiveness.

The status of adaptiveness in water institutions as studied via the status of various determinants of adaptiveness, such as features of structure, processes, and governance and their status was found to vary substantially across the institutions. Eighteen variables pertaining to structure, 25 to processes, and 20 variables related to governance were used to examine the adaptiveness of water institutions. Table 9.5 lists the variables selected based on statistical characteristics and relevance which were used in the analysis. It gives the mean scores and variation. Variables are ordered between 1 and 5, with 1 the lowest and 5 the highest on the issue that they measure. Four control variables and two state dummy variables were also used in the analysis to control for various other factors.

Variations in Water Institutions Across States

Table 9.6 indicates variations as reported by the surveyed farmers across the three study states on aspects of adaptiveness in institutional structure, processes, and governance in water management institutions across the states.

Significant differences were found across the states in many of these features. There were significant differences in the possibility of changing management committees. While management committees could be changed relatively easily in Gujarat and Maharashtra, this was not so in Andhra Pradesh. The absence of interference by the government in determining the rules and policies of an institution was the highest in Maharashtra and the least in Andhra Pradesh. The mean rating on the management committee independently deciding the objectives of an institution was the highest in Gujarat at 4.23 and the least in Maharashtra at 3.83.

On adaptiveness with regard to requests made for special considerations, the highest response was in Andhra Pradesh and the least in Maharashtra. The provision for discussing decisions in the GBM was high in all the states but the rating was the least in Gujarat, which also showed the lowest rating on separate policies to deal with special requests. A large majority of the respondents in Maharashtra reported that the management committee's decisions could be discussed in the GBM. Gujarat showed the least rating in changing existing rules and policies of an institution, as well as the least rating for choice from multiple options.

Table 9.4 Sample Distribution

Type of water institution	*Gujarat*	*Maharashtra*	*Andhra Pradesh*	*Total*
Canal cooperatives	123	103	103	329
Tube well partnerships	48	–	–	48
Check dam groups	16	–	–	16
Tank irrigation associations	–	–	25	25
Lift irrigation cooperatives	–	46	–	46
	187	149	128	464

Source: Authors' own.

Table 9.5 Characteristics of the Chosen Variables

	N (Respondents)	*Mean*	*Std. deviation*	*Coefficient of variation (%)*
Structure				
Total number of functional structural components out of a total of 5	460	4.33	1.064	24.57
Number of objectives of an institution	460	2.02	0.678	33.56
Membership decisions taken by the management committee/general body on its own	462	2.17	1.598	73.60
The management committee can be changed	462	3.40	1.450	42.60
Participation in general body meeting (GBM)	460	1.51	0.834	55.20
There is no government interference in institutional functioning	457	3.51	1.378	39.30
The management committee independently decides the objectives of the institution	463	4.03	1.216	30.20
Processes				
The existing processes are capable of dealing with special cases and situations	461	3.36	1.049	31.20
The institution has separate rules and policies to deal with special requests	459	2.66	1.486	55.90
Members can suggest changes to the rules and policies of the institution	461	4.45	0.824	18.50
Members can make special requests for non-routine considerations	460	3.25	1.419	43.70
Institutional processes facilitate free discussion of management decisions in the GBM	460	4.45	0.842	18.90
The existing rules and policies of the institution can be changed	461	2.91	1.177	40.40
The rules and policies facilitate the consideration of multiple courses of action	460	3.53	1.302	36.90
Governance				
Possibility of change in decisions	457	3.38	1.281	37.90
Consideration of multiple options in decision-making	461	3.76	1.284	34.10
Participation of ordinary members in decision-making	463	4.02	1.189	29.60
Participation of members in taking tough decisions like water pricing	461	1.99	1.573	79.00
Active role of leadership in enhancing participation of members	463	4.04	1.376	34.10
Enforcing compliance to rules	460	4.12	1.329	32.30
The institution is capable of taking up new activities	461	3.35	1.250	37.30

Source: Authors' own.

TABLE 9.6 Adaptiveness and Institutional Structure in Water Management Institutions

Sl.No.	Item	Mean of members' responses (Scale of 5)		
		Andhra Pradesh	Gujarat	Maharashtra
1	The management committee can be changed	2.30	3.81	3.83
2	There is no government interference in institutional functioning	3.02	3.27	3.42
3	The management committee independently decides the objectives of the institution	3.99	4.23	3.83
4	The institution has separate rules and policies to deal with special requests	3.75	2.17	1.97
5	Institutional processes facilitate free discussion of management decisions in the GBM	3.73	3.47	4.85
6	Members can make special requests for non-routine considerations	3.92	3.00	2.94
7	The existing rules and policies of the institution can be changed	3.41	2.13	3.11
8	The rules and policies facilitate the consideration of multiple courses of action	3.38	2.80	4.12
9	Possibility of change in decisions	3.38	3.44	3.19
10	Consideration of multiple options in decision-making	3.34	3.21	4.34
11	Participation of ordinary members in decision-making	3.87	4.33	3.77
12	Active role of leadership in enhancing the participation of members	4.42	3.44	4.46
13	The institution is capable of taking up new activities	3.70	2.59	3.94

Source: Authors' own.

There was a relatively high rating on the aspect that management decisions can be changed and on participation of ordinary members in decision-making across the states. However, the rating for considering multiple options for each decision was the highest in Maharashtra as compared to the other states. There was a stronger role of the chairman in promoting participation in AP and Maharashtra as compared to Gujarat. Also the institutions in Maharashtra were seen to be most capable in taking up new activities.

Thus, there are variations in structures, processes, and governance related to adaptiveness across the study states. However, it is important to analyse these factors of adaptiveness, that is, structures, processes, and governance of water management institutions together vis-à-vis their performance.

Relationship of Adaptiveness with Performance

The institutional features mentioned earlier were analysed and then related to the performance of water institutions. Performance has many dimensions and relates to the following (Crase and Gandhi 2009):

- Scarcity/water availability
- Equity
- Environment
- Economics or viability

Each of these dimensions has multiple indicators. Fifteen such indicators were identified which were rated by the respondents. Apart from examining the performance on individual indicators, a composite score was calculated and used as a measure of overall performance.

- Adequacy of water supply
- Timeliness of water supply
- Efficiency of water use
- Increase in irrigated area
- Increase in area under high value crops
- Increase in area under less water using crops
- Increase in income

- Better maintenance of irrigation structures
- Equitable distribution of water
- Resolution of disputes
- Water table
- Low water price
- Misuse/abuse of water
- Diversification of cropping pattern
- Overall water resource situation in the village

Econometric methods (comprising a factor analysis and TOBIT analysis) were used to establish the relationship of the various selected adaptiveness features with the performance of water management institutions (for details see Bhamoriya 2010).

The Results

The following variables were found to be statistically significant in the results:

Structure

- There is no government interference in determining the rules and policies of the institution
- The management committee can independently decide the objectives of the institution
- The number of functional structural components
- The number of objectives of the institution
- Membership rules are decided by the management committee/general body
- The management committee can be changed

Processes

- Members can make requests for special considerations
- Members can suggest changes in rules and policies
- Existing policies and rules of the institution can be changed
- Rules and policies allow for choice from multiple courses of action
- The decisions of the management can be discussed in the GBM
- Training
- Separate rules and policies exist to deal with special requests

Governance

- Multiple options are considered in decision-making
- Chairman plays a role in increasing participation
- Ordinary members participate in decision-making
- Participation in general body meeting
- Institution is capable of taking up new activities
- The management committee makes users comply with the rules
- Management decisions can be changed

Control

- General position of water resources on the farm
- Reliance on institution

Dummy

- Dummy for the state of Maharashtra
- Dummy for the state of Andhra Pradesh

The significance of two out of the four control variables and both the state dummies indicate that there are significant differences in the performance of institutions across the three states and water management institutions in Maharashtra performed better than their counterparts in Gujarat.

Adaptiveness was found to vary substantially across institutions. It was embedded in the structure, processes, and governance of institutions. Various structural features were identified to be closely related to performance. The institutions displayed differences in these aspects of adaptiveness embedded in the structural features. The number of functioning structural components was positively related to performance. Functioning structural components indicate the completeness of the structure and this would bring greater flexibility. This indicates the importance of completeness of institutional structures. That the management committee can be changed is another major structural indicator closely related to performance. Having this feature was found to be very important for adaptiveness and results. Autonomy from the government in determining the objectives and rules was another important structural feature.

It was found that many processes which exhibit adaptiveness were related to the performance of institutions. Having processes which allow members to suggest changes in rules and policies was found to be an important determinant of the performance of institutions. Existence of processes which allow choice from among multiple courses of action was found to be another major determinant of institutional performance and was positively related to performance. However, having separate processes/rules and policies to deal with special requests and situations was important but not always positively related. This might indicate the need to balance the extent of adjustments possible given the tendency of members to free ride on a collective and hence the need for training members in participating in the functioning of institutions.

The results indicate that where the governance allowed ordinary members to participate in decision-making, adaptiveness was promoted and positively related to performance. However, governance allowing member participation in high level economic decisions, such as pricing of water was not necessarily positively related to performance. This might signal the need for better institution building and training of members for better and positive participation in institutions. The results indicate that the role of the chairman in increasing participation promotes adaptiveness and improves performance. The research found that openness to decision-making in terms of governance by bringing in multiple options into consideration enhanced adaptiveness and improved performance. Changeability of governance/management decisions was found to be positively related to performance indicating that this changeability was an important aspect of adaptiveness that enhanced performance. Where governance showed even greater adaptiveness by making institutions capable of taking up new activities, the performance was further enhanced.

Conclusions and Implications: Principles for Design

The earlier discussion brings out some of the principles or features of design of more adaptive and better performing institutions. Having established the relationship between the existing features of adaptiveness and performance we can conclude that many features impart adaptiveness and are desirable principles of the design of institutions. Some of these principles are now listed.

Completeness

The results indicate that completeness of structures is a very important and desirable design principle for institutions. As mentioned earlier, the presence (or lack) of various institutional structures like bye-laws, general body, chairman, secretary, and a managing committee impact on division of labour, focus, and commitment to the tasks at hand. The adaptiveness that completeness imparts is expected to create discussions and a space for innovation to exploit efficiency and effectiveness gains as per prevalent conditions. Institutions in Maharashtra and Gujarat generally had more complete structures and they also reportedly performed better.

Openness

The results indicate that openness as shown in changeability of governance/management decisions and discussions of multiple alternatives for decision-making are expected to lead to strategic and operational flexibility that enhances performance by reducing wastage of resources. It is expected to aid better utilization of resources as well as building a target-oriented approach in functioning. The ability to correct existing decisions is expected to avoid wastage of precious and scarce resources for small institutions. Gujarat leads in changeability of governance/management decisions whereas Maharashtra leads in considerations of multiple options for decision-making. Water management institutions in these two states also performed better as compared to those in Andhra Pradesh (as given by the coefficients of the state dummies in the model).

Participation

Greater participation of members is found to be important and essential for ensuring that a larger constituency of members is involved and satisfied with managing and governance decisions. This is also seen to influence the performance of institutions. Increased participation calls for greater adaptiveness to involve and create a space for a larger proportion of the members. Where the chairman was more active in ensuring the participation of people, the institutions generally showed better performance. Participation of members is expected to initiate the logic for optimization and adaptiveness enabling the fulfilling of expectations of a larger set of members. However, the extent of adjustments needs to be limited otherwise the collective can be compromised for narrow self-interests. The provision for separate rules and policies to deal with deviations is not always positively related to the performance of institutions. There was a higher response to chairman's role in promoting participation in Maharashtra and Andhra Pradesh.

However, there was also greater response to the existence of separate rules and processes to deal with special requests from Andhra Pradesh. Gujarat leads in the participation of members in decision-making.

Autonomy

Autonomy from the government is found to be important and enables institutions to seek local optimization and therefore creates space for adaptiveness suited to the context of an institution. Autonomy along with increased participation seeks to maintain the balance by making members both beneficiaries as well as decision-makers. Processes that allow members to make suggestions for changes in rules and policies and choosing from multiple courses of action enable autonomy by allowing the members to express their choice and preferences. Autonomy is essential for the practice of preference by members. Changeability of the management committee is expected to build pressure for better performance by increasing answerability due to peer pressure from members. There was least government interference in institutions in Maharashtra and management committees of water management institutions took the most independent decisions in Gujarat as reported in the survey results.

Training

Where members are involved in higher order decision-making, it is found that the relationship with performance is not always positive. Training can play a major role in enhancing the participation of members as decision-makers in such decisions and not only as beneficiaries. Thus, training is seen somewhat as a subtle instrument for building capacities of members to enable a role reversal. Training has the potential to enhance both quantity and quality of participation of members in the functioning of institutions.

Institution Building

Institution building activities would be a backbone of the institutions to be adaptive and successful. The chairman's role in enhancing participation, the managing committee's role in bringing different alternatives for discussion, members' role in suggesting changes to rules and policies, and the role of the general body in being a platform for the participation of ordinary members as well as exercising autonomy from the government can all come together only if they are painstakingly built by effective institution building. Institution building enhances capacities which result in successful performance and it provides the maturity to balance members' dual roles of beneficiaries and decision-makers.

Overall, the research shows that enhanced adaptiveness through important features of structure, processes, and governance of institutions leads to better performance and more successful and sustainable institutions. The features of greater functional adaptiveness can be distilled into at least six design principles for water management institutions, and perhaps for other institutions as well. These design principles of completeness of structure, openness of processes, autonomy and participation in governance, and training and institution building, help in enhancing the desired adaptiveness in institutions and make them more sustainable and successful.

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10 Evolving Regulatory Framework for Rural Drinking Water

Need for Further Reforms

Philippe Cullet

Introduction

The provision of drinking water in rural areas has been a major concern of successive governments in India for several decades. This can be explained easily by the immediate link between water and human survival, as well as that between sufficient safe water and an adequate standard of living. This immediate link between water and human life ensures that it has direct political implications from the local to the national level.

The regulatory framework for rural drinking water surprisingly does not reflect this sense of importance. Indeed, beyond the frequent assertion and reassertion of a fundamental right to water by the superior courts, little effort has been made to develop a comprehensive legislative framework operationalizing the fundamental right. An additional complication is that states have primary responsibility over drinking water. This has led to a maze of instruments that include mostly general provisions in legislation such as panchayat acts at the state level and secondary instruments adopted by the executive at the union level that have had a strong influence in the states because these instruments have come with financial incentives for states to adopt their principles.

The framework that was put in place in the decades following independence was progressively strengthened alongside the increasing importance of rural drinking water supply as a political and policy issue. Yet, the general characterization of the pre-reform framework was that it was piece-meal. Since the early 1990s, different waves of reforms have swept the water sector. In terms of legal reforms, one of the most important changes in recent decades has been the adoption of the 73rd amendment to the Constitution providing for a significant devolution of competences to panchayats. A number of states have accordingly amended their panchayat legislation. This has been complemented by a variety of other reform efforts through other types of instruments ranging from broad national and state water policies to government guidelines specifically focused on rural drinking water supply.

The regulatory framework for rural drinking water supply went through a phase of turmoil from the late 1990s until 2009. The adoption of a new framework, the National Rural Drinking Water Programme (NRDWP, See Box 10.1), replacing the 1970s framework taking into account the reform efforts of the past decade seemed to signal a pause and the time for consolidation of the present set of reforms. Yet, the past two years have confirmed that the evolution of the regulatory framework is not over. This is highlighted, for instance, by the preparation of a strategic plan for the period up to 2022, and a new scheme to foster private sector participation in rural water supply.

This chapter looks at the existing regulatory framework for rural drinking water supply, its evolution over the past two decades, and proposals for further reforms. It also proffers some recommendations as to the desirable direction for further reforms of the regulatory framework in a way that contributes towards realizing the existing basic legal principles in this area, and ensures that the poorest get preferential treatment and that all residents of the country get the same entitlements to drinking water.

Legal Framework Governing Rural Drinking Water

Fundamental Right to Water

The Constitution does not specifically include a fundamental human right to water. Yet, a number of judicial pronouncements have made it clear that the right exists in India. The Supreme Court has repeatedly derived a fundamental right to water from the right to life.[1] Courts have also derived the fundamental right to water from Article 47 of the Constitution. In the Hamid Khan case, the complaint focused on the health consequences of the supply of water with excessive fluoride content. The High Court found that under Article 47 the state has a duty 'towards every citizen of India to provide pure drinking water'.[2]

Further, courts have, on repeated occasions, found that the fundamental right to water includes a duty on the part of the state to provide water. This was, for instance, the case of the Hamid Khan decision. The same position has been restated in strong terms a few years ago in *Vishala Kochi Kudivella Samarkshana Samithi* v. *State of Kerala* where the High Court found that:

> [w]e have no hesitation to hold that failure of the State to provide safe drinking water to the citizens in adequate quantities would amount to a violation of the fundamental right to life enshrined in Article 21 of the Constitution of India and would be a violation of human rights. Therefore, every Government, which has it(s) priorities right, should give foremost importance to providing safe drinking water even at the cost of other development programmes. Nothing shall stand in its way whether it is lack of funds or other infrastructure. Ways and means have to be found out at all costs with utmost expediency instead of restricting action in that regard to mere lip service.[3]

The cases mentioned above confirm that the right to water is well established. Yet, the actual content of the right has not been elaborated upon in judicial decisions. Further context is thus to be found in legislation and subsidiary legal instruments.

Laws Regulating Rural Drinking Water Supply

Drinking water is acknowledged as the primary concern in the water sector. Yet, recognition in legal terms is largely limited to the recognition of the fundamental right to water. Indeed, there is no framework drinking water law to complement the recognition of the fundamental right to water and as a result there is neither any general set of principles that applies to drinking water supply throughout the country nor are there any specific rules giving content to the fundamental right to water.[4]

The absence of broad drinking water legislation notwithstanding, a number of more specific initiatives have been taken over time. Thus, following the adoption of the 73rd Constitutional Amendment, various states have either confirmed or adopted legislative provisions giving panchayats control over water supply at the local level. Different formulations are used and different acts give a different set of competences to panchayats. There is nevertheless broad agreement among panchayat acts in giving control to panchayats over drinking water supply at the local level.[5] Some acts are more detailed than others. Some specify the

[1] *Subhash Kumar* v. *State of Bihar* AIR 1991 SC 420 (Supreme Court of India 1991).

[2] *Hamid Khan* v. *State of Madhya Pradesh*, AIR 1997 MP 191 (Madhya Pradesh High Court 1996), para 6.

[3] *Vishala Kochi Kudivella Samarkshana Samithi* v. *State of Kerala*, 2006 (1) KLT 919 (High Court of Kerala 2006), para 3.

[4] The only proposal for drinking water focused legislation at the union level is limited to certain issues linked to water quality and would not constitute a comprehensive drinking water legislation if it is adopted. See Department of Drinking Water Supply (2007).

[5] For example, Himachal Pradesh Panchayati Raj Act, 1994, s 11(2).

kind of activities that panchayats can engage in, such as constructing, repairing and maintaining tanks or wells, streams, and watercourses and specify their powers, such as the capacity to contract someone for water supply.[6] While panchayat acts are not detailed with regard to water supply rights and obligations of the panchayats, they provide a general binding framework within which all the water supply at the local level must be organized.

Some states have also adopted sectoral legislation that specifically addresses drinking water from the perspective of the regulation of one specific body of water. This is, for instance, the case in Karnataka, Madhya Pradesh, and Maharashtra where groundwater legislation focuses specifically on drinking water.[7] These acts focus on water conservation and availability. They thus neither include any list of principles governing drinking water supply in general nor specifically regulate water supply in detail.

In addition, the union has introduced various quality standards for drinking water supply. These include the Bureau of Indian Standards (BIS) Water Quality Standards (BIS: 10500) 1991 and the *Manual on Water Supply and Treatment* issued by the Central Public Health and Environmental Engineering Organization.[8] While these are, in principle, applicable countrywide, the absence of any legislation directly referring to these standards means that to date their legal status is partly inchoate. They are applicable but not legally binding on water service providers.

Additional Instruments Governing Rural Drinking Water Supply

The limited framework existing to give shape to the fundamental right to water implies that there are significant gaps in the regulatory framework. This has been filled at different levels and in different ways over time. At the most general level, a number of states have adopted state water policies. These documents make a general reference to drinking water and all give it the highest priority in terms of inter-sectoral allocation of water.[9]

At the union level, the centre felt increasingly compelled to involve itself in rural drinking water supply. Since drinking water supply, in principle, falls under the competence of states, the centre decided to use a mix of executive instruments and financial incentives to make its mark at the local level. Over time, while states have retained the overall mandate over rural drinking water supply, the influence of the union framework has been increasingly visible throughout the country.

From a legal point of view, the key dimension of the different instruments adopted by the union government over time is that they create no rights and obligations. These should thus be considered as subsidiary instruments. Yet, in practice, the frameworks of the union government have had a disproportionate influence. This can be explained in part by the financial incentives offered by the centre and in part by the fact that the framework proposed by the centre is similar to what international development agencies propose and implement through the projects they finance in individual states.

Accelerated Rural Water Supply Programme

The first key framework put out by the union to foster better drinking water supply in rural areas was the Accelerated Rural Water Supply Programme (ARWSP). The ARWSP Guidelines were first introduced in 1972 and formally abandoned in 2009. For a number of years, they provided the core framework used by the Rajiv Gandhi National Drinking Water Mission in ensuring the provision of drinking water to all habitations in the

[6] For example, Karnataka Panchayat Raj Act, 1993, s 77.

[7] Karnataka Ground Water (Regulation for Protection of Sources of Drinking Water) Act, 1999, available at www.ielrc.org/content/e9905.pdf; Madhya Pradesh *Peya Jal Parirakshan Adhiniyam* 1986, available at www.ielrc.org/content/e8603.pdf; and Maharashtra Ground Water Regulation (Drinking Water Purposes) Act, 1993, available at www.ielrc.org/content/e9301.pdf. On the Maharashtra Act, see Phansalkar and Kher (2006).

[8] Bureau of Indian Standards Specifications for Drinking Water [BIS Specification 10500], (1991) and Ministry of Urban Development (1999).

[9] Kerala State Water Policy, 2008, available at www.ielrc.org/content/e0804.pdf

country.[10] Some of the salient points of the ARWSP Guidelines included the following:

- They first defined different levels of coverage in terms of quantity. Non-covered habitations were defined as having access to less than 10 litres per capita per day (lpcd). Partially covered habitations were those having access to 10 to 40 lpcd. Covered habitations were defined as having access to 40 lpcd.
- The Guidelines further specified that the source of water had to be within 1.6 km or 100 metre elevation in mountain areas. The water was not to be affected by quality problems even though no specific standards for determining quality were included. Another criterion was that a given public source of water such as a handpump was not to be used to serve more than 250 people.
- The Guidelines also acknowledged the direct link between drinking water for human beings and water for cattle. Consequently, in a certain number of states especially affected by drought, the guidelines mandated that an additional 30 lpcd be provided for cattle.
- The minimum level of 40 lpcd was acknowledged as a minimum level of coverage, to be increased over time.

Reform of the Framework Governing Domestic Water Supply in Rural Areas

The progressive implementation of the ARWSP was carried out until the mid-1990s. Since then, a string of reforms efforts eventually led to abandoning the ARWSP altogether. The first harbinger of reforms was a pilot project sponsored by the World Bank whose principles were adopted in the Swajaldhara Guidelines, 2002. The latter were used as a template for reforms, which eventually led to a complete rethinking of the existing policy framework and the adoption of an entirely new set of guidelines in the context of the NRDWP.

Kicking off the Reforms—The Swajal Project and the Swajaldhara Guidelines

The Uttar Pradesh Rural Water Supply and Environmental Sanitation Project (Swajal Project), a World Bank-funded project started in 1996, was one of the important drivers of change in the rural drinking water sector. The Swajal Project introduced a number of important policy propositions that have, in the meantime, become the standard basis for rural drinking water supply. In particular, it advocated the shift from a supply to a demand-driven approach and the introduction of cost recovery of capital costs and operation and maintenance (O&M).

The Swajal Project and related initiatives taken in the late 1990s, such as the Sector Reform Project, were generally assessed positively by policy makers. This led to the formulation of the Swajaldhara Guidelines, which extended the key principles of the Swajal Project to the whole country during the Tenth plan period.[11] The Swajaldhara Guidelines were premised on the fact that the understanding of water as a social right was misplaced and that it should rather be seen as a socio-economic good.[12] Further, they were based on an understanding that the delivery of the social right by the government did not sufficiently take into account the preferences of users and was ineffective in ensuring the carrying out of O&M activities. This called for a demand-led approach. The link between the demand-led approach and the new conception of water as an economic good was succinctly brought together where the Guidelines argued that the idea of demand-driven system was to take into account the preferences of users 'where users get the service they want and are willing to pay for'.[13] The imposition of full cost recovery of O&M and replacement costs on the communities was expected to generate a sense of ownership and ensure the financial viability of the schemes.[14]

[10] Government of India, Accelerated Rural Water Supply Programme Guidelines (1999–2000) (ARWSP Guidelines), available at www.ielrc.org/content/e9914.pdf

[11] Ministry of Rural Development (2002).

[12] Ibid., Section 1, sub-section 1.

[13] Ibid., Section 1, sub-section 2.

[14] For more details on the Swajaldhara Guidelines, see Cullet (2009).

The New Policy Framework—The NRDWP

The experience gathered during the 10th Plan led the government to suggest an entirely new framework for rural drinking water supply. In a bid to demarcate the new policy principles from earlier reforms, the instrument is now known as the NRDWP.[15] The NRDWP brings a number of key changes to the policy framework for drinking water supply in rural areas.

First, the NRDWP sees water as a 'public good' that everyone can demand and it sees water as a 'basic need'.[16] This characterization is not particularly remarkable in general but does not fit well within the existing legal framework. Indeed, the Supreme Court has repeatedly stated that water is a 'public trust'.[17] This specifically rests on the basis that water is of such importance to people that 'it would be wholly unjustified to make [it] a subject of private ownership'.[18] The Court further specified that the government was supposed to protect water for the enjoyment of the general public rather than allow its use for commercial purpose. Water being a public trust, thus, cannot be a good, even in its characterization as 'public'.

The second understanding of water under the NRDWP is that it is a basic need. In a general sense, the fulfilment of basic water needs contributes to the realization of the fundamental right to water or at least its core content. Yet, from a legal perspective, the notion of basic needs is different from that of a fundamental right. In other words, legal instruments that choose to speak the language of basic needs do not speak the language of fundamental rights.

Second, the NRDWP goes further than simply evacuating the language of fundamental rights. In fact, it operates a U-turn on the policy followed since the 1970s by suggesting that measuring the realization of the fundamental right to water in terms of a quantity of water per capita per day is inappropriate.[19] The NRDPW suggests moving from a fixed minimum to the concept of drinking water security.

Drinking water security is not given a specific definition but it is opposed to the per capita norm followed earlier. Indeed, the NRDWP specifically states it is necessary to 'move *ahead* from the conventional lpcd norms to ensure drinking water security for all in the community'.[20] The basic unit now considered is the household. The NRDWP premises the shift from the individual to the household on the fact that '[a]verage per capita availability may not necessarily mean assured access to potable drinking water to all sections of the population in the habitation'.[21] It does not, however, explain how the shift ensures better coverage in a given habitation.

The new framework is surprising from the perspective of the right to water. At one level, the policy framework has been tightened by bringing down the focus from the habitation to the household. Yet, at the same time, by sidelining per capita norms, it is of concern in terms of the right to water that is an individual entitlement under Indian law. In addition, the foreword to the guidelines specifically indicates that 'norms and guidelines need to be flexible' and further states that flexibility is preferable to the 'adoption of universal norms and standards'.[22] This makes sense in terms of giving panchayats the scope to manage drinking water in the way most suited to local conditions. However, in terms of broad regulation, this does not fit within the framework of the right to water that is essentially based on ensuring the exact same realization of the right (at least its 'core' content) to everyone.

Third, the NRDWP emphasizes the question of 'sustainability' of water supply. This is significant because sustainability is intrinsically linked to equity and has the potential to foster an understanding of drinking water

[15] NRDWP (2010).

[16] NRDWP (2010) s 2.

[17] *MC Mehta* v. *Kamal Nath* (1997) 1 SCC 388 (Supreme Court, 1996).

[18] Ibid., para 25.

[19] Note that at the same time the guidelines indicate that the overall goal is to 'provide every rural person with adequate safe water for drinking, cooking and other domestic basic needs' (NRDWP 2010: s 1).

[20] Ibid., s 4 (emphasis added).

[21] Ibid., s 9 (1).

[22] Ibid., p. iv.

security that contributes to the realization of the fundamental right to water. The main text of the NRDWP does not define sustainability but an annex on sustainability provides interesting insights. The starting point is the notion of sustainable development expounded in the report of the World Commission on Environment and Development (Brundtland Commission 1987).[23] According to the Brundtland Commission, sustainable development is development that meets today's needs without compromising future generations' options. One of the key tenets of the definition is the need to give 'overriding priority' to the essential needs of the world's poor.[24]

The understanding of sustainability propounded under the NRDWP is fundamentally different from that of the Brundtland Commission. It emphasizes four components: source, system, financial, and finally social and environmental sustainability.[25] The focus is on ensuring availability of water and not access (source sustainability), on optimizing the cost of production of water and capacity building (system sustainability), on cost recovery of 'at least' 50 per cent (financial sustainability) and on '[p]roper reject management and involvement of all key stakeholders' (social and environmental sustainability).[26]

The above definitions fall within a context where there is no generally agreed definition of sustainable development in either Indian law or international law. Yet, the NRDWP frames its understanding of sustainability in the context of the Brundtland Commission's report. In doing so, it acknowledges that sustainability first evolved from an environmental perspective and gave utmost priority to the poor.[27] It is thus surprising to find that 'social and environmental sustainability' is the fourth and last component of the definition. In addition, the NRDWP frames the environmental dimension of sustainability in a narrow framework focused on waste management. On the whole, the sustainability dimension of drinking water security as expounded in the NRDWP fails to provide a basis for fostering the realization of the fundamental right to water.

Fourth, the NRDWP places emphasis on the need for infrastructure that provides water from outside a given village through a grid, fed by pipelines or other means of connecting major water sources.[28] Alongside the focus on conjunctive use of surface and groundwater and reliance on multiple sources of water, a grid can make an important contribution to the provision of water. It could also lead to more equity among regions since everyone could, in principle, be provided the same amount of clean water regardless of their geographical location. This would constitute a major step forward in ensuring that the fundamental right to water is realized in the same way for everyone.

At the same time, this is a momentous change from reliance on local sources of water and should be integrated in a much broader policy discussion. Indeed, from the point of the principles and concepts being proposed, there is a tension or maybe even an opposition between the move to foster decentralization and participation and the move towards having a grid covering all villages. The latter will by definition imply a new level of centralization which has, in fact, never been present in rural drinking water supply until now. This may be a positive factor to the extent that the whole new framework is conceived with appropriate safeguards and accountability. It cannot, however, be introduced under the guise of participation and decentralization and the two streams thus need to be clearly distinguished.

Further Reforms

The earlier parts of this chapter brought out two key dimensions of the regulatory framework for rural drinking water supply. On the one hand, there are a series of binding legal principles and instruments governing the field. In particular, rural drinking water supply is on the whole governed by the fundamental

[23] Brundtland Commission (1987).

[24] Ibid., p. 54.

[25] NRDWP (2010: Annexure II: Guideline for Implementation of Sustainability–Swajaldhara Project).

[26] Ibid., Annexure II, s 2.

[27] Brundtland Commission (1987: 54).

[28] NRDWP (2010: s 6).

Box 10.1
National Rural Drinking Water Programme

- The NRDWP replaced the ARWSP since 2009.
- Its basic goal is to provide every rural person with adequate safe water for drinking, cooking, and other domestic basic needs. It seeks to ensure that ultimately all rural households be provided with adequate piped safe drinking water supply within the household premises. This water should meet minimum water quality standards and be readily and conveniently accessible at all times and in all situations.
- The NRDWP is based around a string of principles, including the principle that water is a public good; that it is the 'lifeline activity' of the government to ensure that water needs are met; and that 'market forces alone' should not be the main driving force in fulfilling basic water needs.
- The NRDWP moves away from a measurement of water needs in terms of lpcd towards the concept of 'drinking water security' that considers the household as the basic unit rather than the individual.
- The NRDWP envisages the need for a 'grid supplying metered bulk water' as an alternate supply system at the sub-district, district and/or state level.
- The NRDWP calls for the active participation of stakeholders and envisages that the level of service should be linked to user 'demand'. In addition, it forecasts that the government will not be able to provide all the necessary resources. As a result, it calls for cost sharing between all actors involved and specifically requests panchayati raj institutions to manage the drinking water supply systems created. The role of the state government is to be limited to the responsibility for the bulk transfer of water, its treatment, and distribution up to the doorstep of the village.

right to water. This is supplemented by some legislative instruments, such as panchayat acts. On the other hand, there are various non-binding instruments adopted by the executive, in particular the union government, that govern rural drinking water supply. These instruments have in common that they do not create rights and obligations and can be adopted and modified without any particular procedure, as opposed to the case of an Act of Parliament.

The evolution of the past two decades highlighted above shows that the part of the regulatory framework that has evolved dramatically is the one that is mostly controlled by the executive. This permits a lot of flexibility, rapid changes, and adaptation to new contexts. Yet, at the same time, the Swajaldhara Guidelines and subsequently the NRDWP are crucial instruments that have and will completely redraw the regulatory framework for rural drinking water supply. These instruments have and will affect the way in which the fundamental right to water is realized and the way in which existing legislation, such as panchayat acts are implemented. However, since none of these reforms have ever been adopted by Parliament, there has never been any assessment of their impact on the existing legal framework or of their compatibility.

The reforms that have been introduced to-date raise a number of key questions that need to be much more widely debated. This section seeks to propose a few suggestions concerning the way in which the regulatory framework should move beyond the existing reforms. Yet, this cannot be done in a vacuum since there are already proposals and new instruments seeking to take the rural drinking water sector along the path of further significant reforms. Two of these efforts are introduced here.

New Reform Proposals

The NRDWP framework is yet to be fully operational in some parts of the country, as witnessed in different districts of UP where block and district authorities are at most aware that a new paradigm exists in Lucknow. Yet, the Department of Drinking Water and Sanitation has already moved towards adopting further sweeping reforms. This comes in the form of a strategic plan for the period leading up to 2022.[29]

[29] Ministry of Rural Development (2011).

This strategic plan does not necessarily imply rescinding the NRDWP but can be seen as an additional framework guiding the overall sector for the next decade. The overall conceptual framework of the strategic plan is highlighted in a section entitled 'aspirations' that calls for all rural households to have access to piped water supply in adequate quantity with a metered tap connection providing safe drinking water. The implication of this aspiration is a complete redrawing of the physical map of water supply throughout the country. As indicated in the plan, what is envisaged is on the whole abandoning handpumps whose contribution to water supply is visualized as declining from 70 to 10 per cent while community stand-posts' contribution is meant to decrease from 30 to 10 per cent.

Interestingly, the strategic plan seems to reverse in part the NRDWP decision to abandon a per capita measurement of water supply by suggesting that the goal by 2022 should be that every person should have access to 70 lpcd within 50 metres from their household. This is, however, not conceived as a universal norm. Indeed, the plan goes on to identify three different levels of service: the first one includes basic piped water supply with a mix of household connections, public taps and handpumps and is designed for 55 lpcd. The second one comprises piped water supply with all metered, household connections and is designed for 70 lpcd or more. The third option to be adopted 'in extreme cases' includes handpumps, protected open wells, protected ponds supplemented by other local sources and is designed for 40 lpcd.[30]

The plan does not indicate how these choices will be made. However, it specifies that the first two options are based on at least partial cost recovery, leaving each state to decide on the basis of 'affordability and social equity' within the cost ceiling.[31] The third option to be adopted only in extreme cases is the one where water is still provided free of cost. This seems to imply that the level of service provided will depend on the capacity of water users to pay for it, as experimented for more than a decade in the context of the Swajal Project and Swajaldhara Guidelines.

The plan is clearer than the NRDWP in specifically recommending what it calls 'outsourcing'. The participation of the private sector is thus openly called for in rural water supply for the first time. This is likely to usher in a revolution in the functioning of the rural water supply sector.

Thus, the plan is directly linked to a scheme that is to be implemented in the eleventh plan, the Provision of Urban Amenities in Rural Areas (PURA) Scheme.[32] This scheme proceeds from an idea first mooted in 2003. As the name implies, it seeks to ensure that rural areas get some of the basic amenities enjoyed in urban areas. It is specifically premised on delivering these amenities through public–private partnerships.

The PURA is conceived not only as a way to bring in private sector finance to rural areas but also as a way to rethink the disbursement of existing public sector funding, and in particular to ensure convergence of different schemes such as the NRDWP and the Total Sanitation Campaign. It is particularly significant in the context of this chapter because the first amenity covered is drinking water and sewerage.[33]

One of the striking features of PURA is that it includes different categories of amenities. In the first category are amenities falling under the purview of the Ministry of Rural Development. Besides water and sewerage, it includes areas like construction and maintenance of village streets, drainage, and solid waste management. This is supplemented by so-called 'add-on projects' that include village related tourism or integrated rural business centres. This scheme calls for at least one add-on activity to be included in every project. The mixing of social service delivery by the private sector with purely commercial activities is a novelty for the rural water supply sector. In principle, the two need not conflict but in practice the likelihood that private sector actors may focus on the commercially viable sectors to the detriment of basic needs provision cannot be excluded.

[30] Ministry of Rural Development (2011: 7).

[31] Ibid.

[32] Ministry of Rural Development (2011).

[33] Ibid., p. 7.

The possibility for schemes going awry confirms the need for a regulatory framework that provides general guidance for activities and projects contributing to the realization of the fundamental right to water. Ongoing proposals may generally point towards ways to fulfil the right. Yet, the crux of the matter lies in the finer details. Thus, as witnessed in earlier efforts at turning rural drinking water into an economic good under the Swajal project and the Swajaldhara Guidelines, it is not enough to simply rely on community involvement to ensure equitable results. Indeed, the results of pilot projects showed that the poor were largely excluded from improved water supply infrastructure because they could not pay the capital cost contribution demanded, leading to an increase in inequality in access to water along socio-economic lines rather than to the provision of amenities to people most in need.[34]

Going Beyond Existing Proposals

The existing regulatory framework for drinking water supply suffers from several weaknesses. First, it has some firm basic legal basis like the fundamental right to water but lacks a concrete binding legal framework setting out the parameters for realizing the right. This means, for instance, that while the fundamental right to water implies that every individual is entitled to the provision of safe and clean water, the water quality standards that exist in the country have not been included in any legislation.

Second, the void left by the absence of legislation has been filled by the government through the adoption of secondary instruments. Some of these instruments such as the ARWSP have contributed in no small measure to progress in drinking water provision in rural areas. The reforms of the past decade have, however, highlighted the limitations of a system relying mostly on the executive to realize fundamental rights. Indeed, the shift from the ARWSP to the NRDWP was effected without having to amend any laws. This implies that the elected representatives in Parliament or state legislative assemblies never got to have the final say in the overhaul of the framework for water supply in rural areas.

The sidelining of the legislature concerning an issue as crucial as drinking water supply is a concern in general. More specifically, the problem is that the changed framework seems to be moving away from some of the gains made earlier in terms of the realization of the fundamental right to water. This is, for instance, the case with regard to the shift from providing a minimum quantity of water for every individual to the household based measure. The absence of parliamentary oversight in matters of such importance leaves a gap. Indeed, the only other arm of the state that can then be approached is the court, an option that should remain the last recourse. Indeed, as noted earlier, the courts have not engaged with the specific content of the fundamental right to water, an option, which is sensible since this should indeed be the job of the legislature while the executive should undertake the implementation.

The experience with the reforms of the past decades is full of lessons for the future. A number of areas need to be addressed to ensure that the promise of the fundamental right to water does not remain a promise on paper for a certain section of the population:

- Water law remains underdeveloped as far as drinking water supply in rural areas is concerned. This gap can at best be filled on a temporary basis by secondary legal instruments adopted by the executive. Thus, the basic framework complementing the fundamental right to water must be adopted by the legislature.
- There are increasing inconsistencies between the binding legal principles and the secondary instruments adopted by the executive that could turn into conflicts. This is, for instance, the case with regard to the characterization of water as an economic good in secondary instruments of the executive. This is in contrast with two well-established principles of water law: A fundamental right is by definition not the subject of market forces. Further, water is a public trust and the Supreme Court has specifically asserted the fact that a public trust cannot be alienated, thus making it an impossible candidate for the label of 'economic good'.
- There have been significant reforms and further proposals for reforms with regard to the role that different actors involved in rural drinking water

[34] Sampat (2007).

supply should play. There is a need for further thinking in this area to ensure that decentralization does not end up implying a withdrawal of the union and state governments from the provision of drinking water supply and that the entry of private sector actors does not undermine the existing institutions of democratic governance at the local level but rather contributes to their strengthening. In keeping with the constitutional framework, the gram sabha and gram panchayats must not only be recognized as having control over drinking water supply at the local level but also be given the necessary regulatory and fiscal powers that will ensure effective implementation of the tasks that they have to perform. The primary role of panchayats should be supplemented by support from block and district authorities. state governments should have a coordinating role and provide the framework for ensuring that every individual's water needs are satisfied.

- The institutional reforms that will be adopted are unlikely to be sufficient by themselves because giving stronger fiscal and regulatory powers to panchayats is likely to take time. Yet, even if this cannot be achieved immediately, a limited reform of governance can already provide a much clearer mandate for panchayats. This should include setting out of legally binding water quality standards and ensuring that key advances of the decentralization framework such as reservation are not undermined by the setting up of separate user bodies.

Overall, the regulatory framework for rural drinking water supply must move away from simply thinking in terms of a transfer of responsibility from the state to the private sector. Indeed, there are much bigger systemic challenges that need to be addressed. Among these, it is imperative to understand that water being a fundamental right, its realization must be the same for every single individual throughout the country regardless of location. In principle, the ARWSP model achieved this by seeking a minimum level of supply of 40 lpcd for all rural residents. Yet, the ARWSP was not the norm for all residents of the country since the regulatory framework provided much higher allocations for urban residents.[35] The NRDWP, by moving away from a quantified basis, has removed any point of comparison and further undermined the position of rural residents. The strategic plan takes a step forward in putting the minimum supply quantity at 70 lpcd, a quantity that is the same as the minimum for urban areas. This would seem to imply that the strategic plan recognizes the need to treat everyone similarly. Yet, as indicated above, this is not what the plan does since it qualifies its 70 lpcd measure by providing different levels of service that, in effect, will depend on the amount that individuals can pay. This not only implies that, like under Swajaldhara, there is the risk that wealthier people will get better service but also that richer areas of the country or richer panchayats in a given district will get better amenities than others. The principle of equity that is increasingly touted as a key principle for all reforms must be brought back into the picture. Equity in the case of a fundamental right must imply not only that the poor should not be further impoverished by any reform process but also that the poorer areas—that may also be the ones facing the most severe water supply challenges—should not be further disadvantaged in a framework that seeks to reform the regulatory framework in its entirety.

The lessons of the past forty-odd years are that the Government of India, together with state governments, has done a commendable though far from perfect job. The legal framework has evolved in the past few decades, partly in reaction to actions or inaction of the government, and has recognized the need for stronger control over drinking water supply at the local level and also confirmed the existence of the fundamental right of every single individual. These are key changes that need to be effectively implemented. In this sense, the government has a mandate to take things forward. This must start by giving legislatures the primary control over such a key issue.

[35] Government of India (1988: 294) and Ministry of Water Resources (1999: 63).

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11 Changing Waterscapes in the Periphery

Understanding Peri-urban Water Security in Urbanizing India

Anjal Prakash, Sreoshi Singh, and Vishal Narain[†]

Introduction

Urbanization and economic growth are considered to be the most striking features of the past century (McGranahan 2006). There is currently a radical demographic shift in progress worldwide, wherein people are moving from rural to urban areas at an increasing rate. In the mid-1970s, less than 40 per cent of the world's population lived in urban areas; by 2025 the figure is expected to reach 60 per cent.[1] In 1950, 41 of the world's 100 largest cities were in developing countries. By 1995 this number had risen to 64 and the proportion has been rising ever since. Increase in the urban population is particularly likely to affect low income countries. As per future predictions, nearly 90 per cent of the urban dwellers will be living in developing countries.

The UN-Habitat report 2005 (cited in Adesina 2007: 2) indicates that in 2025, 61 per cent of the 5 billion world population will reside in the urban areas with about 85 per cent of the development process taking place in the urban hinterlands widely referred to as 'peri-urban', 'suburbs', 'urban fringe', 'city edge', 'metropolitan shadow', or 'urban sprawl'. The peri-urban zone is considered to be a transition zone and is conceptualized as a space in 'continuum' with the urban area, characterized by mixed land use with agricultural land predominating the landscape within which there is other rural land that is converted into permanently built-up areas and covered with infrastructure. 'Urban sprawl makes intensive demands on the environmental resources and poses problems by eating into valuable natural habitats of their hinterlands' (OECD 1990 cited in ibid: 3). It is associated with loss of natural wetlands along with loss of core forest habitat, loss or damage

[†] The authors would like to acknowledge the support from International Development Research Center (IDRC), Canada, to the project–Water Security in Peri Urban South Asia: Adapting to Climate Change and Urbanization. This chapter has been culled out from the scoping study as part of the collaborative research project. In particular, intellectual support from Dr Sara Ahmed of IDRC is gratefully acknowledged.

[1] This is not withstanding the fact that definitions of rural and urban vary across countries; sometimes, that may hinder cross-country comparisons (Satterthwaite 2006).

of prime farmland and increase of impervious surface (Hasse and Lathrop 2003). This is a process emerging out of development activities, manifested in changing social and economic interactions and increasing mobility of production factors, such as capital, labour, technology, and information to the urban fringe near mega cities. A 'peri-urban interface'/'urban fringe'/'suburb' comprises small farmers, informal settlers, industrial entrepreneurs, and urban middle and elite classes all co-existing with varied interests, practices, and perceptions (Allen 2003; Iaquinta and Drescher 2000; Narain and Nischal 2007).

The process of rapid urbanization has thinned down the distinction between what is purely 'rural' and 'urban' with the intermediary 'peri-urban' zone becoming more prominent and visible in the future. Since peri-urban regions have specific social, economic, and institutional characteristics, there is a case and need to understand and document these better. An understanding of these unique characteristics is essential in order to develop new and innovative ways of addressing peri-urban challenges, cutting across the frontiers of rural and urban governance.

In this backdrop, this chapter documents the process of urbanization and its impact on the lives of the people and the water bodies in the peri-urban areas of Gurgaon and Hyderabad in India. The chapter is divided into three broad sections. Section one provides an understanding of the urbanization process in Hyderabad and Gurgaon and the issues therein. Section two focuses on the concerns around water insecurity in peri-urban areas due to increased urbanization. Section three focuses on the policy implications coming out from the analysis of the two case studies.

Urbanization trends in Hyderabad and Gurgaon

India's urban population grew from 290 million in the 2001 Census to an estimated 340 million in 2008 representing about 30 per cent of the total population. According to a recent study, the projection of urban growth rate at urban population in India will increase to 590 million by 2030 (MGI 2010). Urbanization is the defining characteristic of cities in India and the two cities under study—Hyderabad and Gurgaon—are not an exception. For these cities, the post-liberalization period has seen a form of development, where the process of change has been induced by growth of the information technology (IT) sector leading to tremendous growth and expansion post-liberalization.

The Growth and Expansion in Hyderabad

Hyderabad is a historical city which was founded in the 15th century and was the centre of princely state rules by Nizams till India's independence. Post-independence, it became a part of the Indian Union and became the capital of Andhra Pradesh, which was mostly carved out of the erstwhile state/province of Madras. In the mid-1990s, when the structural adjustment programme was initiated by the Government of India, Hyderabad became a node in the global web of economic flows and linkages. The development of the city made the Ranga Reddy district (of which Hyderabad is a part), the most developed district of the state. With a population of 5.53 million as per the 2001 Census, Hyderabad is currently ranked as the sixth largest urban agglomeration in the country. The Hyderabad Urban Agglomeration (HUA) consists of the Municipal Corporation of Hyderabad (MCH), 12-peripheral municipalities, Secunderabad Cantonment, Osmania University, and other areas. In recent times, the 12 surrounding municipalities were assimilated and the Greater Hyderabad Municipal Corporation was formed. The population growth rate in these three components within the Hyderabad Urban Agglomeration is given in Table 11.1.

Table 11.1 Percentage Growth Rate of Population in the Components within HUA

	1981–91	*1991–2001*
MCH	45.24	19.02
Surrounding municipalities	160.53	71.72
Others	39.13	25.00

Source: Calculated from data in GHMC Hyderabad City Development Plan (undated).

A future projection of population for HUA is shown in Figure 11.1. This figure projects an interesting trend, whereby the population of the surrounding municipalities will grow very rapidly and is expected to touch the population of the main corporation. The observed growth as well as projections indicate that development will continue to happen in the surrounding areas of the main city. These areas have

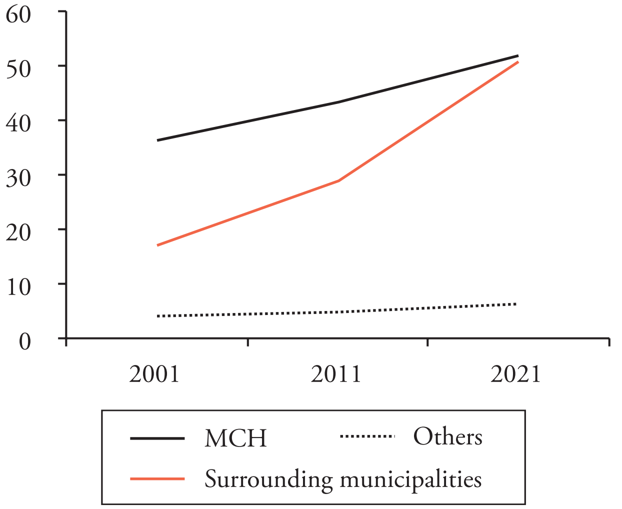

Figure 11.1 Projected Population Figures (in lakh) for Components of Hyderabad Urban Agglomeration (2001–21)

Source: Calculated from data in GHMC Hyderabad City Development Plan (undated).

become nodes of development in recent years and the real estate sector has boomed largely in these areas.

Another interesting issue is the growth of population in the surrounding municipalities of Hyderabad. Table 11.2 shows that the level of urbanization has been decreasing from 1981 to 1991 to 2001 in the municipal corporation area of Hyderabad and the other parts of HUA. However, the surrounding municipalities show increasing levels of urbanization during the same period.

Table 11.2 Level of Urbanization in Hyderabad

	1981	*1991*	*2001*	*2011*	*2021*
MCH	77.49	69.95	63.35	56.09	47.47
Surrounding Municipalities	14.02	22.71	29.67	37.44	46.74
Others	8.49	7.34	6.98	6.48	5.79

Source: Calculated from Census of India (1981, 1991, and 2001) and projected figures in the GHMC Hyderabad City Development Plan (undated: 12).

Table 11.2 shows that much of the growth since 2001 has taken place in the surrounding municipal areas. These areas fall within the jurisdiction of the panchayats and are now considered as revenue villages within the Hyderabad Metropolitan Development Authority. With the expansion of the city, some of the changes that these villages have come across are massive real estate development, decrease in agricultural land and shortage of water for round the year growth of paddy, water stress and degrading groundwater quality, acute shortage of drinking water during summers, increased dependency on bore water for all purposes, and supply of 24×7 water to surrounding development enclaves adjacent to these villages.

The Drivers of Urban Growth in Gurgaon

The present city of Gurgaon can be considered a metropolitan area encompassing settlements around the original city, and expanding even further with the establishment of new neighbourhoods and districts. A favourable tax policy by the Haryana government, improvement in the city's infrastructure by the Haryana Urban Development Authority (HUDA), and the need of a business centre close to the Indira Gandhi International Airport in Delhi saw the emergence of Gurgaon as one of the most prominent outsourcing and off-shoring hubs in South Asia. With the initiation of economic reforms in 1991, Gurgaon saw a massive expansion in its population and economy after the real estate major, the DLF Group, started buying farmland owned by the local people to start developing housing societies for the upper-middle class residents of Delhi. Further to this, the government removed bottlenecks in obtaining permits and provided special incentives to information technology/IT enabled services[2] (IT/ITES) and the business process outsourcing (BPO) sectors which attracted foreign investment. They were to receive preferential allotment of resources and facilities like land and electricity. This made Gurgaon India's outsourcing hub in 1997 when GE Capital International Services (GECIS) was set up as the India-based business process services operations of GE Capital. Very soon, a plethora of BPO and knowledge process outsourcing (KPO)

[2] The information technology-enabled services (ITES) industry provides services that are delivered over telecom or data network to a range of external business areas. Examples of such business process outsourcing (BPO) include customer service, web-content development, back office management, and network consultancy.

firms, such as Genpact, Evalueserve, Dell, Accenture, Hewitt Associates, Copal Partners, and Convergys expanded their operations into the city. Apart from these, a few IT and pharmaceutical firms set up base as well, though their distribution has tended to be skewed. At present, Gurgaon is the regional head office of Alcatel-Lucent, Niksun, IBM, Opera Solutions, and Bain & Company. Gurgaon is also the headquarters of two biggest automobile manufacturers in India—Hero Honda and Maruti Udyog.

In 2005, the Government of Haryana introduced the new industrial policy, which gave further boost to increased and rapid urbanization; the key understanding and motive behind the new initiative was promoting industrial growth, creating wealth for the citizens, and improving quality of life. The professed goals of this policy were to generate employment and entrepreneurial opportunities across all sectors, facilitate dispersal of economic activities in the backward socio-economic regions of the state, and ensuring sustainable development through investment in key sectors. Since the expansion of BPO/IT/ITES in Gurgaon, there has been a large influx of population largely from Delhi and the surrounding states of Uttar Pradesh, Punjab, and Rajasthan. The migration to Gurgaon city has led to rapid urbanization and further growth of urban outgrowths in continuation of the municipal boundaries of the city, better known by the Census of India as the Gurgaon Urban Agglomeration (UA). The total population of Gurgaon UA was 228,820 in 2001, which was 62 per cent of the total urban population of the district. A calculation of population growth reveals that from 1971 to 2001, the growth declined but a projected figure from 2001–11 till 2021 shows that the growth rate is above 300 per cent (see Figure 11.2).

The maximum increase in population has occurred in central Gurgaon town, which forms the industrial region, contiguous to Delhi and is therefore the hub of multinational corporations' expansion (Director of Census Operations 2004: 36, 40, 51 in an excerpt from Singh 2004). The NCR Planning Board as well as the master plans for urban areas and census for rural areas have projected the population of Gurgaon city till 2021 to be above 3 million. Based on these figures, the growth rate of the urban population between 1971–2021 is shown in Figure 11.3, pointing to a massive increase in urban population from 2001 to 2010. Likewise the percentage of the Gurgaon Urban Agglomeration to the total population of Gurgaon district increased from 3.35 per cent in 1971 to 13.80 per cent in 2001. In 2011, this proportion is expected to be 52.53 per cent, which will go up to 76 per cent approximately by 2021 (based on projected figures by Town and Country Planning Organization, Haryana) indicating a very steep rise (See Figure 11.3).

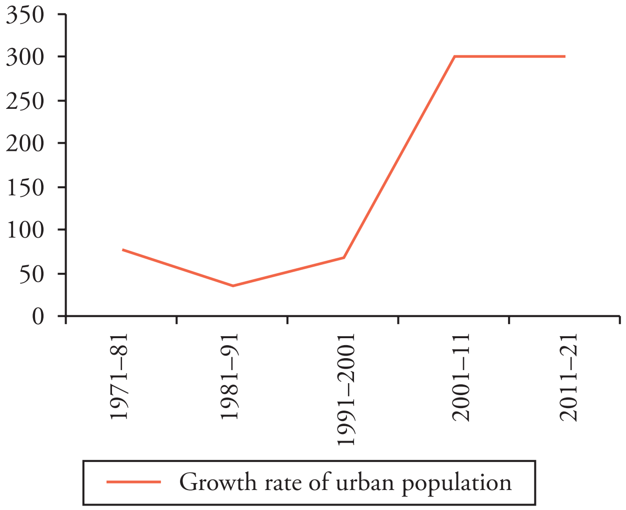

Figure 11.2 Growth Rate of Urban Population in Gurgaon

Source: Calculated and compiled from data given by the Department of Town and Country Planning, Haryana.

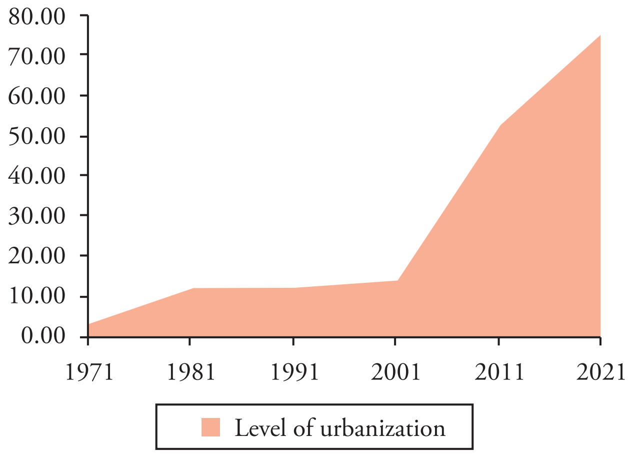

Figure 11.3 Urbanization in Gurgaon District

Source: Prepared from data given by Department of Town and Country Planning, Haryana.

A major impetus to the growth of Gurgaon has come from real estate that has emerged as an important industry in Gurgaon and the construction of office complexes and malls has led to an influx of labour from poor and underdeveloped states like Bihar, Bengal, and Orissa and even illegal migrants from Bangladesh. Real estate remains the third largest employer in the city after IT services and the retail sector (Consultants Mart Report undated). There has been a substantial shift from the traditional means of livelihood like agriculture in terms of the occupational structure (Census of India 2001). Another major driver of land use change has been the initiative of setting up special economic zones (SEZs). In 2005, the Haryana government decided to set up a SEZ through public-private partnership.[3] In the official Master plan 2021, a total of 4,570 hectares has been allocated to SEZs.

Urbanization Induced Water Insecurity for Peri-urban Areas in Hyderabad and Gurgaon

The unplanned and unsustainable development process in Hyderabad and Gurgaon has proved to be quite unsustainable and has turned out to be a serious threat to the cities and their environs. The growth has affected basic amenities, especially water supply for the increasing population in the newly developing areas. In this section, we examine the water insecurity confronting peri-urban residents in these two cities, especially from the peri-urban point of view and derive major conclusions.

Hyderabad—A City Thriving on Peri-urban Water Resources

Hyderabad, being located in an area with hard-rock aquifer, has very limited percolation while water drawn from the aquifer far exceeds the amount that is actually recharged. The groundwater depth during the dry season and during monsoons when correlated to rainfall over the last 10 years can reveal the gravity of the problem. There has been progressive decline in the per cent of rainfall converted into inflows due to increased usage of surface and groundwater in the catchment areas surrounding Hyderabad. Historical data shows that there were 932 tanks in and around Hyderabad in 1973, which had come down to 834 in 1996. Consequently, the area under water bodies got reduced from 118 sq km to 110 sq km. About 18 water bodies of over 10 hectare size and 80 tanks of below 10-hectare size were lost during this period in the HUDA area. Besides the large water bodies, numerous small water bodies in the peri-urban zones also shrank, when the city underwent a wave of real estate growth (Ramachandraiah and Prasad 2008).

However, systems for water and sanitation have often been specifically planned and constructed for either urban or rural situations, resulting in the peri-urban interfaces being neglected or forgotten, leaving large numbers without sufficient clean drinking water or adequate sanitation (Norström 2007; Törnqvist 2007). This makes planning for sustainable water and sanitation systems in peri-urban areas an important and challenging issue, since sources are limited and often diminish over time due to land acquisition for residential and commercial purposes. A survey done in 2003 in Hyderabad revealed the plight of low income households in accessing water, which was supplied either on alternate days for a few hours or once in three or four days (Ramachandraiah and Prasad 2008). This was in sharp contrast to the large quantity of water supplied to the IT companies and other institutions like the Indian School of Business (ISB) and the National Academy of Construction (NAC). Drinking water was supplied by tankers (which made about 5 trips a day) by the local municipality. The plan to lay pipelines so that domestic connections can be given to those who have the ability to pay clearly points to the concept of 'users pay', which brings in inequality and water equity issues.

The area around the Rajiv Gandhi International Airport is a semi-arid zone, dotted with numerous lakes and *kuntas*.[4] There are 140 lakes and kuntas in this area, one of the largest being the Himayatsagar on the north-west. One of the largest manmade is the Himayatsagar in the northwest, whose catchment lies in

[3] This SEZ was expected to be the largest in India and promised to provide 500,000 jobs. The main developer in this project—Reliance Industries Ltd. (RIL)—would hold 90 per cent of the shares of the project (Gurgaon Workers News—Newsletter 2 April 2007).

[4] *Kunta* is local term in Telugu used when referring to a small lake.

an area, where recent developments have started in full swing (HADA 2003). Seventy per cent of this lake has already shrunk due to the drying up of the smaller lakes in the surrounding areas accentuated by low rainfall and low groundwater recharge along with construction of the international airport (Ramachandraiah and Prasad 2004). The area also has good fertile agricultural land, especially at Ravirala, Kongara, Chowdarypalli, Narkhoda, Adibhatla, and Dosawada etc. (HADA 2003).

In many of these villages, residents depend on groundwater for drinking as well as agriculture. The variability of rainfall during monsoons leads to increased stress on groundwater levels, because of rising demand for water for growing rice. The farmers have installed bores up to 100 to 150 feet deep or even more in order to provide water to their fields. In some cases, water requirements are met by transferring from the large water bodies located in the vicinity through artificial channels only during good monsoon periods. But this has been a rare phenomenon in the last several years. Many of the smaller water bodies, which served as natural water harvesting structures have dried up or shrunk in the last 6 to 7 years, when construction activities started on a rapid scale. (extracted from field notes prepared during field visits to peri-urban areas, September and October 2010).

Apart from this, illegal water trade is carried out for supplying water to urban colonies (see Box 11.1). Local people are unaware of the possibilities of a further drop in groundwater levels over time and have not gone in for any way out of this situation through other technical interventions or by identifying other sources or conserving other sources of water which face a threat.

A report by the Ground Water Board shows that in the Ranga Reddy district, '22 mandals out of 37, utilize more than 70% of the available groundwater resource. Based on the stage of groundwater development 15 mandals are categorized as safe (less 70 per cent of available resource), 8 semi critical (70–90 per cent) to critical (90–100 per cent) and 12 over exploited (more than 100 per cent). The maximum stage development of groundwater is 187 per cent in Shamirpet mandal, which falls within the peri urban areas of Hyderabad. Shamshabad and Maheswaram mandals, also falling within the peri-urban area have been categorised as "over exploited"' (CGWB 2007: 22 and 23). The present rate of access to water varies over socio-economic and physical terrains. With the privatization of water and tariffs being the same for commercial and domestic use and within domestic use, between large residential complexes and residences of the lower socio-economic classes, a conflict is anticipated in the core and newly developing peripheries of Hyderabad. Again Hyderabad depends on its peripheral rural counterparts for food. Some farmers in the villages in the peri-urban areas, lack marketing skills and have to depend on local moneylenders to invest in their land, and in return have to sell half of their entire produce at a rate much lower than the market rate and pay higher interests for the investment made. This will pose a serious threat in terms of livelihood along with water stress in the future. Arguments about the need for a 24×7 water supply, have been countered by arguments for 4 hours of daily uninterrupted supply being sufficient for any household. This also leads to wastage of 20 per cent of the water. If 24×7 supply actually takes place, further wastage is expected. Equitable distribution of water to all areas and sectors (CGWB 2007) must be one of the priorities in policy documents. Also, agricultural practices in most peri-urban villages are completely dependent on groundwater and as per current regulation like the Andhra Pradesh Land Water and Trees Act coupled with the free electricity policy of the government, there is accelerated privatization of groundwater in the state as a whole (Ramachandrula undated). Therefore, policy intervention for equity as well as groundwater regulation, especially for peri-urban zones must be taken up as a priority.

Consequences of Urbanization and Peri-urban Growth for Landuse Change and Water Security in Gurgaon

A study by urban scholars (Chaudhry et al. 2008) indicates that the land use pattern in Gurgaon has changed largely because of rapid urbanization and the expansion of the city into the peri-urban areas. Using remote sensing and GIS, the study shows how the expansion of Gurgaon and development of the new satellite town of Manesar saw the total built-up area increasing from 26.58 sq km in 1996–7 to 124.15 sq km in 2001–2. Most of this expansion has taken place in areas which were earlier scrubland, pastures, water bodies, land susceptible to water-logging with a high water table, or agricultural land.

Box 11.1
Water Security Concerns in Mallampet

Mallampet, 7–8 km away from Greater Hyderabad Municipal Corporation (GHMC) boundary is one of the several villages from where water is brought in tankers during summers to serve the needs of the city. This is one of the many villages from where the tankers operated by private entrepreneurs extract water. The sarpanch, Vekatesham indicated that the village has about 500 households, with about 50 acres of agricultural land left but only a small portion of it was actually being cultivated. Some villagers had sold their land and bought land near Narsapur. The primary reason indicated by him for change in the livelihood pattern is the cost of labour in agriculture: 'If industry pays Rs 150/day and agriculture pays only Rs 80/day, a labourer prefers to work in the industry'. The primary source of water in the village comes from 15 bores that have been set up by the panchayat which are up to 400 feet deep. If the lakes are full, the water table tends to be high and with 8 hours of electricity, water can be easily pumped and distributed to all the households for personal use and there is not much scarcity. In 2010, the lakes were full because of good rains. The first bore was dug in 1987, which later dried up due to pollution of the water from the surrounding industries; new bores were dug later. In 2005, some more bores were dug due to increasing demand for water in several other parts of the village along with new storage facilities and new pipe connections. To maintain this system along with a water treatment plant, Rs 2 is collected every month from each household. The village seems to be self-sufficient, but the illegal extraction of water has been a source of worry for the panchayat. For agricultural purposes, there are separate bores installed by villagers. But because right to water is tied to the right to land, many of the villagers who had bores dug in their land for agricultural purposes are actually selling water to private tanker entrepreneurs who in turn sell it to the industries in the vicinity. A villager selling water from his land makes Rs 150–200 from each tanker (5,000 ltrs/10,000 ltrs respectively) of water he sells and the tankers visit the village almost 15 times in a day to abstract water. The villagers are finding this more profitable than agriculture. Some villagers are also buying *manjira* water and bringing it in big tanks from surrounding villages which get supply and are selling it to the village community at Rs 10-15 (approximately) for 20 litres. Much of the water from the bores located in the village lake tend to get further polluted, especially during the monsoons, when the entire drainage water from the villages flows into this lake. The water pollution problem started in 1986 However, after much hue and cry and repeated complaints being filed against the polluting industries, the government has stopped providing permissions to set up new factories in the area... 'Only new factories cannot be set up as per the regulation, but the existing ones still operate and discharge their effluents into the other lakes located near the village', says the sarpanch. During the construction of the ring road, almost 78 acres of land was acquired. The construction is still underway and has encroached portions of the lake which is a source of groundwater for the villagers. However, the impact of builders and real estate developers has not been felt very strongly in the village itself, though land has been sold to developers and has been plotted for future growth. Till 1997, agriculture was the only source of income for a large part of the village but since 2002, with the real estate boom, households started selling their land. However, there are no large apartment complexes in the vicinity; only a few duplex complexes. The water security concerns also emerged very strongly in Mallampet, whose water resources are being randomly exploited by illegal tankers, selling water to the industries, which in turn pollute the groundwater by releasing effluents. This is a vicious cycle which is a cause for worry and needs policy attention.

Source: Field note diary, Sreoshi Singh, 11 November 2010.

Peri-urban areas of large cities are subject to being taken over by expanding boundaries and often grow upon land where the natural water cycle occurred once, such as forests, meadows, or wetlands. This can harm the recharging of the groundwater table, and can affect local water bodies. The natural water cycle is disrupted, and often new pollutants such as pesticides can create problems for the ecology of an area. Figure 11.4 shows the sector-wise percentage gross groundwater draft (in hectares per metre) in the four blocks of Gurgaon district in 2004. Interestingly, the Gurgaon blocks show the highest values in the domestic and industrial sector. Tube wells in the depth range of 45 to 90 m bgl (below ground level) have been installed by different agencies in the blocks.

Further, around Gurgaon city there are eight golf courses. A 100-acre golf course needs roughly 10 million litres of water a day, according to Force, an NGO working for water conservation. This water is enough to meet the requirements of 50,000 households. The eight golf courses (1,200 acres) consume close to 120 million litres of water daily, which is sourced from groundwater. This could be considered bad news for the water table in Gurgaon, which at present is 160

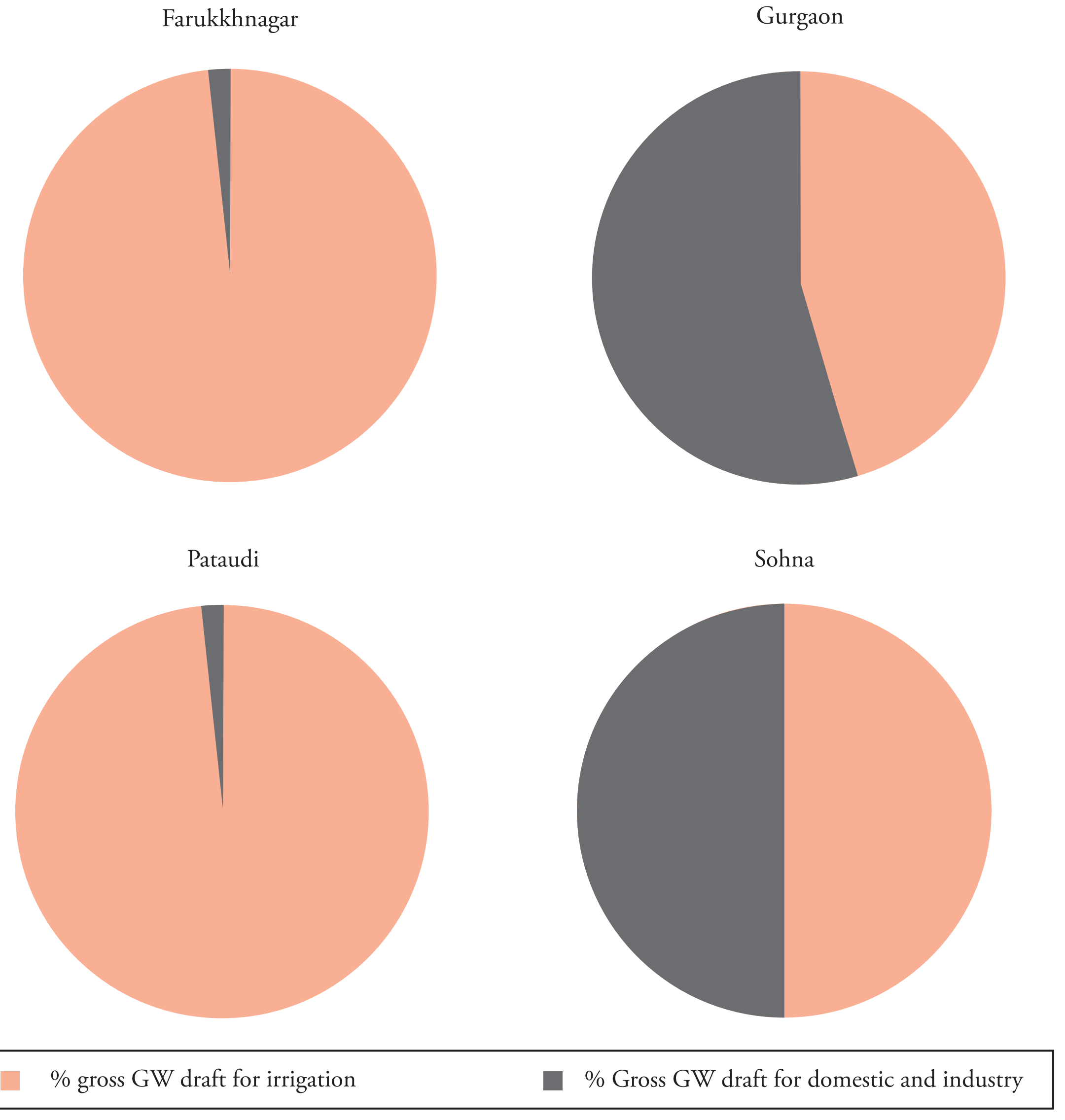

Figure 11.4 Sector-wise Percentage Gross Groundwater Draft, (in ha per metre) in four blocks in Gurgaon, 2004

Source: Central Ground Water Board (2007).

feet below ground level in certain areas.[5] The water runs out at around 200 feet (Gill 2010). Other recreational centres are also coming up which are encroaching forest areas, some of which have been designated as closed forests to be protected against any encroachment due to urbanization (Chaudhry et al. 2008). Besides, land has been acquired to build water treatment plants in peripheral villages to quench the thirst of the city;

[5] *Times of India*, Delhi edition, 2 February, 2010, states that, '… scientists at the Central Ground Water Authority have been warned that Gurgaon's water table has been declining at a rate of about two meters (six feet) every year since 2006. Haryana draws 2.72 billion cubic meters of water whereas the annual availability is 2.64 bcm within NCR. It is predicted by the scientists that the city will have no water left by 2017' and this will also have serious implications for the residents of peri-urban Gurgaon, since their remaining water resources would also be under severe threat.

routes to water sources have been obstructed by construction of highways and water sources have been filled up for residential and other urban purposes (Narain 2009a, 2009b). When land is acquired for urban or other purposes—a common phenomenon in peri-urban contexts—the landowners gain doubly; they not only get the compensation for the land, but also the agreed amount from tenants for the land that is given on *kann*. If, however, a tenant has sown some crop over the land, it is a loss to him when the land goes, as he gets nothing—neither the compensation, nor the value of the crop produced or about to be harvested.

To cater to the increasing gap between demand and supply, illegal groundwater extraction is rampant. In the past three decades, 35,000 bore wells have come up, of which only 9,780 are registered. In May last year, the Central Ground Water Authority (CGWA) allowed more new bore wells to come up creating a flutter among local authorities in Gurgaon (ibid). Moreover, long power cuts during summer accentuate the problem and force residents to depend on tankers, which charge Rs 600–700 per household for supplying about 3,000 to 4,000 litres of water. During summers, severe power cuts often urge residents to demand scheduled power cuts to alleviate their problems, but state-owned Dakshin Haryana Bijli Vitran Nigam (DHBVN) finds itself helpless because of a supply shortage of about 42 per cent (*Hindustan Times*, Anonymous 2010). A 70-km long NCR water supply channel for carrying drinking water supply to Gurgaon, Manesar, Bahadurgarh, Sampla, and Badli has been undergoing construction, at a cost of Rs 322 crore (Akansha 2010). This channel cuts through the peripheral villages, engulfing their land and water sources. Besides, the policies for developing SEZs also have severe socio-economic and environmental impacts because a bulk of the land acquired is fertile, agricultural land or in some cases even forest land (Basu 2007). To attract private investments, state governments have often provided facilities like free or subsidized water supply (Ibid), as a result of which there is inequality in water access for agriculture and domestic uses in the surrounding villages. Another serious impact is with regard to the release of effluents from the SEZs, which pollute the groundwater as well as surface water sources that exist in the vicinity (Sanhati 2009).

Towards Protecting Waterscapes and Mainstreaming Peri-urban in Policy and Planning

Several key issues emerge from a case study of the two cities of Hyderabad and Gurgaon. First, the uncertainty associated with water supply caused by mismanagement of water is further aggravated by the processes of urbanization. Water security, which was earlier ensured by numerous water bodies in and around cities, has been under threat by land use changes, land grabbing, and an environmentally unconscious development focussed on growth through unsustainable means.

When these cities began to attract investment from IT companies and other financial corporations due to opening up of the economy, the government provided land and other basic amenities in order to attract further growth. However, rapid real estate growth in specific locations saw many of the peri-urban villages, earlier outside the main city limits, getting quickly absorbed within the municipal boundaries to be provided regular services. However, in this process large tracts of agricultural land along with water bodies were taken over for developing large residential complexes. Further efforts were also made by the government to develop SEZs and other commercial enclaves in new peri-urban locations, which are outside the city administration but within a specified development zone for which agricultural land was also acquired. This process of annexing agricultural land has caused much threat to the lives and livelihoods of the local villagers around Hyderabad and Gurgaon. The residents in the peri-urban villages of these cities not only lost their main source of livelihood but also access to water, in quality and quantity, forcing them to migrate to the city for alternative sources of livelihood. In recent times, continuous pressure on available groundwater sources has increased the groundwater overdraft leading to acute water scarcity for people, especially the poor and marginalized.

In particular, peri-urban areas in Hyderabad have lost several lakes during the process of development, which were earlier natural sources of water for agriculture and several other economic activities. With the increase in the number of concrete structures, catchment areas of the larger lakes that have historically remained primary sources of water for the city have been reduced. With the pressure on surface sources increasing, newer sources have been tapped by the government.

Third, the water policies have highlighted some of the serious issues discussed earlier, but all of them pertain either to the urban or to the rural areas. There are no specific policies for the peri-urban zones that lie in between and get choked, leaving people more vulnerable. Here lies an important institutional vacuum which requires breaking away from the dichotomy of rural and urban water with a need to better appreciate the linkages and flows of water across rural and urban areas.

Fourth, there is seldom any recognition of water bodies in the planning process. All water bodies are recognized through land survey numbers. A large water body may have two or three or more survey numbers and, therefore, part of the common land can be easily transferred for the developmental process through a nexus of builders, bureaucrats, and local politicians with vested interest in grabbing communal land. There is a need to recognize waterscapes as a separate entity to protect them as a resource that influences water security for the people.

Mainstreaming Peri-urban Issues in Policy and Planning

As urbanization proceeds, the distinction between 'rural' and 'urban' will get blurred, and more of the intermediary, peri-urban zone will become visible. Peri-urban issues need better reflection in policy and planning. There is a need for rigorous studies on the carrying capacity of cities. Urban expansion plans need to be based on the carrying capacity of cities. Otherwise, the ecological footprint of cities will continue to spill over to the peripheral areas, engulfing the land and water resources of peripheral villages, depriving locals of access to land, water, and other natural resources. This breeds a pattern of urbanization that is inequitable, conflict-ridden, and unsustainable. Urban development policies also need to revisit and revise the existing building by-laws in peri-urban areas, which often ignore the negative consequences of urban expansion for the socially and economically marginalized communities who are affected by the development enclaves leading to reduced access to clean and safe water sources as well as other natural resources.

Increasingly, we need to devise ways of breaking the rural and urban dichotomy in planning. The focus of urban authorities on urban expansion and rural authorities on rural areas often implies that the relationships across 'rural' and 'urban' go unaddressed. Even if the peri-urban areas fall within a development zone, the focus tends to be largely urban-centric with little efforts to integrate rural development with the activities undertaken. The 74th amendment to the Constitution of India provides for the creation of District Planning Committees (DPCs)) to integrate planning at a district level. There is a need for such committees to be set up and similar other institutions as well to better integrate planning across rural and urban areas.

In general, there is a need to better recognize flows of water across rural and urban areas. The dichotomy between 'rural' and 'urban' water supply is superficial and overlooks the flow of water between rural and urban areas, which will become more visible with ongoing processes of urbanization. Often the expansion of urban water supply is at the expense of rural water supply, as peri-urban residents give away their land and water to allow canals to pass through to quench urban thirst, or allow water to be transported from their villages to the city in tankers. A strong policy for conserving natural resources, especially water and forests in peri-urban areas should be formulated. They are often a source of livelihood for the landless as well as for resource-poor farmers.

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Section III

Urban

12 Provincial Water Access in China and India

A Comparative Assessment

Fan Mingxuan and Bhanoji Rao

Introduction

When it comes to achieving the Millennium Development Goals (MDGs), China and India are unquestionably the fundamental drivers as their accomplishments determine the well-being of 40 per cent of the world population. According to the Joint Monitoring Programme (JMP), both China and India have already achieved their water-related MDG (half, by 2015, the population without access to improved drinking water). By 2008, 89 per cent of the population in China and 88 per cent in India had access to improved drinking water, exceeding the targets, 84 per cent and 86 per cent respectively, set for 2015 (World Health Organization and United Nations Children's Fund 2010).

However, the percentage of population with access to improved drinking water, the single indicator used for MDG monitoring, is not the only aspect of drinking water provision. The resource availability, quality, and quantity of domestic water as well as capacity to buy water are also essential factors. Therefore, looking forward, it is necessary for both countries to move beyond the basic MDG target and thoroughly evaluate their drinking water adequacy.

China and India face similar challenges. To name a few, their water resources distributions are temporally and spatially uneven, which leads to stress on water supply in the water scarce areas and during the dry season; their surface water quality is deteriorating dramatically; their urban water infrastructures are under tremendous pressure as urban population expands; and both countries are struggling to ensure improved drinking water supply in their vast rural areas. Based upon these similarities, we hope to exchange knowledge and look for common solutions through this comparative assessment.

Index of Drinking Water Adequacy

This chapter evaluates and compares India's and China's performance in achieving drinking water adequacy at provincial/state level using the Index of Drinking Water Adequacy (IDWA).

The IDWA is a benchmarking tool to monitor the performance of the drinking water sector across countries/states. The advantage of this index is that it is more comprehensive than single access indicators such as coverage as used in monitoring progress with respect to MDGs and yet much more straightforward compared to other indices of similar kind as it comprises only five most essential components, namely, water resources availability, access to improved drinking water sources, capacity to buy water, water quality, and water usage. The IDWA was originally proposed in the *Asian Water Development Outlook* (AWDO) of the Asian Development Bank (ADB 2007a). In 2010, the Institute of Water Policy applied this index further to the global level, states of India and provinces of China, and compiled a monograph *Index of Drinking Water Adequacy: International and Intra-national Comparisons*. Due to data limitations and different circumstances of each country, variations in indicators and norms exist in the construction of IDWA for India and China.

Resources

Ideally, the 'internal renewable fresh water resources per capita' should be used as the resource indicator. However, due to data limitation, for Indian states we have used a proxy indicator 'renewable groundwater resources per capita'. The resource index takes the resource available for each provinces/states as a percentage of the water demand projection for 2010 of the respective countries. The Central Water Commission (CWC) of India has projected a water demand of 1848 litres per capita per day (lpcd), and the National Development and Reform Commission (NDRC) has projected that of 1232 lpcd for China.

Access

Earlier research on IDWA used 'access to improved drinking water sources' as the indicator, but later we replaced it with house connection for water. As explained by Seetharam and Rao (2010), the access to water via improved water sources is sub-optimal in terms of ensuring minimal health risk. It was also pointed out that the opportunity cost of time lost in collecting water makes water connection at home an even better choice. Percentage of households with water connection is used as access indictor for China. However, the current surveys and Census in India do not collect information on access through house connection separately. Thus, data on access through tap water (including house connection and public taps) are used here as proxy.

Capacity

'GDP per capita' is used as the indicator for provinces'/states' capacity to produce or purchase water. The provinces/states with the highest and lowest gross domestic product (GDP) per capita in the respective countries serve as the benchmarks for capacity index.

Quality

We approach water quality through its impact on human health and make use of the diarrhoeal death rate as the quality indicator for India. However, in China, diarrhoeal death rate is very low across all provinces that it provides no comparison; hence we used the percentage of polluted water supplied for domestic use as the quality indicator. We thus took zero diarrhoeal death and zero polluted water supplied for domestic use as the norm for India and China, respectively and equating it to 100, the rest of the index was worked out.

Use

Per capita use of domestic water is employed as the 'use' indicator. For India, data are not available at state level; hence we used the per capita water supplied in major cities as a proxy. Due to data limitation, we could compute the use index for 18 states/union territories (UTs) only. Unlike other components of the index, higher use index is not necessarily good as it might also indicate overuse of resources. Therefore, we used Singapore's domestic water use in 2007, 157 lpcd, where water conservation is combined with 24×7 supply, as the optimal level and the norm (100), and anything above this is not rewarded. Both countries have regulations on the minimal supply for domestic use, anything below that could not meet the basic human need, and this minimal level is 70 lpcd for India and 75 lpcd for China.

The detailed information on indicators, norms, and computations for both countries is summarized in Table 12.1. Annexure 12.1 provides the data and sources for each component used in constructing the index. As data for Indian states are limited, 32 out of total 35 states/UTs are included in the index. Further, due to constraints of water use data, final indices were derived for only 18 states. Tables 12.2 and 12.3 present the indices for both countries.

Comparisons between India and China

Overall, the index for Chinese provinces is higher than that of Indian states, with a mean of 75.7 for 31 provinces in China and for 58.9 for 18 Indian states. The

Table 12.1 Summary of Methodology

	Indicator: India	Indicator: China	Norm: India	Norm: China	Index Computation: India	Index Computation: China
Resource	Renewable ground water resource per capita	Renewable internal fresh water per capita	Per capita water demand in 2010 of 1848 lpcd = 100	Per capita water demand in 2010 of 1232 lpcd = 100	*Resource Index for State j*= $100 \times \frac{\text{Renewable ground water per capita in state } j}{1848 \text{ lpcd}}$	*Resource Index for Province j*= $100 \times \frac{\text{IRWR per capita in province } j}{1232 \text{ lpcd}}$
Access	Households with access through tap	Households with house connections	Index = 100 when 100 per cent of the population has access to water	Index = 100 when 100 per cent of the households have access to water	*Access Index for State j*= $100 \times \frac{\text{Population with access in state } j}{\text{Total population in state } j}$	*Access Index for Province j*= 100 × (*Urban access rate in province j* × *per cent*
Capacity	Per capita GDP		log (lowest provincial per capita GDP) = 0; log (highest provincial per capita GDP) = 100.		*Capacity Index for State/Province j* $100 \times \frac{(\log \text{ per capita GDP}) - (\log \text{ capita GDP min})}{(\log \text{ per capita GDP max}) - (\log \text{ capita GDP min})}$	
Quality	Diarrhoeal Death Rate	Polluted water supplied for domestic use	Index=100 when there are no diarrhoeal deaths	Index =100 when there is no polluted water supplied for domestic use	*Quality Index for State j*= 100–*Diarrhoeal death rate in state j*	*Quality Index for Province j*= $100 - \frac{\text{Polluted Water Supplied in Province } j \text{ for domestic use in lpcd}}{\text{Total Water Supplied in Province } j \text{ for domestic use in lpcd}}$
Use	Per capita water supplied in selected cities	Water for domestic use per capita	Singapore's per capita domestic water use in 2007 of 157 lpcd =100; Minimum requirement of 70 lpcd=0	Singapore's per capita domestic water use in 2007 of 157 lpcd =100; Minimum requirement of 75 lpcd=0	*Use Index for State j* = $100 \times \frac{\text{per capita water in supplied in state } j - 70 \text{ lpcd}}{157 \text{ lpcd} - 70 \text{ lpcd}}$	*Use Index for Province j* = $100 \times \frac{\text{per capita domestic water use in province } j - 75 \text{ lpcd}}{157 \text{ lpcd} - 75 \text{ lpcd}}$

Source: Authors' calculations.

Table 12.2 IDWA for Indian States

	Resource	*Access*	*Capacity*	*Quality*	*Use*	*IDWA-4 components*	*IDWA-5 components*
Andhra Pradesh	71	67.4	49.5	98	67.0	71.48	70.58
Arunachal Pradesh	100	81.4	44.5	74.4		75.08	
Assam	100	9.8	34.8	68.6		53.30	
Bihar	52.1	4.1	0	98.7	42.5	38.73	39.48
Chhattisgarh	100	17.5	37.7	99.5		63.68	
Delhi	3.2	85	83.6	95.1	85.1	66.73	70.4
Goa	30.8	86.3	91.6	100		77.18	
Gujarat	46.3	68.2	58.3	99.9	87.9	68.18	72.12
Haryana	65.3	66.1	68.8	98.4	57.5	74.65	71.22
Himachal Pradesh	10.5	79.2	60.5	95.2	100	61.35	69.08
Jammu and Kashmir	39.5	71.3	40.5	97.2		62.13	
Jharkhand	30.7	10.7	29.6	99.9	100	42.73	54.18
Karnataka	44.7	78	51.1	87.9	12.6	65.43	54.86
Kerala	31.8	22.6	57.7	99.8	100	52.98	62.38
Madhya Pradesh	91.4	23.4	29	97.1	38.5	60.23	55.88
Maharashtra	50.4	71.1	62.4	98.6	94.7	70.63	75.44
Manipur	24.6	36.5	33.3	93.4	46.0	46.95	46.76
Meghalaya	73.5	59.3	44.4	81		64.55	
Mizoram	6.7	40.1	47.4	84.3		44.63	
Nagaland	26.8	27.8	43.8	98.6		49.25	
Orissa	93	15	32.7	98.6	19	59.83	51.66
Punjab	100	54.2	63.8	97.2	69	78.80	76.84
Rajasthan	30.3	44	35.4	99.5	31	52.30	48.04
Sikkim	21.9	72	49.5	84.5		56.98	
Tamil Nadu	54.8	84.6	55.2	98.6	19	73.30	62.44
Tripura	100	33.5	48.1	87.1		67.18	
Uttar Pradesh	68.1	63.9	21.5	99.5	88.5	63.25	68.3
Uttaranchal	39.6	12.2	47.3	98.7		49.45	
West Bengal	56.1	24	47.2	87.9	69	53.80	56.84
Andaman andNicobar	100	88.3	65.1	92.5		86.48	
Chandigarh	3.8	97.9	100	96.82	88.5	74.63	77.404
Puducherry	24.3	95.8	78.1	91.27		72.37	

Source: Authors' calculations.

Note: As the *Use* indicator is not available for all states, IDWA-4 components is calculated for all states based upon resource, access, capacity, and quality indicators while IDWA-5 components is calculated using all five indicators for the states for which *Use* indicators are available.

Table 12.3 IDWA for Chinese Provinces

	Resource	*Access*	*Capacity*	*Quality*	*Use*	*IDWA*
Beijing	33	98.7	94	100.0	100.0	85.0
Tianjin	22	99.1	85	100.0	54.3	71.1
Hebei	39	98.9	47	100.0	24.8	57.3
Shanxi	61	96.6	39	99.9	0.0	55.4
Inner Mongolia	100	98.5	54	100.0	98.9	82.3
Liaoning	100	99.7	58	100.0	96.0	85.5
Jilin	100	98.4	44	99.7	50.9	71.8
Heilongjiang	100	99.0	44	99.9	77.2	79.0
Shanghai	36	100.0	100	99.4	100.0	87.0
Jiangsu	100	99.5	70	99.7	100.0	91.7
Zhejiang	100	95.7	74	99.8	100.0	92.5
Anhui	100	95.9	24	99.8	46.5	60.9
Fujian	100	94.5	57	100.0	100.0	87.6
Jiangxi	100	94.7	27	100.0	77.2	68.1
Shandong	80	97.7	61	100.0	23.0	66.7
Henan	84	98.0	36	99.9	28.4	57.9
Hubei	100	91.8	36	100.0	79.1	73.4
Hunan	100	95.3	32	99.9	100.0	75.0
Guangdong	100	94.4	69	99.9	100.0	89.3
Guangxi	100	83.8	25	100.0	100.0	75.3
Hainan	100	96.2	33	100.0	100.0	77.8
Chongqing	100	90.6	33	99.9	100.0	76.1
Sichuan	100	93.3	26	99.9	48.8	64.4
Guizhou	100	94.6	0	100.0	62.7	64.3
Yunnan	100	85.3	19	100.0	55.4	68.1
Tibet	100	32.0	25	100.0	100.0	70.0
Shaanxi	100	91.7	32	100.0	28.9	64.2
Gansu	100	89.2	18	99.7	27.8	59.6
Qinghai	100	77.8	31	100.0	100.0	80.5
Ningxia	36	94.3	32	100.0	8.2	45.6
Xinjiang	100	88.0	41	100.0	87.7	81.0

Source: Authors' calculations.

regional disparity in the two countries is not significantly different, as each has a similar standard deviation from the mean (11.8 for Chinese provinces and 11.1 for Indian states). Figures 12.1 and 12.2 visualize the drinking water adequacy across the two countries.

Comparing the resource indices of the two countries, majority of the Chinese provinces have enough water resources to meet the demand for water (with index value of 100); however, most Indian states could not meet the demand (with value of index less than 100). The gap between demand and supply in India could be exaggerated as the indicator did not include surface water due to data limitation. At the national level, after taking into account the surface water produced internally, Chinese have higher per capita water resources (5480 lpcd) than Indians (3410 lpcd)[1] while the demand in China (1232 lpcd) is lower than in India (1848 lpcd). Although both countries have enough water resources to meet their potential demand at the national level, with the excess of supply over demand higher in China than in India. The resources are extremely uneven across states/provinces, which causes the state/provincial level insufficiency of resources. Thus, both countries need to address, at the national/basin level, the effective allocation of resources and at the provincial level, demand management and water use efficiency.

Although the indicator used for access index in China 'house connection', is stricter than 'access through tap'

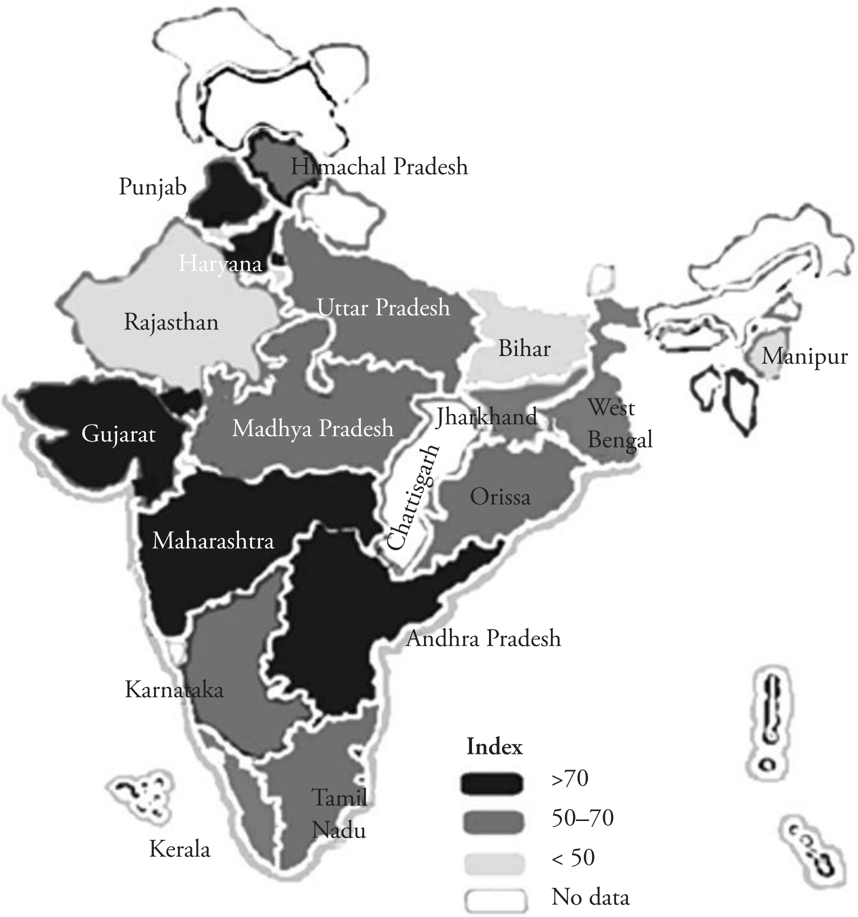

Figure 12.1 IDWA for Indian States

[1] FAO AQUASTAT database. 1280 km^3/year of internal renewable water resources, which translate to about 3410 lpcd.

Figure 12.2 IDWA for Chinese Provinces

used for India, the overall access index in Chinese provinces is higher than that of Indian states. The access indicator, percentage of households with access to tap water/house connection is highly correlated with the capacity indicator, GDP per capita, with a correlation coefficient of 0.78 for China and 0.68 for India, which implies that programmes targeting on improving water access will achieve results only when strong economic development takes place.

The reason for selecting a different quality indicator for China is because of the near zero diarrhoeal death rates, 0.085 and 0.1 case per million people in 2006 and 2007, respectively. With the new indicator, the quality index for Chinese provinces (mean of 99.9 and standard deviation of 0.14) remains higher than that of India (mean of 93.7 and standard deviation of 7.13).

The use index of Indian states is only slightly lower than that of Chinese provinces; however, rural domestic water use in India is not taken into account. Comparing the existing urban data and the trend of water use in urban areas in the past several years, we could conclude that most Indian cities are striving to increase drinking water supply in order to provide a decent amount of water for basic human needs, while in most of the cities in China, the water supply can sustain continuous water needs of the citizens.

Policy Implications

To improve the drinking water adequacy in both countries, a comprehensive set of policy measures and an effective governance system are required. However, in this section, we focus only on direct policy implications derived while computing IDWA.

Water Conservation and Demand Management

Demand management directly influences two of the components in IDWA. As the demand for water reduces, the resource index can be improved without increasing resource availability. In the context of domestic water use, water conservation and demand regulation might not lead to an increase of the index; however, it would help in optimizing the amount of water consumed.

Unless demand regulation is accorded appropriate importance in water resource planning, it will remain difficult for both India and China to meet the growing need for water. Unlike industrial and agricultural water use, less attention has been paid in both countries to regulation of domestic water use. Although domestic use is a small portion of total water consumption, as compared to other water use sectors; the amount of water used in the domestic sector is significant due to the large population base in both countries.

In recent years, some initiatives have been taken in China. The standards of water quantity for urban and rural domestic use were issued by the Ministry of Housing and Urban Rural Development and the Ministry of Health, respectively. These standards suggest the optimal quantity for each province, separately for rural and urban areas, depending upon the economic development, resource availability, and housing condition. However, the enforcement of these standards is unclear. The use of water conservation appliance remains voluntary. Water pricing has recently been rationalized in a number of cities in China, which have opted to encourage conservation behaviour.

Unlike the stand-alone water saving initiatives in China, the National Rural Drinking Water Programme of India has built-in water conservation and demand management components, such as awareness campaigns. However, the effectiveness of these measures has not been evaluated.

The effectiveness of the demand management structure in both countries is not well-studied, and requires further investigation. Singapore provides an excellence example for both countries in urban water conservation, while cooperation in sharing experiences in innovative ways of rural water saving could benefit both countries.

Drinking Water Supply

Drinking water supply initiatives play a critical role in securing water access. Both India and China have taken a similar approach in terms of urban water supply. One such example is public–private partnership (PPP) to provide better quality services and attempts to rationalize domestic water tariffs with the objective of achieving cost recovery for water utilities.

In terms of rural water supply, the two countries had started with similar government initiatives. India launched the National Rural Drinking Water Supply Programme in 1969; and in 1986 the national level apex committee of drinking water was formed, the National Drinking Water Mission (later renamed Rajiv Gandhi National Drinking Water Mission or RGNDWM). India committed to the MDG of the United Nations in 2002 and all drinking water related programmes were consolidated under the RGNDWM. China started only in 1984 when the rural drinking water supply formally became one of the development priorities. In 1991, it was included in the five-year development plan for the first time. By the end of 2004, the Government of China declared that it had successfully eliminated drinking water difficulty[2] and it embarked on the next stage of ensuring drinking water safety[3] in 2005.

The drinking water safety programme and other similar initiatives in China are fully government funded, designed, and implemented while India experienced paradigm shift, from the 'Government-oriented supply-drinking approach' to the 'People-oriented demand-responsive approach'. The Swajaldhara projects started piloting in 1999 and it changed the role of government from service provider to facilitator. With the government paying for 90 per cent of the infrastructure cost, and community paying for the remaining 10 per cent and 100 per cent of the operation and maintenance cost, the communities were made responsible for their water supply projects.

The water supply sector is far more dynamic and innovative in India than in China. The non-governmental organizations are also involved in improving drinking water access, for example, the micro-credit initiative led by Gramalaya in Tamil Nadu. The involvement of

[2] Drinking water difficulty refers to a situation where a household does not have access to water: (i) within 1000 meters horizontally or 100 metres vertically within the premises, or (ii) for 100 continuous days, or (iii) drinking water contains more than 1.1 mg of fluoride per litre.

[3] Drinking water safety is achieved when: (i) drinking water is accessible within 800 metres horizontally or 80 metres vertically within the premises; (ii) enough water is available for domestic purposes as per provincial standards; (iii) drinking water is from a source which has less than 5 per cent probability of failure in supply; and (iv) the water obtained is in line with national drinking water quality standards.

local community and civil society is recognized by the Government of China as essential to the sustainability of water supply programmes, but concrete action is yet to be taken. This is where the Indian experience could be invaluable.

The government-led programme in China has so far been successful in achieving the set targets. It has benefited from the clear agenda and goals set by the central government and diligent implementation at the local level, which are missing in India.

Correlation with Other Development Indicators

Drinking water adequacy has positive correlation with other social indicators such as education, life expectancy, and income and has a negative correlation with the poverty ratio, as illustrated in Table 12.4.

TABLE 12.4 Correlation between IDWA and Other Social Indicators

	India	*China*
IDWA–education	0.29	0.31
IDWA–life expectancy	0.41	0.37
IDWA–income	0.76	0.59
IDWA–HDI	0.54	0.48
IDWA–Poverty	–0.79	–0.35

Two important points are of note. First, per capita income has a relatively high correlation with IDWA, confirming perhaps a two–way relationship between adequacy of water supply and income growth. This is also confirmed indirectly by the high negative correlation between IDWA and poverty level. These observations are, however, subject to some pertinent data problems.

Data Issue

Water-related data are far from sufficient in both countries. The index presented above is constrained by the availability of data. In India, data for some essential indicators are not available at the state level. In China, the data collection methods and definition of indicators are often questionable and hence the accuracy of existing data sets is of some concern.

Nevertheless, both countries have their advantages in the data collection process that they can share with each other. India's National Sample Survey System is much more matured. The National Sample Surveys on various social-economic issues are conducted in successive rounds, with water and sanitation related issues covered in the Housing Conditions Survey. This provides solid ground for policy makers to grasp snapshots of the water and sanitation situation despite the inconsistent intervals between two rounds of the same survey. China's administrative system is more effective for data reporting. Almost all the ministries have their own statistical yearbooks, in which the performances at state level and city/county level are reported. Although the non-survey nature of these data can cause problems, for example, when ministries use different indicators for the same issue or report contradictory data on the same indicator; it can still provide a perspective on the state of affairs in the water sector to some extent.

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Annexure 12.1 Data for Constructing IDWA

A12.1.1 Resource Index, India

State	*Annual replenishable groundwater resources 2004 (BCM)*	*2001–4 average population*	*Lt/cap/p.a*	*lpcd*	*Resource index*
National	433.02	1,028,738,218	420,920.50	1,153.20	
Andhra Pradesh	36.5	76,210,003.50	478,939.70	1,312.20	71.00
Arunachal Pradesh	2.56	1,097,984.00	2,331,545.80	6,387.80	100.00
Assam	27.23	26,655,764.00	1,021,542.70	2,798.70	100.00
Bihar	29.19	82,998,754.50	351,692.00	963.50	52.10
Chhattisgarh	14.93	20,833,901.50	716,620.50	1,963.30	100.00
Delhi	0.3	13,850,753.50	21,659.50	59.30	3.20
Goa	0.28	1,347,834.00	207,740.70	569.20	30.80
Gujarat	15.81	50,671,008.50	312,012.70	854.80	46.30
Haryana	9.31	21,144,782.00	440,297.80	1,206.30	65.30
Himachal Pradesh	0.43	6,077,950.00	70,747.50	193.80	10.50
Jammu and Kashmir	2.7	10,143,850.00	266,171.10	729.20	39.50
Jharkhand	5.58	26,945,914.50	207,081.50	567.30	30.70
Karnataka	15.93	52,850,781.00	301,414.70	825.80	44.70
Kerala	6.84	31,841,187.00	214,816.10	588.50	31.80
Madhya Pradesh	37.19	60,348,011.50	616,258.90	1,688.40	91.40
Maharashtra	32.96	96,878,813.50	340,218.90	932.10	50.40
Manipur	0.38	2,293,948.00	165,653.30	453.80	24.60
Meghalaya	1.15	2,318,911.00	495,922.40	1,358.70	73.50
Mizoram	0.04	888,286.50	45,030.50	123.40	6.70
Nagaland	0.36	1,990,018.00	180,902.90	495.60	26.80
Orissa	23.09	36,804,330.00	627,371.80	1,718.80	93.00
Punjab	23.78	24,358,999.50	976,230.60	2,674.60	100.00
Rajasthan	11.56	56,507,094.00	204,576.10	560.50	30.30
Sikkim	0.08	540,925.50	147,894.70	405.20	21.90
Tamil Nadu	23.07	62,405,839.50	369,676.90	1,012.80	54.80
Tripura	2.19	3,199,101.50	684,567.20	1,875.50	100.00
Uttar Pradesh	76.35	166,197,960.50	459,391.90	1,258.60	68.10
Uttaranchal	2.27	8,489,174.50	267,399.40	732.60	39.60
West Bengal	30.36	80,176,098.50	378,666.50	1,037.40	56.10
Andaman and Nicobar	0.33	356,076.00	926,768.40	2,539.10	100.00
Chandigarh	0.023	900,817.50	25,532.40	70.00	3.80
Puducherry	0.16	974,172.50	164,242.00	450.00	24.30

Source: Planning Commission (2002).

A12.1.2 Access Index, India

State	*Percentage of households with access through tap (urban)*	*Percentage of households with access through tap (rural)*	*Percentage of households with access through tap*	*Access index*
National	74.3	30.1	43.1	43.1
Andhra Pradesh	75.4	63.8	67.4	67.4
Arunachal Pradesh	87.2	79.8	81.4	81.4
Assam	36.6	6.3	9.8	9.8
Bihar	29	1.1	4.1	4.1
Chhattisgarh	60.5	7.6	17.5	17.5
Delhi	88	46.4	85	85
Goa	87.7	85	86.3	86.3
Gujarat	83.8	58	68.2	68.2
Haryana	76.9	61.2	66.1	66.1
Himachal Pradesh	88.5	78	79.2	79.2
Jammu and Kashmir	90.9	65.5	71.3	71.3
Jharkhand	49.1	3.5	10.7	10.7
Karnataka	91.3	70.2	78	78
Kerala	41.6	15.5	22.6	22.6
Madhya Pradesh	66.8	9.1	23.4	23.4
Maharashtra	88.9	56.9	71.1	71.1
Manipur	65.6	24.7	36.5	36.5
Meghalaya	95.6	50.6	59.3	59.3
Mizoram	72	14.6	40.1	40.1
Nagaland	25.7	28.6	27.8	27.8
Orissa	63.6	5.8	15	15
Punjab	82.1	36.3	54.2	54.2
Rajasthan	86.6	28.5	44	44
Sikkim	98.2	67.4	72	72
Tamil Nadu	81.4	87.3	84.6	84.6
Tripura	60.6	27.4	33.5	33.5
Uttar Pradesh	75	60.8	63.9	63.9
Uttaranchal	47.3	2.4	12.2	12.2
West Bengal	70.4	7.8	24	24
Andaman and Nicobar	98.9	83.1	88.3	88.3
Chandigarh	99.1	89.1	97.9	97.9
Puducherry	94.4	99.1	95.8	95.8

Source: Ministry of Statistics and Programme Implementation (2010).

A12.1.3 Capacity Index, India

State	*Per capita GDP (in Rupees)*				*Log of average*	*Capacity index*
	2003–4	*2004–5*	*2005–6*	*Average*		
National	20,871	23,198	26,003	23,357		
Andhra Pradesh	22,041	23,755	26,226	24,007	4.38	49.5
Arunachal Pradesh	19,322	22,185	22,335	21,281	4.33	44.5
Assam	15,487	16,900	18,378	16,922	4.23	34.8
Bihar	6857	7454	7871	7394	3.87	0.0
Chhattisgarh	15,515	17,513	21,290	18,106	4.26	37.7
Delhi	48,628	53,639	59,555	53,941	4.73	83.6
Goa	54,577	66,135	74,925	65,212	4.81	91.6
Gujarat	26,922	28,846	32,991	29,586	4.47	58.3
Haryana	34,099	37,800	41,997	37,965	4.58	68.8
Himachal Pr.	28,333	31,198	33,954	31,162	4.49	60.5
Jammu and Kashmir	17,991	19,337	20,799	19,376	4.29	40.5
Jharkhand	12,951	15,555	16,327	14,944	4.17	29.6
Karnataka	20,901	24,714	29,185	24,933	4.40	51.1
Kerala	25,995	29,065	32,450	29,170	4.46	57.7
Madhya Pradesh	14,306	14,471	15,466	14,748	4.17	29.0
Maharashtra	29,165	32,481	36,090	32,579	4.51	62.4
Manipur	14,728	16,433	17,770	16,310	4.21	33.3
Meghalaya	19,702	21,170	22,852	21,241	4.33	44.4
Mizoram	21,963	22,417	24,029	22,803	4.36	47.4
Nagaland	20,821	20,998	21,083	20,967	4.32	43.8
Orissa	14,252	16,306	17,707	16,088	4.21	32.7
Punjab	31,182	33,158	36,759	33,700	4.53	63.8
Rajasthan	16,507	16,874	18,141	17,174	4.23	35.4
Sikkim	21,476	23,791	26,628	23,965	4.38	49.5
Tamil Nadu	24,084	27,509	30,847	27,480	4.44	55.2
Tripura	21,138	22,836	25,700	23,225	4.37	48.1
Uttar Pradesh	11,458	12,196	13,315	12,323	4.09	21.5
Uttaranchal	20,312	23,069	24,870	22,750	4.36	47.3
West Bengal	20,872	22,675	24,533	22,693	4.36	47.2
Andaman andNicobar	32,670	34,640	36,984	34,765	4.54	65.1
Chandigarh	70,434	79,562	89,034	79,677	4.90	100.0
Puducherry	47,778	43,303	50,900	47,327	4.68	78.1

Source: Ministry of Finance (2008).

A12.1.4 Quality Index, India

State	Diarrhoeal Death			Population (1000)	Death per million population	Quality index
	2006	2007	Average			
National	3176	3603	3390			
Andhra Pradesh	124	198	161	80,430	98	98
Arunachal Pradesh	30		30	1,170	74.4	74.4
Assam		911	911	29,009	68.6	68.6
Bihar				90,830	98.7	98.7
Chhattisgarh	13	11	12	22,955	99.5	99.5
Delhi	85	70	77.5	16,065	95.1	95.1
Goa		0	0	1,537	100	100
Gujarat	4	3	3.5	54,814	99.9	99.9
Haryana	42	30	36	23,040	98.4	98.4
Himachal Pradesh	28	33	30.5	6,425	95.2	95.2
Jammu and Kashmir	32		32	11,603	97.2	97.2
Jharkhand	1	6	3.5	29,173	99.9	99.9
Karnataka	1279	80	679.5	56,137	87.9	87.9
Kerala	4	12	8	33,569	99.8	99.8
Madhya Pradesh	88	302	195	66,801	97.1	97.1
Maharashtra	93	199	146	104,104	98.6	98.6
Manipur	17	16	16.5	2,561	93.4	93.4
Meghalaya	33	60	46.5	2,472	81	81
Mizoram	20	10	15	955	84.3	84.3
Nagaland	0	6	3	2,132	98.6	98.6
Orissa	40	68	54	39,053	98.6	98.6
Punjab	64	84	74	25,976	97.2	97.2
Rajasthan	21	38	29.5	62,431	99.5	99.5
Sikkim	8	9	8.5	579	84.5	84.5
Tamil Nadu	42	140	91	65,261	98.6	98.6
Tripura	69	19	44	3,421	87.1	87.1
Uttar Pradesh	55	137	96	183,856	99.5	99.5
Uttaranchal	6	18	12	9,216	98.7	98.7
West Bengal	964	1118	1041	85,780	87.9	87.9
Andaman and Nicobar	2	4	3	411	92.5	92.5
Chandigarh	0	7	3.5	1,100	96.82	96.82
Puducherry	8	11	9.5	1,088	91.27	91.27

Source: Ministry of Health and Family Welfare (2007 and 2008).
Note: Estimate for Bihar is based on the average of Madhya Pradesh, Rajasthan, and Uttar Pradesh.

A12.1.5 Use Index, India

State	*City*	*lpcd*	*City*	*lpcd*	*Average lpcd*	*Use index*
Andhra Pradesh	Hyderabad	122	Visakhapatnam	124	128.3	67.0
	Vijayawada	158	Guntur	109		
Bihar	Patna	107			107.0	42.5
Delhi	Delhi	144			144.0	85.1
Gujarat	Ahmadabad	146	Surat	147	146.5	87.9
Haryana	Faridabad	120			120.0	57.5
Himachal Pradesh	Shimla	113	Dharamshala	198	162.3	100.0
	Palampur	176				
Jharkhand	Jamshedpur	203	Bokaro	298	179.3	100.0
	Chas	37				
Karnataka	Bengaluru	81			81.0	12.6
Kerala	Trivandrum	125	Kozhikode	193	159.0	100.0
Madhya Pradesh	Indore	80	Bhopal	99	103.5	38.5
	Jabalpur	139	Ujjain	96		
Maharashtra	Mumbai	191	Nagpur	100	152.4	94.7
	Nashik	92	Kohlapur	133		
	Pimpri-chinchwad	246				
Manipur	Imphal	110			110.0	46.0
Orissa	Bhubaneswar	92	Berhampur	81	86.5	19.0
Punjab	Amritsar	95	Jalandhar	165	130.0	69.0
Rajasthan	Jaipur	97			97.0	31.0
Tamil Nadu	Chennai	87	Coimbatore	109	86.5	19.0
	Tiruchirapalli	79	Ooty	71		
Uttar Pradesh	Varanasi	147			147.0	88.5
West Bengal	Kolkata	130			130.0	69.0
Chandigarh	Chandigarh	147			147.0	88.5

Source: Ministry of Urban Development (2009); ADB (2007b).
Note: The basic data are from two different sources. For those cities whose per capita water use is reported in both sources, the average is used. For those which are reported in only one source, the number is used directly.

A12.1.6 Resource Index, China

Year	*Water resource per capita (cubic m)*				*Average water*	*Resource*
	2005	*2006*	*2007*	*Average*	*resource lpcd*	*index*
National	2,151.8	1,932.1	1,916.3	2,000.07	5,480	
Beijing	151.2	141.5	148.2	146.97	403	33
Tianjin	102.2	95.5	103.3	100.33	275	22
Hebei	197	156.1	173.1	175.40	481	39
Shanxi	251.5	263.1	305.6	273.40	749	61
Inner Mongolia	1,917.3	1,719.8	1,232.2	1,623.10	4,447	100
Liaoning	896.3	615.5	610.8	707.53	1,938	100
Jilin	2,066.8	1,300.3	1,269.2	1,545.43	4,234	100
Heilongjiang	1,954.2	1,904.8	1,286.4	1,715.13	4,699	100
Shanghai	138	153.9	187.9	159.93	438	36
Jiangsu	626.6	538.3	653.3	606.07	1,660	100
Zhejiang	2,077.2	1,829.5	1,777.2	1,894.63	5,191	100
Anhui	1,178.8	949.3	1,165.3	1,097.80	3,008	100
Fujian	3,975.5	4,577.7	3,005.7	3,852.97	10,556	100
Jiangxi	3,513.2	3,768.7	2,556.5	3,279.47	8,985	100
Shandong	451	214.8	414.6	360.13	987	80
Henan	597.2	342.8	196.1	378.70	1,038	84
Hubei	1,640.6	1122	1,782.1	1,514.90	4,150	100
Hunan	2,649.5	2,794.9	2,247.1	2,563.83	7,024	100
Guangdong	1,906.4	2,396.1	1,686.3	1,996.27	5,469	100
Guangxi	3,703.8	4,011.3	2,922.4	3,545.83	9,715	100
Hainan	3,722.4	2,735.4	3,373.3	3,277.03	8,978	100
Chongqing	1,827.4	1,356.8	2,357.6	1,847.27	5,061	100
Sichuan	3,569.6	2278.1	2,822.6	2,890.10	7,918	100
Guizhou	2,244.4	2,176.1	2,805.2	2,408.57	6,599	100
Yunnan	4161.7	3,832.2	5,013.9	4,335.93	11,879	100
Tibet	16,117.06	149,001.4	152,969.2	106,029.22	290,491	100
Shaanxi	1,322.7	739.1	1,007.7	1,023.17	2,803	100
Gansu	1,042.4	709.9	875.9	876.07	2,400	100
Qinghai	16,176.9	10,430.8	12,029.5	12,879.07	35,285	100
Ningxia	143.6	176.8	171.1	163.83	449	36
Xinjiang	4,808.9	4,695.1	4,167.8	4,557.27	12,486	100

Source: National Bureau of Statistics (2006, 2007, and 2008).

A12.1.7 Access Index, China

	Percentage of urban households with house connections	*Total urban households*	*Percentage of rural households with house connections*	*Total rural households*	*Percentage of total households with house connections*	*Access index*
National	97.7	31.84	48.6	68.16	64.2	
Beijing	98.3	75.35	97.00	24.65	98.0	98.0
Tianjin	98.9	67.42	84.80	32.58	94.3	94.3
Hebei	99.0	23.47	68.40	76.53	75.6	75.6
Shanxi	97.6	30.26	68.10	69.74	77.0	77.0
Inner Mongolia	97.0	40.12	32.60	59.88	58.4	58.4
Liaoning	99.6	51.77	45.50	48.23	73.5	73.5
Jilin	97.0	49.97	31.90	50.03	64.4	64.4
Heilongjiang	98.3	55.68	42.80	44.32	73.7	73.7
Shanghai	100.0	81.49	98.30	18.51	99.7	99.7
Jiangsu	99.5	35.95	83.00	64.05	88.9	88.9
Zhejiang	99.9	33.26	83.40	66.74	88.9	88.9
Anhui	98.4	18.65	19.50	81.35	34.2	34.2
Fujian	99.3	29.38	73.70	70.62	81.2	81.2
Jiangxi	97.3	23.21	17.60	76.79	36.1	36.1
Shandong	91.8	22.34	62.80	77.66	69.3	69.3
Henan	95.8	19.56	27.70	80.44	41.0	41.0
Hubei	98.9	33.47	28.60	66.53	52.1	52.1
Hunan	99.3	23.94	25.60	76.06	43.2	43.2
Guangdong	97.2	48.84	58.70	51.16	77.5	77.5
Guangxi	96.2	18.30	41.20	81.70	51.3	51.3
Hainan	95.1	32.21	37.30	67.79	55.9	55.9
Chongqing	95.3	23.15	33.50	76.85	47.8	47.8
Sichuan	96.9	19.39	35.10	80.61	47.1	47.1
Guizhou	96.9	14.84	52.20	85.16	58.8	58.8
Yunnan	96.9	21.84	57.50	78.16	66.1	66.1
Tibet	92.5	19.18	8.70	80.82	24.8	24.8
Shaanxi	96.8	23.52	49.00	76.48	60.2	60.2
Gansu	99.2	25.46	36.70	74.54	52.6	52.6
Qinghai	98.3	39.70	54.30	60.30	71.7	71.7
Ningxia	98.7	36.09	25.30	63.91	51.8	51.8
Xinjiang	91.8	44.19	63.60	55.81	76.1	76.1

Source: *Provincial Statistical Yearbook*(s); and State Council Second National Agriculture Census Committee and National Bureau of Statistics (2008).

A12.1.8 Capacity Index, China

	GDP per capita (Yuan)				*Log of average GDP per capita*	*Capacity index*
	2005	*2006*	*2007*	*Average*		
National	14,170	16,155	18,665	16,330	4.21	
Beijing	45,444	50,467	58,204	51,372	4.71	94
Tianjin	35,783	41,163	46,122	41,023	4.61	85
Hebei	14,782	16,962	19,877	17,207	4.24	47
Shanxi	12,495	14,123	16,945	14,521	4.16	39
Inner Mongolia	16,331	20,053	25,393	20,592	4.31	54
Liaoning	18,983	21,788	25,729	22,167	4.35	58
Jilin	13,348	15,720	19,383	16,150	4.21	44
Heilongjiang	14,434	16,195	18,478	16,369	4.21	44
Shanghai	51,474	57,695	66,367	58,512	4.77	100
Jiangsu	24,560	28,814	33,928	29,101	4.46	70
Zhejiang	27,703	31,874	37,411	32,329	4.51	74
Anhui	8,675	10,055	12,045	10,258	4.01	24
Fujian	18,646	21,471	25,908	22,008	4.34	57
Jiangxi	9,440	10,798	12,633	10,957	4.04	27
Shandong	20,096	23,794	27,807	23,899	4.38	61
Henan	11,346	13,313	16,012	13,557	4.13	36
Hubei	11,431	13,296	16,206	13,644	4.13	36
Hunan	10,426	11,950	14,492	12,289	4.09	32
Guangdong	24,435	28,332	33,151	28,639	4.46	69
Guangxi	8,788	10,296	12,555	10,546	4.02	25
Hainan	10,871	12,654	14,555	12,693	4.10	33
Chongqing	10,982	12,457	14,660	12,700	4.10	33
Sichuan	9,060	10,546	12,893	10,833	4.03	26
Guizhou	5,052	5,787	6,915	5,918	3.77	0
Yunnan	7,835	8,970	10,540	9,115	3.96	19
Tibet	9,114	10,430	12,109	10,551	4.02	25
Shaanxi	9,899	12,138	14,607	12,215	4.09	32
Gansu	7,477	8,757	10,346	8,860	3.95	18
Qinghai	10,045	11,762	14,257	12,021	4.08	31
Ningxia	10,239	11,847	14,649	12,245	4.09	32
Xinjiang	13,108	15,000	16,999	15,036	4.18	41

Source: National Bureau of Statistics (2006, 2007, and 2008).

A12.1.9 Quality Index, China

	Polluted water supplied for domestic use (lpcd)	*Total Water supplied for domestic use (lpcd)*	*Polluted water as percentage of total domestic water supplied*	*Quality index*
Beijing	0.00	250	0.00	100.0
Tianjin	0.00	117	0.00	100.0
Hebei	0.00	96	0.00	100.0
Shanxi	0.77	67	1.15	99.9
Inner Mongolia	0.15	150	0.10	100.0
Liaoning	0.26	156	0.17	100.0
Jilin	3.11	116	2.68	99.7
Heilongjiang	2.07	143	1.45	99.9
Shanghai	18.97	308	6.16	99.4
Jiangsu	4.78	167	2.86	99.7
Zhejiang	3.27	179	1.83	99.8
Anhui	1.73	109	1.59	99.8
Fujian	0.10	162	0.06	100.0
Jiangxi	0.03	132	0.02	100.0
Shandong	0.15	92	0.16	100.0
Henan	0.67	101	0.66	99.9
Hubei	0.51	139	0.37	100.0
Hunan	3.78	191	1.98	99.9
Guangdong	3.49	272	1.28	99.9
Guangxi	0.42	243	0.17	100.0
Hainan	0.00	193	0.00	100.0
Chongqing	1.35	158	0.85	99.9
Sichuan	1.25	115	1.09	99.9
Guizhou	0.01	129	0.01	100.0
Yunnan	0.00	119	0.00	100.0
Tibet	0.00	244	0.00	100.0
Shaanxi	0.05	98	0.05	100.0
Gansu	3.13	96	3.26	99.7
Qinghai	0.65	160	0.41	100.0
Ningxia	0.09	82	0.11	100.0
Xinjiang	0.00	143	0.00	100.0

Source: National Bureau of Statistics (2007); World Bank (2007).

A12.1.10 Use Index, China

	Water for domestic use (100 million cu.m)			*Population (year-end, 10,000 persons)*			*Average water for domestic use lpcd*	*Use index*
	2006	*2007*	*Average*	*2006*	*2007*	*Average*		
National	693.8	710.4	702.1	1,581	1,633	1,607	149	
Beijing	14.4	14.6	14.5	1,075	1,115	1,095	251	100.0
Tianjin	4.6	4.8	4.7	6,898	6,943	6,921	119	54.3
Hebei	24.1	23.9	24.0	3,775	3,393	3,584	95	24.8
Shanxi*	9.3	9.5	9.4	2,397	2,405	2,401	73	0.0*
Inner Mongolia	13.1	14.2	13.7	4,271	4,298	4,285	156	98.9
Liaoning	24.3	24.3	24.3	2,723	2,730	2,727	154	96.0
Jilin	11.5	11.7	11.6	3,823	3,824	3,824	117	50.9
Heilongjiang	20.0	18.6	19.3	1,815	1,858	1,837	138	77.2
Shanghai	20.4	21.6	21.0	7,550	7,625	7,588	317	100.0
Jiangsu	46.1	48.4	47.3	4,980	5,060	5,020	171	100.0
Zhejiang	32.6	33.9	33.3	6,110	6,118	6,114	183	100.0
Anhui	24.4	26.1	25.3	3,558	3,581	3,570	113	46.5
Fujian	21.0	21.2	21.1	4,339	4,368	4,354	162	100.0
Jiangxi	20.9	22.9	21.9	9,309	9,367	9,338	138	77.2
Shandong	31.3	32.5	31.9	9,392	9,360	9,376	94	23.0
Henan	34.6	32.7	33.7	5,693	5,699	5,696	98	28.4
Hubei	28.8	29.4	29.1	6,342	6,355	6,349	140	79.1
Hunan	44.2	44.6	44.4	9,304	9,449	9,377	192	100.0
Guangdong	92.4	90.5	91.5	4,719	4,768	4,744	269	100.0
Guangxi	41.9	48.6	45.3	836	845	841	263	100.0
Hainan	5.9	6.1	6.0	2,808	2,816	2,812	197	100.0
Chongqing	16.2	17.3	16.8	8,169	8,127	8,148	163	100.0
Sichuan	34.2	34.4	34.3	3,757	3,762	3,760	115	48.8
Guizhou	17.7	16.9	17.3	4,483	4,514	4,499	126	62.7
Yunnan	19.5	19.9	19.7	281	284	283	120	55.4
Tibet	2.5	2.1	2.3	3,735	3,748	3,742	225	100.0
Shaanxi	13.3	13.6	13.5	2,606	2,617	2,612	99	28.9
Gansu	9.1	9.5	9.3	548	552	550	98	27.8
Qinghai	3.2	3.3	3.3	604	610	607	163	100.0
Ningxia	1.8	1.8	1.8	2,050	2,095	2,073	82	8.2
Xinjiang	10.7	11.3	11.0	2,006	2,007	129,725	147	87.7

Source: National Bureau of Statistics (2007 and 2008).

Annexure 12.2 Social Indices

A12.2.1 Social Indicators for India

State	*Education Index*	*Life Expectancy Index*	*Income Index*	*Human Development Index*	*Poverty Ratio*	*IDWA*
Andhra Pradesh	0.539	0.672	0.513	0.575	15.8	70.58
Bihar	0.413	0.626	0.308	0.449	41.4	39.48
Gujarat	0.612	0.661	0.544	0.606	16.8	72.12
Haryana	0.57	0.703	0.579	0.617	14.0	71.22
Karnataka	0.607	0.687	0.531	0.608	25.0	54.86
Kerala	0.751	0.867	0.544	0.721	15.0	63.38
Madhya Pradesh	0.569	0.552	0.447	0.523	38.3	55.88
Orissa	0.56	0.582	0.403	0.515	46.4	51.66
Punjab	0.58	0.766	0.589	0.645	8.4	76.84
Rajasthan	0.578	0.628	0.466	0.557	22.1	48.04
Tamil Nadu	0.662	0.702	0.549	0.638	22.5	62.44
Uttar Pradesh	0.456	0.587	0.423	0.489	32.8	68.30
West Bengal	0.588	0.679	0.511	0.593	27.5	56.84

Source: Planning Commission (2002).

A12.2.2 Social Indicators for China

State	*Education Index*	*Life Expectancy Index*	*Income Index*	*Human Development Index*	*Poverty Ratio*	*IDWA*
Beijing	0.92	0.85	0.92	0.9	0.6	85
Tianjin	0.93	0.83	0.88	0.88	0.1	71.1
Hebei	0.87	0.79	0.73	0.8	2.6	57.3
Shanxi	0.87	0.78	0.7	0.78	8	55.4
Inner Mongolia	0.83	0.75	0.76	0.78	5.6	82.3
Liaoning	0.88	0.81	0.78	0.82	4.2	85.5
Jilin	0.86	0.8	0.72	0.8	4.8	71.8
Heilongjiang	0.87	0.8	0.73	0.8	4.3	79
Shanghai	0.93	0.89	0.94	0.92	0	87
Jiangsu	0.86	0.82	0.84	0.84	0.7	91.7
Zhejiang	0.85	0.82	0.82	0.83	0.4	92.5
Anhui	0.78	0.78	0.65	0.74	2.2	60.9
Fujian	0.82	0.79	0.77	0.8	0.3	87.6
Jiangxi	0.84	0.73	0.66	0.74	3.7	68.1
Shandong	0.84	0.82	0.79	0.82	1.1	66.7
Henan	0.83	0.78	0.69	0.77	2.9	57.9
Hubei	0.84	0.77	0.69	0.77	2.8	73.4
Hunan	0.85	0.76	0.68	0.76	3	75
Guangdong	0.86	0.81	0.82	0.83	1.1	89.3
Guangxi	0.84	0.77	0.65	0.76	3.6	75.3
Hainan	0.82	0.8	0.68	0.77	0.6	77.8
Chongqing	0.83	0.78	0.68	0.76	5.3	76.1
Sichuan	0.8	0.77	0.65	0.74	3.4	64.4
Guizhou	0.74	0.68	0.55	0.66	9	64.3
Yunnan	0.76	0.68	0.63	0.69	8.1	68.1
Tibet	0.55	0.66	0.65	0.62	20.6	70
Shaanxi	0.84	0.75	0.68	0.76	6.7	64.2
Gansu	0.73	0.71	0.62	0.69	7	59.6
Qinghai	0.75	0.68	0.67	0.7	12.6	80.5
Ningxia	0.79	0.75	0.67	0.74	9.6	45.6
Xinjiang	0.84	0.71	0.71	0.75	7.7	81

Source: UNDP (2009).

13 Review of Reforms in Urban Water Sector

Institutional and Financial Aspects

Subodh Wagle, Pranjal Deekshit, and Tejas Pol

Introduction

The urban water supply sector in India faces chronic shortages in investment and inadequate operation and maintenance (O&M), which have led to problems such as inadequate coverage, intermittent supply, inequitable water access, deteriorating infrastructure, and environmental unsustainability of water.

These problems are often attributed to the lack of administrative and managerial capacities of urban local bodies (ULBs), political interventions in levying and recovering tariffs, failure to monitor and evaluate the performance of urban water systems, lack of norms for benchmarking, and poor quality of supply and service from public utilities. The situation highlights policy and governance failure in the urban water sector.

Against this background, the process of governance reforms, which started almost two decades ago, proposes, an array of measures for the institutional and financial restructuring ofthe urban water supply sector (UWSS).

A large part of the voluminous policy-level literature on urban water sector reform comes from the International and Bilateral Financial Institutions (together called IFIs). These institutions have been strong proponents of reforms and have shaped the policy-level discourse as well as practice-level instruments to promote reforms (World Bank [WB] 2006, 2008; and Asian Development Bank [ADB] 2007).

Diagnosis of the WSS Situation

The diagnosis of the urban water crisis in India as presented by IFIs has been largely accepted by most central and state government agencies. The diagnosis clearly holds two factors responsible for the poor state of urban water supply. First, the lack of recovery of capital and management costs affecting the financial health of the water utilities and the sector. Second, the 'state-dominated' model for water provisioning has led to an inefficient and ineffective urban water sector. Tariffs are inadequate to cover even the cost of O&M, which directly affects the economic viability of the operations and financial health of the sector.

Another factor underlying the dismal state of performance of WSS sector is the lack of accountability of the frontline service providers (WB 2004). In the institutional model, all the three key governance functions—policy-making, service provision, and regulation—are concentrated in the hands of state-owned agencies. The state-owned agencies have two critical weaknesses that affect service provisioning. First, the influence of vested political interests on state agencies interferes in key techno-economic decisions such as tariffs, investments,

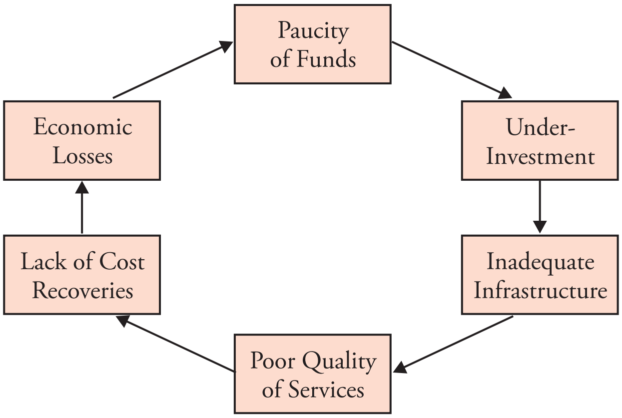

Figure 13.1 Vicious Cycle of Issues with Infrastructure Service Provisioning

Source: Authors' analysis

and purchases. Second, state-owned agencies lack effective accountability. There are no provisions or mechanisms through which the consumers of the services can directly hold the service-providing agency accountable for the cost or quality of the service provided. It is often argued that the accountability of state-owned agencies to the public can be achieved through elections that the political functionaries at the helm of affairs have to face. However, this indirect and longer route of accountability mechanism, has not worked effectively in practice (WB 2004). Opacity in operations and decision making has further compounded the problem. These weaknesses bring in many deficiencies in the structure and functioning of these agencies and allow vested political and economic interests to serve their own private interests by means of these agencies. Some of the deleterious impacts of such capture of agencies by vested interests are: clientelism or political patronage, artificially depressed tariff, and irrational allocation or siphoning of funds. The ultimate casualty of such capture is rational decision-making and efficient, effective, and timely implementation of decisions.

The Prescription

Based on the diagnosis, the IFIs provide a prescription that could largely be articulated in terms of two broad categories of reform measures: (i) institutional and governance reforms and (ii) economic and financial reforms. Table 13.1 presents a snapshot of urban water reforms.

Institutional Reform Measures

The institutional reforms suggested by IFIs, argue for four fundamental institutional changes: (i) restructuring the roles and functions of institutions in the sector (WB 2006); (ii) strengthening of ULBs (WB 2006, 2008); (iii) seeking participation of private players; and (iv) separation of the function of regulation from execution and also handing over the regulatory function to specially created independent regulatory bodies (Rees 1998; Ehrhardt et al. 2007).

The reformists argue that in the process of restructuring of roles and functions, policymaking should be separated from the function of service provisioning, with the assumption that the policy-making function will continue to remain with the state agencies. This separation of policy-making from service provisioning is seen as essential to curb political interference in service provisioning. Strengthening of ULB-level institutions involves delegation of functions and powers to these agencies from state level agencies. The focus is on handing over the function of service-provision to ULB-level institutions (as mandated by the 74th Constitutional Amendment Act), with state level agencies playing a supportive role. This would allow ULBs to take decisions on capital investments in infrastructure expansion and up-gradation and also give them freedom to choose engineering consultants without relying on the state level agency. Private sector participation (PSP) has been recommended, especially in service provisioning. Such participation is argued to enhance the efficiency, efficacy, and accountability as private players would be bound by a contract, stipulating all the possible parameters of service provisioning, to which they can be held accountable (Brockelhurst and Janssens 2004). Alternatively, the private provider would be regulated by the Independent Regulatory Authority (IRA). At the policy level, this would require transformation of the status of users from *'Beneficiaries'* to *'Consumers' or 'Customers'*. Given the weak capacity of ULBs, they would require support to engage private players, monitor PSP contracts, and, if required, to also support local-level private players maintain efficient operations.

The establishment of IRAs is aimed at separating regulation from policymaking. As IRAs are independent of the state, this mechanism insulates the service providers from partisan interference. It must be pointed out that though an IRA is a regulator, it also handles the

Table 13.1 Urban Water Reforms—A Snapshot

Category of Reforms	*Practice Pointers*
Institutional Reforms	Restructuring the Institutional Structure in the Sector *(Measures: Separation of the functions especially of state level agencies, Corporatization of state level Bodies, Restricting their role to support and facilitation)*
	Consolidation and Strengthening of Institutions especially at the ULB Level *(Measures: Delegate functions and powers to ULB-level agencies from the state level, Consolidate the agencies performing separated functions of 'promoter of infrastructure' and 'service provider', Give freedom to ULBs to choose engineering consultants, Build capacity at the ULB level)*
	Seeking PSP in Service Provision Function*(Measures: Support local private players, Transform the status of users from 'beneficiaries' to 'customers', Provide support for facilitating PSPs)*
	Establishing Appropriate Regulatory Mechanism*(Preferably establishment of an IRA or at least ensuring 'Regulation by Contract')*
Financial Reforms	'Price (or Tariff) based on the Principle of (Full) Cost Recovery' *(Measures: Making cost recovery the central and non-negotiable element of reform, to be implemented through IRA, which makes it politically feasible)*
	Ring-fencing of Budget and Accounts of Water Sector Operations at ULB Level *(In order to help the ULB to borrow or leverage external funding as well as to access capital (bond) markets)*
Other Key Reforms	Implementation of principles of 'Universal Metering' and '24×7 Supply' *(These technical measures are seen as necessary for improving the techno-economic viability and would contribute to the improvement of the financial health of the utility)*
	Work on Strengthening of Surface and Groundwater Sources *(Through a variety of measures such as GroundwaterRegulation and Watershed Development)*

Source: Adapted from WB (2006); ADB (2007).

decision-making function—though in an adjudicatory manner—on key issues such as tariff and entitlement. The reform literature also mentions the use of the instrument of 'regulation by contract' especially with private sector service providers, in case the IRA is not established (Groom et al. 2006; ADB 2001).

Economic and Financial Reform

The focus of economic and financial reforms, as proposed by IFIs, is on cost recovery. The main instrument is rationalization of tariffs so that the tariffs reflect the true cost of supplying water to consumers. Another strongly recommended financial reform is the 'accounting and financial ring-fencing' of water utilities. This involves maintaining budget and accounts of water provisioning as separate from rest of the operations of the ULBs. Both these measures, tariff rationalization and ring-fencing of finances of water utilities, are expected to strengthen the water utilities financially and enable them to approach sources of finance other than government grants and ULB budgets, through diverse mechanisms, including municipal bonds and internal and external borrowings.

A Review of Urban Water Reform in Indian States: Similarities and Differences

In the previous decades, many states have brought out State Water Policy documents. More than ten major Indian states have endorsed reforms in the urban water sector in their water policy documents. Some states such as Karnataka and Goa have come out with separate state policy documents for urban water supply and sanitation. A review of these policies shows that the states have approached reforms in diverse manner, especially in terms of emphasis and priorities for areas of reforms as well as the instruments used. Despite the diversity, reform efforts by states can be broadly classified into two categories: (i) economic/financial reforms and (ii) governance/institutional reforms.

Table 13.2 presents a brief review of state-wise progress of reforms under these two categories.

Economic and Financial Reforms in States

The review in Table 13.2 shows that states such as Tamil Nadu and Karnataka have invested considerable efforts in institutionalizing financial reforms. The focus of reforms is on areas such as 'cost recovery'. Bengaluru (Karnataka) collected upfront payments for expansion of the supply network. Tamil Nadu completed the first round of financing of water supply project in small and medium towns using bonds from market. The

Table 13.2 Key Highlights of Urban Water Reforms in Selected States in India

S. No.	*State*	*Key Highlights*
1.	AP	• Financial: (i) Hyderabad Metropolitan Water Supply and Sanitation Board (HMWSSB) introduced block tariff structure and also started manufacturing and selling of canned water on a pilot basis,[1] (ii) Municipal bonds have been used by HMWSSB and Vishakhapatnam Corporation[2]
2.	Delhi	• Institutional: (i) Incorporation of Delhi Jal Board (DJB) 1998;[3] • Financial: (i) Introduced block tariff, though initial PPP efforts failed, (ii) PSP in Soniya Vihar Water Treatment Plant[4]
3.	Gujarat	• Institutional: Incorporation of Gujarat Water Infrastructure Development Company (GWIDC);[5] many proposals for PPP in water infrastructure and maintenance; • Financial: Issue of municipal bonds in Ahmedabad[6]
4.	Karnataka	• Financial: Upfront collections from potential users for network expansion in Bengaluru[7]
5.	Kerala	• Financial: (i) Kerala Water Authority (KWA) adapts to block tariff structure, (ii) Bottled water production to begin soon; plant has been set up by KWA[8]
6.	Madhya Pradesh	• Institutional: (i) Proposals to form tariff regulatory commission, (ii) Projects, supported by ADB and WB to improve water supply in four cities.[9]
7.	Maharashtra	• Institutional: (i) Maharashtra Water Resources Regulatory Authority (MWRRA) instituted; Process of bulk water entitlements and rationalizing bulk tariff is underway,[10] (ii) Unbundling of state WSSB into public sector companies is in process,[11] (iii) Study Committee for exploring municipal services regulatory in Maharashtra.[12] • Financial: (i) Cities such as Nagpur, Navi Mumbai, and Badlapur introduced block tariff, (ii) All beneficiary small and medium towns under 'Urban Infrastructure Development Scheme for Small and Medium Towns' are in process to introduce block tariffs, (iii) Direct Investment by a PPP contractor in water supply system of Nagpur city, for up-scaling existing intermittent system to a 24×7 supply system

[1] http://www.hyderabadwater.gov.in/wwo/, last accessed in January 2011.
[2] http://niua.org/present_series/syndey/sydney_paper.pdf, last accessed in January 2011.
[3] www.delhijalboard.nic.in, last accessed January 2011.
[4] www.urbanindia.nic.in/programme/uwss/uiww/PPT.../DJB_Water_PPT.pdf
[5] http://pd.cpim.org/2006/1231/12312006_gujarat.htm
[6] www.ilfsindia.com/downloads/bus_rep/ahmedabad_bonds_rep.pdf
[7] http://indiancities.berkeley.edu/speaker_content/docs Ranganathan_etal_EPW_Piped_Water_Supply_Greater_Bangalore.pdf, last accessed January 2011.
[8] www.kwa.kerala.gov.in, last accessed February 2011.
[9] http://www.manthan-india.org/IMG/pdf/Paper_on_Water_Sector_Reforms_in_MP_Final_Jan_09.pdf, last accessed in January 2011.
[10] www.mwrra.org, last accessed January 2011.
[11] http://www.dgmarket.com/tenders/np-notice.do~1093241, last accessed August 2011.
[12] http://niua.org/projects/hpec/FinalReport-hpec.pdf, last accessed August 2011.

8.	Orissa	• Institutional: (i) Legal actions regarding transfer of functions such as tariff and water supply to ULBs are complete, (ii) Proposal to form Orissa Water Corporation (Public Ltd Company) under consideration[13]
9.	Rajasthan	• Institutional: (i) 24x7 schemes on pilot basis in Jaipur, Ajmer, and Nagaur,[14] (ii) Assigning water supply function to ULBs
10.	Tamil Nadu	• Financial: (i) TNUDF supported pooled finance model, (ii) PPP in Thirupur[15] town for upgrading water supply system and providing sewerage services to industries and domestic users, (iii) Initiative of raising finance by a way of upfront collection from beneficiaries for upgrading sewerage system in Alandur[16]
11.	Uttar Pradesh	• Institutional: (i) Restructuring of Uttar Pradesh Jal Nigam(UPJN) into 4–5 different utilities is under consideration,[17] (ii) Assigning water supply functions to ULBs is complete; (iii) ring-fencing is in progress
12.	West Bengal	• Financial: PPP contracts at Salt Lake and Haldia with Jamshedpur Utilities & Services Company Ltd[18] (JUSCO)

Source: Compiled from different hard and electronic sources—state government websites.
Note: PPP–public–private participation; DJB–Delhi Jal Board; WSSB–water supply and sanitation board; TNUDF–Tamil Nadu Urban Development Fund.

proceeds of bonds were used to provide loans to small and medium towns and the levels of Non-Performing Assets (NPAs) on these loans are nil (Vijaybaskar and Wyatt 2005).

The review also pointed out that tariff restructuring has been taken up by many ULBs and state level water para-statal agencies. Similarly, promotion of PPP is also being pursued by a number of states and ULBs, especially municipal corporations in big cities, despite public protests against such efforts. Such protests have been witnessed in cities such as Latur (Maharashtra) and Mysore (Karnataka). As far as innovative financing instruments are concerned, barring a few exceptions like Karnataka and Tamil Nadu, the majority of states are yet to use financial instruments such as bonds, pooled finance, or avail of Viability Gap Funding (VGF) schemes offered by the central government.

Institutional and Governance Reforms

Most states are yet to restructure the pre-existing, state level government institutions such as public health and engineering departments (PHEDs), water supply and sanitation boards (WSSBs), and city water boards (CWBs). While the Delhi Government constituted an autonomous body, viz., Delhi Jal Board (DJB), initiatives such as incorporation of the Orissa Water Corporation and restructuring of WSSBs of Maharashtra and UP are still at the proposal stage. The restructuring plan of WSSBs proposes unbundling of engineering, O&M, and regulatory functions of the boards by incorporating independent public sector companies for each of the functions.

Similarly, implementation of the reform measure for devolution of functions to ULBs is slow in most states. Related measures such as 'rationalization of staff-configurations in the ULBs for water supply function' also remain neglected. Only Maharashtra and Gujarat governments have taken few steps towards rationalizing staff configurations.

Though endorsed by most state policies, PSP-related reforms are pursued by most states with caution. Apart from the commonly known PPP initiatives such as those in Jamshedpur, Tiruppur, and Nagpur, a total of 54 PPP projects are already under operation (IIR 2010). These include PPP projects for: (i) development and maintenance of infrastructure, (ii) industrial water

[13] http://www.orissadiary.com/Shownews.asp?id=15785, last accessed in January 2011.
[14] http://udhrajasthan.gov.in/UDH_ENG/Final-TOR-for-Empanelment-of-consultants.pdf, last accessed January 2011.
[15] Vijaybaskar and Wyatt (2005).
[16] niua.org/present_series/syndey/sydney_paper.pdf, last accessed in January 2011.
[17] http://planningcommission.nic.in/plans/stateplan/upsdr/vol-2/Chap_b10.pdf, last accessed in January 2011.
[18] http://www.pppinindia.com/pdf/dea_ppp_water-supply.pdf, last accessed in January 2011.

supply, and (iii) desalination and sewage treatment. However, direct private sector investment has not happened so far in the urban water projects, barring exceptions like Chandrapur. Coming to the IRAs, only four states have enacted IRA laws, viz., Maharashtra, Arunachal Pradesh, Uttar Pradesh (UP), and Andhra Pradesh (AP). However, the IRAs have been established only in Maharashtra and UP, and the UP IRA is yet to be operationalized. Even in these states, the jurisdiction of the IRA is limited to tariff determination and entitlement allocation for the bulk water. Thus, the decisions and processes related to tariffs at household level still remain under the regulatory control of the ULBs or the respective state governments. Implementation of principles such as Cost Recovery or Scarcity Pricing has not yet taken place in retail-level pricing in the urban water sector. The IRA in Maharashtra attempted to implement the Cost Recovery Principle for bulk water in an ad hoc and disjointed manner, attracting severe criticism and opposition from the stakeholders. In Maharashtra, there is an indication from the state government of the establishment of a separate IRA in future to regulate municipal services. Such a body would regulate intra-city water activities as prescribed by the reforms.

However, there is hardly any comprehensive or concerted effort to implement reform measures in any state or city. Instead, the ground reality shows few a sporadic and unconnected efforts to implement reform measures in some of the cities.

Review of Performance of Reform Initiatives

In this section, a review of five initiatives that attempted to reform water supply sector is presented. The review looks at the achievements as well as shortcomings of these initiatives.

Tiruppur Water Supply Project: A PPP Initiative

The water supply project at Tiruppur (in Tamil Nadu) is a PPP project. It is one of the widely cited reform initiatives in the urban water sector. A Special Purpose Vehicle (SPV) called the 'New Tiruppur Area Development Corporation Limited' (NTADCL) was formed for this PPP, with diverse equity-holders, including AIDQUA-Mauritius,[19] and a consortium of private contractors led by Bechtel and Mahindra & Mahindra. The other stakeholders (not equity-holders) include: ILFS, local knitwear industry (one of the beneficiaries), a lenders' consortium led by IDBI and the Government of Tamil Nadu. It began operations in early 2005.

The review of the Tiruppur water supply project indicates that the recovery of costs is in doldrums. The NTADCL lost Rs 70 crores in 2008–09, taking the accumulated losses to Rs 177 crores. It sought Rs 65 crore assistance from the state government to support restructuring of its debt from the consortium led by IDBI. It has been argued that the global economic slowdown resulted in reduction in demand for water from industries. This pushed NTADCL into losses, as the industrial consumers were expected to cross-subsidize the domestic users. There were other problems also. The private operator allegedly neglected water supply to domestic users in the peripheral areas of the town (Dwivedi 2010). Even in situations of low water off-take by the industrial users, the NTADCL was not mandated to supply extra available water to domestic water users. In that sense, the project has not helped the domestic consumers (Madhav 2008).

Tamil Nadu Urban Development Fund (TNUDF)

The mandate of the Tamil Nadu Urban Development Fund (TNUDF) is to access capital markets to finance municipal infrastructure projects. The TNUDF lends money to ULBs to finance capital investments in urban infrastructure. It is cited as a success story of reform as the statistics quoted show that the default of TNUDF loans has been about 5.25 per cent during during the seven year period (from 1998 to 2004) (Venkatachalam 2005). One of the reasons for better performance of TNUDF is the relatively better condition of ULB finance in Tamil Nadu. Another factor that has helped the financing position of ULBs is the regular transfer of grant from State Finance Commission (SFC) to ULBs.

[19] AIDQUA Holdings (Mauritius) Inc., a Mauritius-based company, registered as 'Private Offshore Company Limited by Shares'. Its home jurisdiction is Mauritius and entity number is C25537. (This information is sourced from http://www.seravia.com/corporation/mauritius/aidqua-holdings-mauritius-inc-2k69biagi3#detail, last accessed in August 2011)

Larger ULBs in the state such as Madurai and Chennai, as well as Chennai Metro Water Supply and Sewerage Board (CMWSSB) have issued bonds using their financial strength, while smaller ULBs are accessing the Water and Sanitation Pooled Finance (WSPF) Scheme of TNUDF.

However, a closer look at the allocations to various sectors revealed that, though the water sector was indicated as the priority sector, a large portion of funds was allocated to projects for roads and bridges (Vijaybaskar and Wyatt 2005). Further, it is also pointed out that many of the ULBs accessed softer loans from Tamil Nadu Urban Finance and Infrastructure Development Corporation (TUFIDCO), a state financial institution, in order to foreclose costlier loans availed from TNUDF. This led to a steep fall in TNUDF's returns on assets from 5.40 per cent to 1.48 per cent. Even earlier recoveries by TNUDF were not fully sourced from direct revenues (such as property tax or user charges) of ULBs, but a substantial component came from state transfers.

Chennai Metro Water Supply and Sewerage Board

Chennai Metro Water Supply and Sewerage Board (CMWSSB) or Metrowater,[20] one of the earliest reforms initiatives in the sector, is now almost one and half decades old. In the year 2002, it reported a surplus in its revenue account for the tenth consecutive year and had been operating without state grants for the seventh consecutive year. Metrowater streamlined its operations, froze new appointments, instituted audits in a wide range of operational sectors, expanded its network and coverage, modernized its systems, contracted out several components, and stayed on track with its Master Plan (Coelho 2010). It can also be viewed as a classic example of 'ring-fencing' of an urban water utility as envisaged the in reforms. However, at the same time, gradual yet significant reduction of government subsidies, without any effort to generate internal cross-subsidies, led to marginalization of those who could not afford to pay for water. This essentially threatened the water security of the poorer sections of the society, both rural and urban (Ibid. 2010). In addition, the CMWSSB is also termed as the culprit behind the conflicts caused by large-scale transfer of groundwater from peri-urban areas, though external factors such as extreme water scarcity due to drought were also partly responsible (Janakrajan et al. 2007; Coelho 2010). In the late 2004, when Metrowater's rate of extraction of water from private agricultural wells in the peri-urban areas of AK Basin reached about 100 million litres a day, crises erupted in the region. Protest action by about 400 farmers against Metrowater resulted in attacks on the pumping facilities of 'Metrowater'.

Greater Bengaluru Water Supply and Sewerage Board

'Upfront payments' charged by the Greater Bengaluru Water Supply and Sewerage Board (GBWSSB) to future consumers for expansion of water supply network in the uncovered areas of Bengaluru is cited as one of the positive developments in reform efforts. However, despite upfront payments, the consumers are reported to not be receiving the level of service that they were promised. This failure is explained by citing the haphazard and rapid growth of settlements in the service areas of the GBWSSB which was not envisaged during the planning stage and which resulted in significant cost escalations. However, this failure is due to the criteria set for the assessment of GBWSSB's performance. Part of the capital for WSS expansion for GBWSSB came from pooled fund bonds issued to market. As a result, GBWSSB's main preoccupation was with financial viability, while enhancement in water supply or sustainability was not on its radar at all. Despite these issues, GBWSSB had to take many extraordinary measures to ensure financial sustainability of the project, such as: (i) waiver of late penalties in the wake of late water supply and (ii) allowing payment of charges in twenty installments instead of upfront payment (Ranganathan et al. 2009).

PPP initiatives in Maharashtra

There are three known PPP initiatives in Maharashtra—Chandrapur, Nagpur, and Latur. Water supply operations in Chandrapur town were privatized under a management contract as early as in 2001, when the

[20] The 'Chennai Metrowater supply and sewerage board' is commonly known as 'Metrowater' in Chennai. For more information, long on www.chennaimetrowater.com

Chandrapur Municipal Council (CMC) came under severe pressure for not running the scheme efficiently. While the contract has very modest expectations from the private provider, it gives full flexibility to the private operator for making investments. However, the performance of the local consortium, *Gurukripa Associates* has been dismal. Its efforts for expanding network and ensuring equity in supply have been negligible (PRAYAS 2010). Different explanations have been put forth: (i) interference by local politicians in day-to-day operations, (ii) scarcity of bulk water, due to failure of the state government to solve conflict the between National Thermal Power Corporation (NTPC) and CMC, and (iii) failure to undertake efforts for capacity building of CMC. Nonetheless, profit earnings were to the tune of Rs 40 lakhs during the period 2005–6 to 2009–10.[21]

The PPPs are supposed to free public resources. However, the investment pattern in the pilot project for 24×7 supply in Nagpur indicates that the entire investment of Rs 22 crores was made from public funds, more specifically from the central government scheme, Jawaharlal Nehru National Urban Renewal Mission (JNNURM), which included provision for assured profits for the private operator. It is reported that despite support for capital investments from government agencies, the private operator tends to concentrate on service provisioning to the better-off sections of the society and neglects service provision to the sections deemed unable to pay for the services. Some news reports have indicated that the water bills for some consumers rose by five times in the pilot zone, though there was no hike in tariff. As per the explanations by the Nagpur Municipal Corporation, the steep increase in the water bills could be due to the new practice of charging consumers based on meter readings. This however, indicates that sufficient effort was not made to make people aware about factors such as in-house leakages beyond the point of meter.

Similarly, lack of sufficient efforts for building awareness, ensuring transparency and public participation, and confidence building before engaging in PPP initiatives has led to suspicion and conflicts over the PPP in water distribution in the town of Latur. Further, the failure of efforts to resolve the conflict and secure legitimacy and acceptance from the citizenry resulted in the suspension of the Latur PPP project.

Based on these short case studies, it may be suggested that there is a need to undertake detailed and objective studies of these efforts, driven by genuine will to understand the strengths and weaknesses of the reform measures initiated in the country. Without such studies, it would be difficult to argue for wide-scale replication of such measures.

Conclusion

The performance review of the UWSS reforms in various Indian states brings out important gaps in achieving the four key objectives of reforms (discussed above). The review of these reforms suggests that the process of initiating and undertaking reforms is disjointed at various levels of governance institutions. States have implemented different elements of the reform proposals. One can observe significant level of unevenness in prioritizing techno-economic, financial, and institutional aspects of reforms across states as is evident from dissimilarities in reform initiatives in Maharashtra, Tamil Nadu, and Karnataka. This has resulted in chaos at the state and local levels in adaptation to the reforms, without much improvement in water sector service delivery.

The hasty push (for example, in the case of Tiruppur and Chandrapur) for reforms has resulted in grave failures. Many initiatives are fraught with premature and unripe ground conditions for adoption of reforms at the local level. This shows that the reforms are being pushed without doing the basic spade work such as building accurate databases and realistic assessments of the scale of investment required for debt-bearing capacity (or credibility) of the ULBs. The PPP failures have also raised questions about the veracity and authenticity of the surveys such as Water Treatment Plant and Common Effluent Treatment Plants, emphasizing the need for sound methodologies to assess the feasibility of reforms. In many SMTs, reforms such as PSP are not gaining ground due to lack of reliable databases.

[21] Interview of the Chartered Accountants of Gurukripa Associates, the firm contracted for running the PPP in Chandrapur.

Another problem with the reform process has been the lack of proper sequencing. While the number of ULBs is significantly low, the situation is further aggravated by measures of institutional reforms at the state level that are haphazard and run parallel with each other and without any coordination. In fact, institutional restructuring such as establishment of regulatory institutions and restructuring of para-statal bodies is a pre-requisite for system-level or ULB-level efforts for PSP or for financial reforms (such as municipal bonds).

Almost all the reforms designed at both, the state and the ULB, levels have been designed 'externally'. No buy-in from the stakeholders of the reforms was sought. Such non-participatory and, therefore, opaque process of design and implementation of reforms has resulted in an initial resistance from the stakeholders, which has concretized further after the deficiencies in the design and implementation processes surfaced.

Thus, the reform initiatives undertaken in the UWSS need overhauling at the conceptual and practical levels. Both the substance of as well as the process of designing and introducing reforms are fraught with serious lacunae. While the sector needs urgent and fundamental reforms, there is no such awareness and willingness in different sections for systemic, appropriate, participatory, transparent, and methodologically sound reforms in the urban water sector.

Recommendations

Techno-economic and financial objectives, which lie at the substantive core of reform, should be accompanied, with equal emphasis, by social, democratic, and environmental objectives. Equity in service delivery and affordability of tariff should be the main concerns. These can be achieved either through inclusion of substantive values in the law or through policy directives from the government. The current trend of a hasty rush for PPPs needs to be halted. PPPs should be viewed not as financial band-aids (as they involve long-term contractual obligations), but from the lenses of the broader objectives and long-term planning. PPPs should proceed with systematic data-building and sectoral studies, and the design of the PPP contract should be subjected to public scrutiny. Entry-level regulation by a politically accountable regulatory system is as important as regulation of functioning. To address the disjointedness in reforms, proper streamlining of institutional developments at the central, state, and at local levels is essential. Also, internal consistencies within different reform measures at different levels should be identified and effectively addressed. The key to successful implementation of reforms is their legitimacy and acceptability among the main stakeholders, viz., consumers and citizens. This requires diligent adherence to participatory, transparent, and accountable processes at every juncture and every level, bordering even towards 'process fundamentalism'.

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14 Addressing the Challenge of Financial Sustainability in Urban Water Supply Services—Role of Performance, Monitoring, and Planning

Vandana Bhatnagar and S.R. Ramanujam

A Sector in Disrepair

India's urbanization levels, currently estimated at about 30 per cent, are low compared to international standards. The country has, however, witnessed rapid growth in its urban population over the years, and is second only to China in the total number of urban residents (see Table 14.1). India's urban sector also makes a disproportionately large contribution to the country's economy. The contribution of India's urban sector to the gross domestic product (GDP) is expected to increase from about 63 per cent in 2007 to about 75 per cent by 2021 (Planning Commission 2007). Urbanization levels in India are further projected to reach about 40 per cent by 2030. According to one estimate, urban growth would account for two-thirds of the aggregate population growth in India between 2001–26, and the urban population will increase by 7–10 million annually (average) over the next 20 years.

The current state of supply of core services in the urban areas, especially water supply and sanitation (WSS), is inadequate by most standards. The high growth of urban population will add further pressure on the provision of these services. For a sector of this scale and salience, in terms of its impact on public health and quality of life, there is a surprising absence of any system of regular information gathering on the sector, at the city, state, and national level. Only a handful of cities in the country would have an updated consumer database, asset register, record of water produced/consumed, or even revenue accounts to enable accurate estimation of cost recovery. Consequently, any objective analysis of the sector is constrained at the very outset

Table 14.1 International Comparison of Urban Population

Country	*Urban population (2010)*	
	Percentage	*Million*
Argentina	92.4	38
Brazil	86.5	172
Mexico	77.8	86
Philippines	66.4	62
South Africa	61.7	30
Indonesia	53.7	129
China	44.9	607
India	30.1	367

Source: United Nations Human Settlement Programme, UN-Habitat.

by the absence of baseline information. Occasionally, organized data gathering has been attempted. Three exercises covering a sample of cities in the last five years corroborated the widespread consensus about the state of the sector (see Table 14.2).

Estimates of the proportion of urban Indian households with access to an improved water source are relatively high (hovering around 90–5 per cent). Despite this, however, there is cause for concern. Access to piped water supply is closer to 75 per cent, while households with direct connections are approximately 55 per cent. That means only half the urban households in the country have access to house connections. While partly attributable to lack of network coverage, this is also a result of weak emphasis on provision of direct connections by service providers. Complex administrative procedures for connections, poor quality of piped service, accompanied by relatively high connection costs, are factors which further inhibit direct connections even where a network exists. Recent data gathered for 28 cities under the Service Level Benchmarking (SLB) initiative reveal an increase in direct connections by a mere 2.8 per cent over the period 2008–9 (see Table 14.3 for city-wise increase in connections).

Moreover, the coverage figures do not reflect actual availability of water supply, which is better reflected by service quality indicators such as hours of supply, water quality, and quantity (see Table 14.2). On all these indicators, performance remains extremely weak and in several instances is seen to be declining over time.

Data available from 28 urban centres covered under the SLB initiative suggest that only eight meet the 135 litres per capita per day (lpcd) water supply benchmark (nine reported less than 100 lpcd) and none have 24 hour supply (21 reported water supply of less than 5 hours a day). Other studies have reported a decline in the availability of water (hours of daily supply), in several cities, for example, Ahmedabad, Bengaluru, Chennai, Coimbatore, Dehradun, Kolkata, Guwahati, Hyderabad, and Visakhapatnam (Savage and Dasgupta 2006). The situation in smaller urban centres may be even worse (see Table 14.4).

The water supply sector in India thus continues to be plagued with severe deficiencies in terms of availability, quality, and equity of services. Though access to infrastructure may be keeping pace with urbanization, access to reliable and affordable services remains poor, resulting in high coping costs for consumers.

Table 14.2 Indian Water Utilities Performance Indicators

Indicator	*ADB 20 (2007)*	*SLB 28 (2009)*	*S.E. Asia (average)*
Production			
Water production (lpcd)	240	225	—
Service:			
Coverage	81.2 (incl. public taps)	66.6 (only direct)	74.9
Water availability (hrs/d)	4.3	3.3	22.9
Water consumption (lpcd)	123.3	126.4	106
Efficiency:			
Unaccounted water (per cent)	31.8	44.1	27.8
Connections metered (per cent)	24.5	49.8	99.4
Unit production cost (Rs/m^3)	3.4	5.7	—
Operating ratio*	1.63	1.49	0.84
Break up of total operating cost			
Power/fuel (per cent)	43.9	40.4	—
Personnel (per cent)	29.7	27.0	—
Repair and maintenance (per cent)	11.5	12.9	—
Staff/1000 connections	7.4	8.4	7.2

Source: Ministry of Urban Development (2010) and Asian Development Bank (2007).

**Note*: Definitional differences exist between the two data points; lpcd: litres per capita per day.

Table 14.3 Growth in Direct Connections (2008–9)

City	*Coverage (per cent) (direct)*	*Growth in connections (per cent)*
Thiruvananthapuram	68	0.70
Indore	38	1.11
Amritsar	66	1.58
Bhubaneswar	45	1.69
Bhopal	35	1.97
Delhi	72	2.38
Tiruchirapalli	42	2.77
Hyderabad	66	3.26
Kozhikode	39	3.42

Source: Ministry of Urban Development (2010).

Table 14.4 City/Town-wise Average Access to Drinking Water

City/Towns (population)	*Average access to drinking water (per cent)*
Class I cities (100,000 and above)	73
Class II cities (50,000–99,999)	63
Class III cities (20,000–49,999)	61
Other cities/towns (<20,000)	58

Source: Planning Commission (2007).

The poor levels of service are closely mirrored in the weak financial health of service providers, most of which are unable to recover even operation and maintenance (O&M) costs. Only 5 out of 28 cities covered under the SLB initiative reported 100 per cent recovery of O&M costs, while 13 of the cities recovered less than 50 per cent of these costs. Collection efficiency of water supply related charges reflects an equally poor performance with more than half the cities reporting collection efficiency levels below 70 per cent, and of these 7 reporting below 50 per cent.

Critical Need—Sustainable Asset Creation and Management

The current state of the sector can be correlated with a steady decline in asset quality and asset management practices. Over the decades, public service agencies have tended to focus on asset creation, with limited or no incentives aimed at fostering asset management and sustained service quality. In contrast, modern utilities practice asset management, which is defined as 'a systematic approach to managing service assets in order to minimize costs over the useful life of the assets while maintaining adequate service to customers'.[1]

It is important to recognize the fundamental barriers that inhibit the adoption of such an approach and prevent improved services and financial sustainability. Asset maintenance hinges on sound planning, operating systems, and financial flows to cover maintenance requirements, for which no incentives exist in today's systems. Allocation of funds for O&M purposes (usually a municipality function) tends to be inadequate and lacking incentives for service delivery, and hence asset maintenance. The reasons are discussed here.

First, the functions of policy making, financing, regulation, and service delivery overlap, or are improperly distributed, in most states. There is a lack of alignment between the responsibility for investment which is at the state level, and O&M which is at the urban local body (ULB) level. The resulting separation of asset building and O&M responsibilities has diluted the responsibility towards service delivery. The asset planning process, usually undertaken at the state level, is often disconnected with the ground realities of service provision at the ULB level. It tends to be ineffective in delivering target outcomes, and is often accompanied by a lack of requisite technical and financial capacity in ULBs.

Second, most cities depend entirely on higher levels of government for capital investment and substantially for even O&M expenses. As a result, the orientation of cities is to propose investments and seek grants from the state government. Extensive dependence on grants from higher levels of government weakens the motivation for effective asset management and cost recovery.

[1] United States Government Accountability Office (2004).

Service levels no longer remain the focus of the city. Low tariff levels as well as lack of willingness to pay for poor services further distance the ULBs from their customers and aggravate the decline in services.

The third barrier is the continuous decline in the capacity of cities. Even as other infrastructure sectors are moving ahead by upgrading and expanding their professional resources, to meet the emerging challenges, the WSS sector has tended to get ossified. Fresh recruitments in state departments/ boards are negligible due to the freeze on hiring for over a decade, resulting in little induction of fresh talent and modern operating practices in the sector.

In recognition of this fundamental weakness of poor asset management in the sector, a stated objective of the reformist agenda of the Jawaharlal Nehru National Urban Renewal Mission (JNNURM) has been to secure the linkages between asset creation and maintenance for long-run project sustainability. Related to this, another reform condition under JNNURM is the full recovery of operating costs. While there is growing acceptance of these objectives in sector vocabulary, the vast majority of providers continue to remain trapped in a 'vicious circle' of poor services, deteriorating asset quality, and weak financial health (see Figure 14.1). As a consequence, even while a majority of the providers have sought funding for additional assets under JNNURM, requisite preparation has not been done to meet the associated asset management and maintenance requirements.

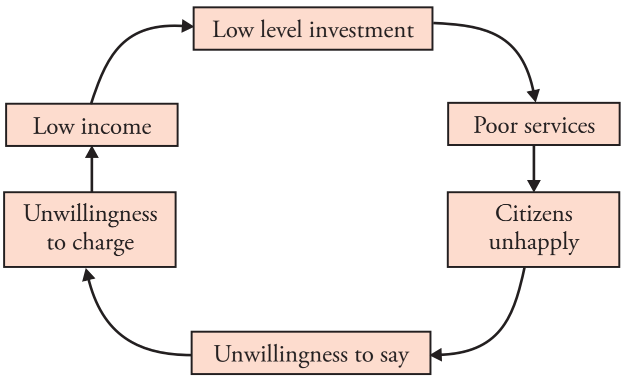


FIGURE 14.1 Vicious Circle of Poor Service Delivery

Source: Authors' own.

GROWING FINANCING GAP

Lack of sustainable asset creation and management has been a core reason for the state of disrepair in the sector. Today, as a result of these past practices, the sector is facing the dual challenge of deteriorating infrastructure as also an increasing gap in infrastructure requirements. Any intervention for improvement of the existing scenario requires significant capital investment, more so given that the water sector is among the most capital intensive infrastructure sectors. Given the fragile financial health of service providers, there is also a critical need to ensure that the infrastructure created through the investments is of a sustainable nature and ensures requisite improvement in service quality.

Over the decades, public funding for the WSS has been rising under various central and state government allocations. Figure 14.2 shows the increase in the allocations made in the last three Five Year Plans (FYPs) towards improvement in the urban water supply services (its share of the total public sector outlay has, however, remained in the range of 1–1.5 per cent since the first FYP).

A similar trend is visible under the two centrally-sponsored schemes JNNURM and Urban Infrastructure Development Scheme for Small and Medium Towns

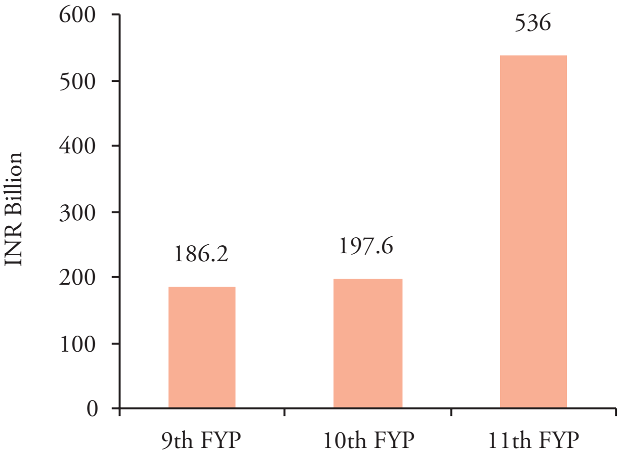


FIGURE 14.2 Five Year Plan Allocation for Urban Water Supply Sector

Source: *Report of the Working Group on Urban Development, Urban Water Supply, and Sanitation and Urban Environment* for Eleventh Five Year Plan (2007–12).

(UIDSSMT), wherein urban water supply has been identified as one of the core sectors for assistance. Table 14.5 gives the share of urban water supply projects in total funds sanctioned as on December 2010.

Table 14.5 Share of Water Supply Projects in Total Project Funding

	Total project funds sanctioned (Billion rupees)	*Share of Urban Water Supply projects (per cent)*
JNNURM	602.15	34.6*
1 UIDSSMT	129.29	65.2

Source: High Powered Expert Committee Report.
Note: *Highest share amongst sectors.

Despite the increased funding allocations, these remain inadequate to meet the investment needs of the sector. According to a World Bank estimate (World Bank 2006), India would need to invest an average of Rs 855 billion during the Eleventh (2007–12) and the Twelfth (2012–17) Plan periods in order to meet the infrastructure gaps and to achieve the Millennium Development Goals (MDGs) fixed for the sector.

The recently published report on *Indian Urban Infrastructure and Services* (March 2011) by the High Powered Expert Committee (HPEC) for estimating the investment requirement for urban infrastructure services has estimated the investment requirement in the water sector as Rs 3.2 trillion for the period 2012–31. Approximately 50 per cent of this requirement is to meet the unmet demand and is, therefore, an immediate requirement. The Committee has also estimated O&M requirements of Rs 5.46 trillion, resulting in an aggregate cost of Rs 8.67 trillion for the period 2012–31.

In contrast to the substantial investment requirements being faced by the sector, the ability of the ULBs to undertake the scale of investments needed and to meet the financing gap is severely limited. Compared to these investment requirements, the revenue of the all local bodies in India in the year 2007–8 was Rs 444.3 billion and the total expenditure was Rs 470.2 billion, implying a deficit of approximately 5 per cent of revenues.

Given the weak status of municipal finances, central and state financing will continue to play a predominant role in the sector in the foreseeable future, even while municipalities would be expected to mobilize revenues to cover the operating requirements of the existing and proposed infrastructure. Recognizing this reality, the Eleventh FYP estimates that over 95 per cent of the total funding requirement will have to be generated from public funding sources (including investments by public financial institutions and multilateral agencies).

Despite the predominance of public financing, given the investment gap in the urban water supply sector and issues concerning poor service delivery, the government at all levels has been pushed to explore the option of increased private sector involvement in the sector. This is indicated in the National Water Policy 2002, where private participation has been encouraged in feasible areas. The Eleventh FYP also emphasizes the need for leveraging governments' investments to initiate public–private partnerships (PPPs) and for bringing in efficiencies of the private sector.

Challenges for Achieving Financial Sustainability

Even as increased funding allocations and investments are made to address the infrastructure gaps in the sector, concerns still remain on the core issues of asset management and financial health of the sector. Current service delivery institutions do not have the capacity to ensure asset maintenance and meet the growing investment needs of the sector.

Three broad thrust areas need to be addressed to secure the long-term financial sustainability of the sector.

- Generation of revenues to cover O&M requirements through adoption of cost recovery strategies.
- Allocation of public funds to investments that deliver service gains, while being financially and operationally sustainable.
- Effective leveraging of the private sector to meet investment and operational needs of the sector.

A host of institutional, financial, and operational interventions are required at the local, state, and national levels, to deliver on each of these thrust areas. Even while these are explored and implemented, a simple but important step is increased performance orientation in monitoring, financial, and planning processes.

Through three storylines, we analyse each of the thrust areas identified for financial sustainability and the significance of performance orientation within each of these.

Thrust Areas for Strong Asset Management and Financial Sustainability

Cost Recovery

Among the list of mandatory reforms under the JNNURM is a requirement for urban water service providers to recover the costs of their services through 'reasonable user charges'. It is expected that service providers should aim to recover at least operational costs, later moving towards full cost recovery, and thus reduce dependence on fiscal transfers and grants to deliver WSS services.

In attempting to address the goal of cost recovery, the sector discourse has typically tended to focus on tariff revision. While this is a significant imperative, the scope for improving cost recovery levels through operational interventions has often been neglected. Such interventions include improved billing and collection practices, increasing the customer base, and reduction in non-revenue water and efficient energy use. Also neglected is the need for arriving at an efficient cost structure as the basis for calculating tariff levels.

In a study by the Water Sanitation Programme (WSP 2011b), a comparative analysis of ULBs was undertaken in 2006–7, to understand the factors affecting cost recovery in India and provide an assessment of current performance. More than half, that is, 14, of the 23 cities failed to recover O&M costs, with no city recovering the full cost. Average revenue per kilolitre (kl) of water was Re 1 to Rs 11, against the average cost of Rs 2 to 22.

Seven cities[2] were studied in detail to assess their cost revenue potential through operational improvements, as also their tariff structures. The operational interventions assessed were of three types, namely: (i) increasing the connections base, (ii) improving collection efficiency, and (iii) reducing non-revenue water. Assessing revenue increase potential through improvements on these parameters, revealed significant scope for increasing cost recovery. A few examples are provided in Box 14.1.

The study estimated the total revenue potential of such operational interventions, and compared these to prevailing levels of revenue generation to assess the potential impact on cost recovery. The results are provided in Table 14.6. As is evident from the table, in four out of seven cities, there is potential to more than double the revenue through operational improvements, leading to operational cost recovery.

This analysis highlights the significant scope for improving cost recovery of WSS services through operational interventions. It also highlights the extent of inefficiencies existing in the prevalent cost structures which need to be addressed while designing rational tariff structures. Addressing existing operational inefficiencies and the resulting service improvements would also help increase consumer confidence and hence the willingness to pay higher tariffs.

To identify and incentivize these operational interventions for improved cost recovery, service providers need to first undertake an assessment of their current performance on these indicators, compare against benchmarks to identify gaps, and initiate actions to improve on these, while also creating incentives for ongoing improvements. However, due to a continued neglect of operational systems, providers do not usually measure and report these operational indicators. Requisite incentive structures and information systems need to be created to begin tracking of these operational indicators, identifying performance gaps, and incentivizing improvements.

The storyline emerging from the above analysis may be captured as follows:

Storyline I: Improving cost recovery levels requires a concerted thrust on harnessing operational efficiencies accompanied by tariff revisions that are based on rationalized cost structures.

Sustainable and Outcome Linked Investments

As described above, over the years there has been a steady increase in public funds being assigned to the

[2] Ludhiana, Pune, Hyderabad, Indore, Chandigarh, Cochin, and Dehradun.

Box 14.1
Revenue Increase Potential through Operational Interventions—A Few Examples

Increasing Coverage

Ludhiana: 15 per cent undeclared area of the city was not serviced, with a potential water demand of 62,000 kl. At minimum rates, this implied an annual revenue potential of Rs 86 million. In addition, supplying water to un-served industries, having potential water demand of 60,000 kl per day, could generate Rs 166 million.

Pune: Around 60,000 potential tax payers were not in the water charge database. At the minimum annual charge of Rs 900 this represented a revenue potential of Rs 54 million.

Dehradun: Of potential 135,000 consumers only 60,000 consumers were covered under the water and sewerage charge of Rs 1800 per annum. After excluding slum dwellers, the remaining 50,000 consumers represented an annual revenue potential of Rs 90 million.

Reducing Non-revenue Water

Ludhiana: Reversing exemption of 72,000 households (provided free water) and imposing the water and sewerage charge at minimum rates could generate Rs 181 million in additional revenue.

Chandigarh: Technical loss estimated at 25 per cent, if brought down to 10 per cent could save 52,627 kl water per day which could translate into a revenue potential of Rs 76 million per annum (higher if calculated at production cost).

Pune: Reducing technical loss level from an estimated 25 per cent to 10 per cent could save 150,000 kl water per day, having a revenue implication of Rs 164 million.

Improving Collection Efficiency of user Charges

Indore: Raising collection efficiency from the current 22 per cent to 90 per cent of billed amount (Rs 440 million) could yield an additional Rs 280 million.

Cochin: Raising collection efficiency from the current 13 per cent to 90 per cent of billed amount (Rs 465 million) could yield an additional Rs 357 million.

Source: WSP (2011b).

Table 14.6 Revenue Generation Potential Through Operational Improvements

Name of Factor	*Dehradun*	*Ludhiana*	*Chandigarh*	*Indore*	*Pune*	*Hyderabad*	*Cochin*
Reducing Total NRW	21	181	146	35	164	348	21
Improving Collection Efficiency	37	165	34	280	410	1650	357
Increasing Consumer Base	90	252	36	391	119	144	23
Total Revenue Improvement Potential (A)	148	598	216	706	693	2143	401
2006–7 Total Operative Income (B)	130	225	492	159	1015	2572	193
Potential for increase in operative income A/B (per cent)	114	266	44	444	68	83	208

Source: Water Sanitation Program (2011b).
Note: NRW is non-revenue water.

urban water supply sector. Investments are being made to address the gaps in infrastructure access and quality. However, concerns are being raised regarding their efficacy in delivering service improvements and their operating cost implications.

Under JNNURM and UIDSSMT, over Rs 300 billion has been sanctioned for water supply projects. Service gains are projected from these investments, as detailed in respective project reports. However, as of now, no provision exists under any state/central government monitoring system to track whether or not these service gains are being, or would be, realized. This additional capital expenditure will also have significant operating cost implications for the concerned cities.

A similar picture emerges with respect to state budgetary allocations to ULBs wherein the proposed outlay increased by 86 per cent from Rs 187 billion under the Tenth FYP to Rs 350 billion under the Eleventh Five Year Plan (Planning Commission 2007). However, once again, processes for identification of investments, and monitoring of outcomes are either weak or absent.

Public funding will continue to account for bulk of the investments made in the WSS sector (central and state government allocations for the Eleventh FYP accounted for over 80 per cent of the funding requirements of all the basic services combined). Against this background, the following questions arise with regard to the efficiency of investments being made:

- Could there be greater optimization in the choice of investments (and technologies), such that targeted service gains are achieved at lower capital costs and operating costs?
- Could there be a better phasing of investments to align with the ULB's financial capacity to undertake the ensuing asset maintenance costs?

Past experience suggests that asset creation has often tended to be financially or operationally unsustainable, leading to underutilization of assets and poor asset maintenance, in turn resulting in rapid deterioration of asset quality, and finally little or no improvement in services. Conducting an overall assessment for sustainability of currently ongoing investments is difficult given the absence of monitoring systems. However, some anecdotal information is revealing.

The total JNNURM funding approved for water projects in Bhopal is Rs 7.35 billion which is over 50 times its revenue for 2008–9. Similarly, investments in urban water projects approved for Ujjain and Amritsar are 15 and 12 times, respectively, the total billed revenue for financial year (FY) 2009. Given the scale of these investments, compared to their existing revenue base, the ULBs would need to make substantial efforts to ensure recovery of operating costs associated with the investments. This challenge is further exacerbated by the fact that projects are being designed for projected demand over long-term horizons (usually 30 years), resulting in bulky upfront investments with large excess capacity.

An associated concern is the lack of alignment of investments with desired service outcomes. In an analysis undertaken for a million plus city, the impact of two investment options was compared, namely augmentation of capacity versus distribution network improvements. The performance assessment revealed adequate water available with marginal shortfalls. The concerns were, however, more at the distribution level, demonstrating lack of metering, high levels of non-revenue water (NRW) and inequitable distribution of water. A comparison of the impact of the two investment options was undertaken (see Table 14.7). While this case is illustrative, there have been several instances of ULBs initiating investment proposals, focusing on

Table 14.7 Comparison of Investment Options—Implications for Cost Recovery

	Indicator	*Current status*	*With bulk supply project*	*With distribution improvement Project*
1.	Coverage (per cent)	68	68	90–95
2.	lpcd (consumer level)	81	135	93
3.	Metering	Less than 1%	Less than 1%	100%
4.	NRW (per cent)	51	51	25
5.	Hours of supply	1.5–2 hours on alternate days	1.5–2 hours on alternate days	Daily
6.	Cost recovery (per cent)	42	31	Near 100

Source: Calculated from a note by CRISIL for WSP's internal analysis.

augmentation of bulk supply, when the service delivery improvements are likely to emerge from implementation of interventions aimed at distribution network improvement.

What emerges from the above examples is that investments need to be based on: (i) clear service/performance outcomes and (ii) an assessment of options to ensure alignment with the ULB's financial capacity. This can be done through preparation of performance improvement plans and business plans by ULBs. Based on these specific projects and investments may be identified and developed. Through such a planning process, investments could be undertaken aimed at specific and measurable performance outcomes, while maintaining alignment with the financial capacity of the ULBs (including expected grants, fiscal transfers etc.). To operationalize this planning process, it further needs to be accompanied by increased predictability of funding streams which can be achieved through multi-year budget plans covering a three to five year period.

A shift in planning and investment processes, as described here, would begin with an assessment of the current baseline performance and gaps vis-à-vis desired standards. Funding allocations made on the basis of these plans would need to be followed up by ongoing monitoring of performance to confirm whether targeted levels are, in fact, being achieved. The recent Planning Commission proposal to set up an Independent Evaluation Office is a step in this direction at the level of national programmes. Similar monitoring and evaluation is required at the state and ULB levels.

The above analysis can be synthesized in the following storyline:

Storyline II: With growing public funding in the sector, care needs to be taken to ensure that investments are efficiently allocated and are sustainable else these might not deliver the desired service outcomes and could lead to a further decline in the financial health of the sector.

Private Sector Participation

Despite its relatively small (or even negligible) share in the urban water supply sector, of late the private sector is becoming increasingly active in this sector. In a study undertaken by WSP of 26 PPP projects in the urban water supply sector since the 1990s, it emerges that while several projects were attempted through the PPP route in the 1990s, only 40 per cent of these reached the stage of contract award (WSP 2011a). This trend has changed since 2005 with an increase in the incidence of contracts awarded. Today, PPP projects have a total reach of approximately 5 million urban population.[3] The year-wise increase in the population covered by active PPP contracts is presented in Figure 14.3.

While the overall number is still very small, the trend is significant. There are increasing instances of cities exploring the PPP option as a means to address their service gaps. A few other observations emerging from the WSP study are useful in this context.

In contrast to the 1990s when PPPs were primarily aimed at augmentation of the bulk water supply system, today, approximately 60 per cent of the PPP projects address O&M improvements in the distribution system, while 30 per cent aim at bulk water supply augmentation. Further, the type of PPP arrangements being implemented have also changed. From the 1990s when the majority of projects attempted were based on build–operate–transfer (BOT) models with 100 per cent private financing, the scenario changed since early 2000 to one where the majority of O&M improve-

Figure 14.3 Urban Population Covered by PPP Contracts in Water Supply

Source: Water Sanitation Program (2011a).

[3] Estimated on the basis of information on the population expected to be covered under each active project.

ments were sought through management contract-based interventions. Today, the operational contracts are a mix of BOT and management contracts.

Going forward, while the private sector will continue to bring in operational and management expertise for improving service delivery, a growing imperative is to bring in increased private investments to address the financing gap in the sector. Private sector participation has the potential to address both the critical needs in the sector : (i) good quality infrastructure management and service delivery and (ii) meeting financing gaps. However, the high risk perception and weak revenue streams associated with the water supply sector, often act as a deterrent, or result in loading of higher risk premia in the pricing of services by the private sector. Factors contributing to high risk perceptions include political uncertainties, poorly structured contracts, lack of clear baseline information, and unrealistic performance targets.

The storyline on private sector participation in the sector could, therefore, be captured as follows:

Storyline III: To meaningfully engage the private sector in addressing service and investment gaps, there is a need to reduce perceived risks associated with the sector.

Starting Point for Course Correction

As explained earlier, the state of disrepair in the sector can be attributed to poor asset management and the increasing financing gap. The challenge of financial sustainability of the sector can be improved by focused interventions to: (i) achieve cost recovery, (ii) increase allocative efficiency of public investments, and (iii) enhance private sector participation.

These solutions seem evident, fundamental, and practical. However, many institutional and operational issues arise when these are adopted, the most fundamental of which is the continuous neglect of performance orientation in decision making, and relatedly, the lack of performance data to take steps in this direction. The poor attention to data systems for measuring performance has resulted in the absence of any objective data on the sector at present; this, in turn, has brought us to a situation where it is almost impossible to carry out an objective diagnosis of any service provider. In the absence of a good diagnosis, decisions are based on hypothesis and can lead to poor results. To illustrate, we look at the following issues.

Cost Recovery

At present, most discussions on cost recovery have become synonymous with tariff revision. As has been discussed above, many cities can achieve significant improvements even with current tariff levels. However, in the absence of any performance data on costs, collection efficiency, and percentage of illegal connections etc. it becomes difficult for an external agent (such as the state government) to emphasize this approach or introduce mechanisms to incentivize its adoption. The result is a continued neglect of efforts to improve operational efficiencies, which in turn could become the basis for rational tariff setting.

Sustainable and Efficient Investments

In the absence of any operational performance data (such as physical losses, commercial losses, and uncovered customers), most of the investment arguments from service providers focus on expensive bulk water supply investments. In the absence of data, it is easiest to establish the need for additional bulk water based on projected population growth. As a result, critical improvements required in operations (or) in distribution are not highlighted and, therefore, not prioritized.

Private Sector Participation

In order to gain meaningfully from the private sector, the service levels expected need to be clarified upfront along with a clarity on the levels of investment required (if any) to meet them. Experience with some recent contracts reveals a high risk perception associated with poor baseline information, weak contractual structures, and unrealistic performance targets. These factors gain further salience in the context of distribution-led projects, where the uncertainties of existing asset quality, baseline performance (for example, NRW and lpcd) and complexity of the operating environment, are greater.

A strong emphasis on improved performance monitoring and performance led planning is thus an important step on the journey towards correcting the state of disrepair in the sector. Good quality data can facilitate quality diagnosis and meaningful decision making. Recognizing the importance of this aspect, the Government of India has, in parallel to JNNURM, taken an important step in this direction, which is discussed here.

Service Level Benchmarking

In 2008–9, the Ministry of Urban Development (MoUD) launched the Service Level Benchmarking (SLB) initiative, covering water supply, sewerage, solid waste management, and storm water drainage. As part of this initiative, a performance monitoring framework was formalized in a *Handbook of Service Level Benchmarking*, which was operationalized through an SLB Pilot Initiative covering 28 cities (see Box 14.2). Through this initiative, the aim has been to emphasize not just reporting of data, but also planning for improvements in information systems and performance. It is an attempt at demonstrating a performance orientated approach to service delivery.

The experience with the SLB Pilot Initiative influenced the Thirteenth Finance Commission (TFC) to incorporate benchmarked performance as per the SLB framework as one of nine criteria for the release of performance grants to local bodies, which are estimated at Rs 80 billion over the period 2010–15 (see Box 14.3). To enable the adoption of this framework, the MoUD initiated a National Rollout of the SLB framework in 2010. As part of this, training and orientation is being provided to state/ ULB functionaries, accompanied by development of a national web-based software database in which ULBs would be required to upload their performance data. Consequent to support being provided under the National Rollout, over 1400 ULBs from 14 states have notified their SLB data as of 31 March 2011, in compliance with the requirements of the TFC requirements.

The significance of the SLB initiative has been further reflected in the recently published HPEC report on *Indian Urban Infrastructure and Services* which recommends the adoption of the SLB framework. It states that 'The benchmarks are important for shifting focus from the creation of physical infrastructure to service delivery because poor governance can create situations in which additional capital investments in urban infrastructure do not result in corresponding improvements in service delivery.' The Report further recommends that the SLB framework be adopted in cities and be used for planning performance improvements; and future grant programmes use the SLB framework to set service delivery targets and monitor performance improvement. The Report also recognizes that sector improvement measures such as regulation are now possible since a framework for service delivery norms has been formally established.

Institutionalizing Performance Orientated Decision-making

Even while articulating the merits of a performance orientated approach, it is important to recognize barriers that may inhibit the adoption of such an approach and the associated measures needed to overcome these.

Sustained attention to underlying data systems: After decades of neglect, substantial effort would be needed to build good quality data systems for measuring performance. To begin with, these may include preliminary investments in monitoring equipment (for example, flow metres, pressure gauges, water quality testing infrastructure) or in creation/up-dation of databases (for example, household surveys, asset registers, and network maps). Subsequently, a high degree of administrative commitment would be required to ensure the discipline of ongoing monitoring and updation of databases, followed by review at appropriate levels of decision making.

Overcoming a fragmented institutional framework: The above performance approach is being applied in the existing institutional framework, which as discussed before, is characterized by lack of incentives for performance improvement; especially where service delivery is fragmented functionally. Substantial reform effort is required to resolve these institutional weaknesses. There is a need to clarify the roles and responsibilities of the various actors, consolidate the functions of promoter of infrastructure and provider of service, and 'ring fence' WSS operations at the local level (World Bank 2006). These institutional reforms need to accompany efforts to implement performance based decision making, in order to harness the full service gains of such a system.

Need to build a bottom–up demand for performance data: Most of the efforts at performance planning are top–down. Given the diversity and scale of the urban sector, a top–down approach has its limitations. It cannot understand local conditions fully, and does not foster ownership at the local level. These make the approach susceptible to mis-reporting. Only a bottom–up approach that engages consumers and has

Box 14.2
Service Level Benchmarking—From Concept to Implementation

Programme Development

During 2005–7, the MoUD carried out two benchmarking exercises for urban water supply with assistance from the WSP and the ADB. Based on these exercises, the Ministry set up a Working Group to suggest a framework for improving performance measurement in the water and sanitation sector. After extensive deliberations and consultations, in 2008 the Ministry released a *Handbook of Service Level Benchmarking* covering water supply, sewerage, storm water drainage, and solid waste management services. The Handbook incorporated a set of performance indicators with corresponding benchmarks, a data reliability scale for each of these, and suggested processes for utilizing performance data to plan performance improvements.

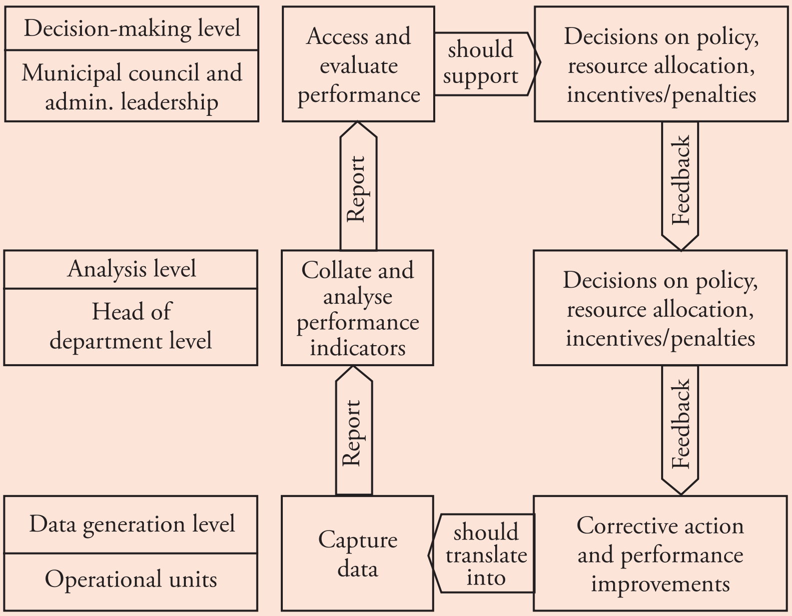
To demonstrate how the SLB framework could be operationalized, an SLB Pilot Initiative was launched in early 2009 by the MoUD under a partnership arrangement with various development agencies [Japanese International Cooperation Agency (JICA), Gesellschaft für Internationale Zusammenarbeit—Germany (GIZ), Department for International Development—UK (DfID), Centre for Environmental Planning and Technology (CEPT), and Public Record of Operations and Finance (PROOF)] including WSP as lead technical advisor. The Initiative covered 28 cities (including 16 JNNURM cities) representing a total population of approximately 50 million. Spread across 14 states and 1 union territory, the cities represented diverse operating conditions, institutional arrangements, and state contexts. As part of the initiative, cities undertook: (i) *performance assessments* based on the uniform indicator framework in the SLB Handbook; (ii) development of *information systems improvement plans* (ISIPs) to address data quality issues; and (iii) development of *performance improvement plans* (PIPs) using the SLB data.

On completion of the exercise, cities presented not just their performance data but also their ISIPs and PIPs, which resulted in valuable insights on strategies for improving service delivery, efficiency levels, and also priority areas for investments. Data for the 28 cities was captured in the *SLB Databook 2008–09* to facilitate comparisons and further performance gap analysis.

Performance Led Urban Services

Under the Pilot initiative, the SLB framework was presented as a means to not just report to higher tiers of government, but to also improve decision making at the local level. It was an attempt at demonstrating a performance orientated approach to service delivery, or what may be otherwise referred to as Performance Led Urban Services (PLUS). The approach is represented in this schematic from the *Handbook of Service Level Benchmarking*.

Such an approach could help improve the technical and financial sustainability of services in various ways. By facilitating improvement actions that unlock efficiency gains and strengthen revenue flows, cities are encouraged to optimize existing assets. Through the adoption of performance-oriented planning and budgetary processes, investments can be made in new assets that are more efficient and sustainable. With improved baseline information, target setting, and monitoring systems, ULBs can engage with the private sector more effectively.



Box 14.3
Thirteenth Finance Commission Report—Role of Service Level Benchmarking

Recognizing the growing importance of ULBs, the TFC has proposed a significant increase in allocations for ULBs. For the first time, local bodies have been devolved a share (2.28 per cent) of the divisible tax pool over and above the share of the states, and a part of this devolution will be in the form of a performance grant. The share of ULBs in the total allocation for local bodies has increased from 20 per cent under earlier FC allocations to 26.8 per cent, resulting in a five-fold increase in total funds allocated for ULBs with just the performance grant component constituting close to double the entire ULB allocation under the 12th FC.

	Allocations for ULBs
11th FC (2000–4)	Rs 20 billion
12th FC XII (2005–9)	Rs 45 billion
TFC (2010–15)	Rs 230 billion (performance grants: Rs 80 billion)

The performance grant component requires compliance with nine conditionalities. One of these requires service standards to be instituted as per the SLB indicator framework for essential services provided by local bodies. To begin with, this would entail a state gazette notification by 31 March 2011, announcing the minimum service standards that would be achieved by the end of 31 March 2012, by each ULB. This conditionality, therefore, requires ULBs to assess their current performance levels, decide on performance targets for the next year, and declare the same.

Source: Thirteenth Finance Commission Report 2010–15.

local political involvement can yield sustainable results. Substantial capacity needs to be built at community and local political levels to achieve this.

In parallel, mechanisms such as an independent regulatory framework can deepen this orientation. Good quality regulation relies on good quality performance data. Therefore, when independent regulation takes root, the demand for performance data and performance oriented planning may be expected to widen further.

Conclusion and Next Steps

Conclusion

The Indian urban water supply sector is at a critical juncture, facing the dual challenge of rehabilitating a deteriorating asset base and increasing investments to keep pace with rapid urbanization and a shrinking water resource base. While there is strong consensus on the problems as well as the required solutions, implementation has been ineffective in the absence of performance oriented planning and monitoring.

The MoUD has initiated an exercise to introduce a performance orientated approach in the water and sanitation sector. As a first step, an SLB framework has been finalized for the sector, which has been piloted in 28 cities, and is now being rolled out at a national scale. Efforts are also underway in some cities to use SLB data as a basis to develop plans for undertaking performance and information system improvements.

Other stakeholders in the sector have also recognized the importance of SLBs. The TFC has stipulated implementation of the SLB framework as one of the pre-conditions for the disbursal of performance linked grants. The HPEC has recommended that the SLB framework be fully adopted and has also recommended that the next generation of JNNURM use the SLB framework to set service improvement targets for cities.

Thus, a fundamental shift that was required in the sector has been initiated; one that focuses on service delivery that is technically and financially sustainable. Moreover, influential stakeholders and several states have already endorsed this approach and have recommended that future programmes should be built on this foundation.

Next Steps

These early gains need to be deepened through meaningful and much needed institutional changes in the sector.

Past debates have reinforced the need for effective decentralization of water supply functions to cities. Associated with this, are the changes at the state level administration of the water sector. The first institutional change that is required is the integration of planning, capital investment, and service delivery of water supply functions. In many states, a para-statal still controls planning and investment, even if O&M has been devolved to cities. A customer focussed service delivery requires accountability and functional autonomy. Integration of all water supply functions within one agency is a key requirement to achieve this. The second change that is required is the devolution of this integrated function to urban local bodies along with transfer of requisite financial powers. For effective customer focus and accountability, it is necessary that this function is not carried out as a departmental function at the state level, but is provided as a service at the city level. The last institutional change is the form of service delivery at the city level itself. Ring fencing of the function within the local body (or) corporatization of service delivery, are the directions for this step. This last change will also enable smaller cities to regionalize service delivery, in a formal voluntary arrangement, to benefit from economies of scale.

An institutional framework for capital investments will need to support these changes, since the ULBs will not be in a position to finance investments in the short-term. The HPEC Report has already outlined the contours of the next phase of JNNURM and such an upfront reform linked financing will be a key support. Along with that, revenue sharing arrangements between tiers of government will also need to be streamlined.

The existing institutional arrangements neither assure quality of service nor enable meaningful cost recovery. In order to move towards sustainable cost recovery and service delivery outcomes, a regulatory framework is also necessary.

Thus, the next generation of institutional reforms will need to focus on streamlined and empowered service delivery, public sector accountability, and sustainable cost recovery, within an overall framework of fiscal support from higher levels of government and regulation.

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15 Private Sector Involvement in Water

Part I PPPs in the Drinking Water and Irrigation Sectors

A Review of Issues and Options*

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Introduction

In urban areas, urban local bodies (ULBs) are responsible for providing drinking water to households, commercial, and industrial establishments. This includes bulk water abstraction, creation of storage and treatment facilities, distribution, and management of wastewater. Water for irrigation is provided by the water resources or irrigation departments at the state level. Historically, both drinking water supply and irrigation have been provided by publicly-owned (state or local government) entities, which have often been vertically integrated regional monopolies. Private sector participation, under various public-private partnership (PPP) models, is being considered as an option for improving services by the central and state governments and initiatives are being taken to improve the management of the assets of the water sector and the delivery of public services through this framework.

This chapter explores the various issues faced in attracting private participation in the water sector—both for urban drinking water and irrigation purposes.

Urban Drinking Water and Sanitation

Several state governments and agencies have tried to engage the private sector, particularly for drinking water services with limited success. This could be primarily attributed to the following reasons:

- Lack of adequate project development.
- Projects not being bankable.
- Most of the earlier projects being operator-led rather than government/ULB-led, which in the absence of adequate project development, has led to protracted negotiations and stifled successful project implementation.
- Procurement issues—projects based on negotiated contracts and not through a competitive bidding process.
- Security of payments to private operator.
- Low tariff regime.
- Lack of credible information.
- Lack of government support and political will.

Among these reasons, the private sector perceives availability of credible information, payment (including termination payment) guarantee structures, and the presence of a business case for the project (robust revenue model, risks on tariff, or otherwise) as the most important aspects that affect their decisions on participation in PPP projects.

* The references given at the end suggests the material that were referred to on multiple occasions and inferences drawn.

Risks Related to Availability of Information

Before putting out the project bid for private participation, it is important for a procurement entity to prepare updated information that is relevant so as to facilitate a private operator to take informed decisions on whether to bid for the project or not, and to formulate its proposal. Insufficient or inaccurate data makes it difficult for a private operator to make a realistic assumption of capital, O&M costs, and revenues for a project. For instance, the following information would be important from a private operator's perspective to take an investment decision:

- Details of existing assets and their condition. The information expected is complete inventoried assets, particularly those that are underground, their condition, types of material, age, and repair history. Typically, ULBs try to give sample information on these as they do not have a comprehensive asset register, though developers expect a detailed condition assessment report prior to bidding. This information becomes even more critical in the case of a concession contract where a private operator assumes financing risk. The information must not only include details as to when technical studies were conducted but also the name of the consultant so as to enable a bidder to assess the quality of the output. It is expected that the contracting agency undertake surveys and investigations and make the information available to all potential bidders, as it is impractical and inefficient for each bidder to undertake its own survey, or guess the condition of the site, or qualify the bid (which renders that bid non-compliant).
- An updated database on ownership of properties within a ULB's jurisdiction, number of connections, project population, bulk water allocation for the ULB, length of the network distribution, storage reservoirs, assessment of baseline non-revenue water, status of billing, and collection, including details of arrears payable by consumers are required to be furnished. Details on utility lines passing underground, such as water supply, electricity, storm water drainage, and underground drainage (UGD) are also important for assessing the costs and time frame for shifting, and road cutting, etc. It will also help the ULB/utility agencies to grant clearances to a private developer in a timely manner.
- It must be specified whether additional land is required for the project for creating new facilities for water storage, and treatment plants, etc. If yes, the bidders need to know whether the authority has the necessary rights over the land for developing such facilities. Failure to deliver land (with the necessary access rights over it) is one of the most common authority defaults in Indian PPP projects and one of the hardest to cure, so the issue is best addressed up front.
- Grant of right of way to a private operator in a timely manner is paramount for implementing projects. If there is considerable delay in the project timetable once the agreement with a private party is signed, this could jeopardize the ultimate success of the project and expose the authority to significant claims from the operator for time and cost relief. Equally, bidders may be reluctant to commit to a project in which key parts of the project sites have not yet been acquired.
- Bidders also need to know to what extent they would have rights over buildings, machinery, plant, equipment, fixtures, materials, land, and overhead tanks, etc., and the operator can grant security rights of some of these to the lenders.
- A private operator is required to be given freedom to sub-contract a portion of the work to contractors of its choice rather than the authority controlling this.

Payments to Operator

One of the primary risks, which the private sector perceives today relates to the security of project returns, in turn linked to tariff increases and adequate connection charges. Payments to the operator would need to be ensured as most ULBs do not have adequate resources to meet this expenditure. Therefore, a suitable payment guarantee mechanism needs to be created to increase the comfort level of the developer and the lenders. For instance, structures could include escrow of water charges, devolutions from the state government, property tax, and other revenues collected by the ULB, a letter of credit based structure, and so on.

Experience shows that if the viability of a project solely depends upon future increases in water tariff, the private sector has expressed reservations to undertake such a project as tariff related decisions are prone to political and local exigencies. Mechanisms should be developed to mitigate this, depending on the business case to offset tariff risks. Even if escalations are provided for tariffs, the private sector expects structures to ensure that the same are adopted, and there is a provision for contractual protection in case there is a deviation.

It is useful to structure payments to operators in line with investment requirements, with indexation over the period of the contract, and not make it a fixed number. In international PPP projects it is common for the contractor payment to be indexed in order to account for the effects of inflation over a long concession period. If there is no indexation mechanism for operator payments, it will lead to bidders factoring inflation into their pricing, which might not ensure value for money.

If a contract envisages that a ULB provide financial support, such as minimum revenue guarantees, payout during the construction period, or other guarantees like minimum water consumption or purchase guarantees, a private operator would be interested in knowing the source of the funds to meet this expenditure. The ULB may need to provide adequate legal and administrative mechanisms to provide this additional support and give assurances to creditors that the government will comply with the guarantees given by the ULB.

Framework for Fixing and Collection of Water Rates

Increasing water charges prior to demonstration of service usually result in consumer resentment. For instance, there was strong opposition when the Tiruppur Municipality increased water rates from Rs 4 per kilolitre to Rs 6 per kilolitre for residential consumers even before the water supply started, whereas a residential consumer in Coimbatore district was paying Rs 3.50 per kilolitre. Rates for commercial establishments were also increased from Rs 6 per kilolitre to Rs 10 per kilolitre.[1]

Experience shows that usually municipal laws do not have specific provisions giving rights to the commissioner or chief municipal officer to delegate the collection responsibility to private contractors. For instance, in Madhya Pradesh the chief municipal officer or persons authorized by the Municipal Council receive payments at the rates fixed by the ULB. Once a connection is given to a consumer, it is the responsibility of the chief municipal officer to enter the name of the consumer in the ULB's register. ULB's records have the name of the owner or occupier, name of the street where the building or land is situated, description of water connection (domestic or non-domestic), rate applicable, and the amount of rate assessed thereon. It needs to be seen whether the legal framework permits delegation of these rights to a private operator.

Capital Risk

With a growth in population, extension of the municipal area over a period of time, and the addition of different categories of consumers, there will be need for lumpy investments during the contract period. There should be a mechanism for addressing this kind of investment. This may be done either by sharing the investment between the ULB and the private operator or making a provision for the private operator investing on its own and recovering this through a suitable contractual mechanism.

Revenue Risk

- Typically, the operator likes to know whether the ULB will provide a payment guarantee with a minimum amount for new work (for example, extension of the service coverage area and the resultant increase in revenue thereof) in a pre-estimated timely manner as well as any financial support for undertaking such additional work (capital investments) during the contract period.
- Usually, obligations are cast upon the operator to pay penalties for non-compliance of environmental regulations in the event of deterioration in the quality of treated wastewater. Similarly, if the project area is a sub-division of a city/town, the operator's responsibility for satisfactory disposal of wastewater is to be spelt out in clear terms. Also past liabilities, if any, relating to the operations of water and sewage have to be on the account of the ULB and not passed on to a private operator.

[1] *Frontline*, Vol. 23, No. 7, (8–21 April 2006). Available at: http://www.hinduonnet.com/fline/fl2307/stories/20060421007101000.htm last accessed on 15 June 2011.

- The operator may seek an assurance from the ULB/government that the users are prohibited from using groundwater and water from the project must be the only source of water to be supplied to the consumers.
- Though developers are willing to take risk of collection, they would need legal and administrative support to address defaults in payments. In such case, the contract could provide for recourse taken to a ULB to recover money from defaulting consumers or whether there could be a back to back agreement for payment of such dues by the ULB directly.
- Regarding illegal use and unauthorized connections, the contract needs to clearly set out the administrative support that would be provided to the operator. Incentives to the operator may be considered for detecting illegal and unauthorized use of water by the citizens.

O&M Risk

Risk of power charges increase in the future should be adequately addressed either by means of passing through or carrying out periodic energy audits so as to reduce the consumption of power.

Private Operator's Right to Disconnect Non-paying Customers and Powers to Re-connect

Unless provided in specific terms under the municipal law, it is the commissioner or chief municipal officer who has the power to cut-off the water connection of a defaulting consumer. The same is the case for re-connecting the water supply. Therefore, even under PPP arrangements, the ULB official has to specifically authorize disconnection and re-connection and only then will the private operator will be in a position to take appropriate action in this regard. Suitable covenants are required to be incorporated in the PPP contract in this regard.

Opportunity to Negotiate during Bid Process

Typically, tenders floated by ULBs for PPP arrangements do not allow bidders the option of marking up or otherwise submitting comments on the draft contract, except during pre-bid meetings. Often some suggested changes to the draft contract desiring transfer of certain risks to the authority are not accepted. Negotiations with a successful bidder prior to the execution of the PPP agreement are also not envisaged. In international PPP projects it is common for the tender process to allow for negotiations on key contract conditions. This allows the bidders to suggest alternative risk allocation, which could result in a more competitive bid price. It may also allow for practical issues in the agreement to be refined throughout the process. The complexity of a PPP project usually demands a more bilateral approach.

Performance Security

It is common practice to seek a performance security from the operator so as to ensure that in case of default or delays, certain deductions could be made towards liquidated damages. It must be ensured that the security is as objective and as clear as possible and preferably relates to material rather than trivial failures by the operator. Secondly, the value of the security should be kept as low as possible. The authority should consider its 'genuine pre-estimate of loss' if the operator breaches the terms of the contract.

Other Issues

Typically, in water PPPs, especially short-term contracts,[2] it is expected that employees of the ULB will acquaint themselves with the technological and operational improvements made by a private operator in a project during the contract period and subsequently this learning will be put to use in the post-contract period. To enable this, PPP contracts usually envisage deputation of ULB employees to a private operator. The contract conditions in this regard must be strictly adhered to by the ULB and employees deputed to a private operator in a timely manner and for the agreed period so that they are able to retain the knowledge acquired during the contract period and impart training to other ULB employees so as to achieve longer-term benefits.

Irrigation Sector PPPs

The Government of India has been contemplating PPPs in the sector for some time now. In 1995, the Ministry of Water Resources constituted a high level committee

[2] For instance, a management contract of 3–5 years.

to examine the feasibility of private sector participation in the sector. The committee recommended that a few projects may be taken up on a pilot basis. Subsequently, the National Commission for Integrated Water Resources Development Plan in 1996 felt that private players would get interested in the sector only if adequate return from users of water is recovered and concluded that private sector participation was possible in industrial water supply and in urban areas. In 2000, the Planning Commission set up a working group on 'Private Sector and Beneficiaries Participation' for formulating the Tenth Five Year Plan (2002–7). Barring a few successful international case studies, there is no base case in India that could set an example for future development of projects with private investment in the irrigation sector. In August 2001, the working group in its report suggested that pilot projects could be identified by each state during the Tenth Plan period and criteria for selection of pilot projects would have to be worked out. In 2003, a group of experts in PPPs in water resources recommended that the State Water Regulatory Authority be set up. It was provided that the authority must be a statutory body headed by a retired judge of the Supreme Court/High Court and include government organizations dealing with water resources and concerned stakeholders, including water users associations (WUAs). It was recommended that the draft contract to be entered into between the government and the private sector be approved by the authority before it is entered into. It was suggested that private participation must initially be attempted in canal/water conductor and distribution systems. Head works may not be entrusted to the private sector till some experience is gained on regulatory mechanisms for PPPs. The framework of PPPs was also spelt out which said that initially management contracts should be considered and subsequently lease and build operate transfer (BOT) options could be considered in order of priority. It was also felt that wherever possible, WUA/local body/*gram* panchayat must be involved in the decision-making process and while structuring PPP contracts.

The financial performance of the sector for the country as a whole, has been deteriorating over the years, partly because of increased operations and maintenance (O&M) expenditures and low and unrevised water rates. Planners and policymakers have long recognized the importance of increasing the recovery rate and have suggested various policy measures to improve the financial performance of the sector. A recent study on the financial aspects of the water sector conducted by the Central Water Commission concluded that though several state governments have decided to recover at least the O&M costs and a percentage of capital costs from users, yet there has been a significant gap between the revenue assessed and actually recovered.

The governments may also need to consider other ways of attracting private capital in the irrigation sector. These could be through a viability gap fund (VGF), deferred payment structure or annuity models, creation of a corpus fund (such as the Central Road Fund), and similar other structures. While government funding from budgetary allocations for the development and maintenance of irrigation infrastructure will continue, efforts could be made to recover some of its costs through user fee collected from WUAs.

Most state governments are looking at PPPs with the sole intention of acquiring financial resources. However, in the irrigation sector there are no financially free standing projects. The private sector would primarily look at commercial returns to be attracted to invest in the sector. Typically, a private investor expects an internal rate of return of 12 to 15 per cent on his investments. The financial case for an irrigation project would need to be proven. Projects are unlikely to be sustainable on user charges alone and there may be a need to evaluate grant of rights to the private sector for accessing revenues from the project. Additional sources of revenue could be from energy projects (hydel power plants, solar energy plants), fisheries (reservoirs and barrage ponds), tourism facilities (boating rights, reservoir spots), and permitting sale of unutilized surplus water for other uses. It must be kept in mind that certain activities like permitting tourism facilities in the sector is not proven and supply of surplus water for industrial purposes may be in conflict with exclusivity of domain of the state and hence to be allowed based on local conditions and on case-to-case basis.

For improving the O&M of built assets, it may be useful to outsource certain activities to the private sector under PPP arrangements. This will enable transfer of modern technologies, particularly in equipment and instrumentation, operational improvements, automated and computer based task communication, and improvement and modernization of labour and maintenance intensive equipments.

Key Issues

In India, there are virtually no successful examples of private participation in the irrigation sector.[3] Perhaps, high capital costs in creating irrigation assets, relatively longer gestation periods, and low revenues in the form of water charges, has deterred policymakers from attempting private participation in this sector in comparison to other sectors. For long, award of contracts to private contractors has been prevalent for construction and repair of irrigation works. Since the private sector market is not ready to invest as recovery is not assured, most developers are comfortable with item-rate contracts—even EPC is an innovation.

It is estimated that during the Eleventh Plan period (2007–12), the sector needs nearly Rs 2,62,508 crore for major, medium, and minor irrigation works, command area development, flood control, and watershed development. Out of this, nearly 89 per cent of the investment is estimated to be met by state governments. For 2011–12, the state's contribution comes to Rs 69,090 crore (at 2006–7 prices).[4] Inadequate provisioning by state governments due to other commitments has often affected the O&M of assets and also sub-optimal delivery of the completed projects. In the 1990s, states like Karnataka, Maharashtra, and Gujarat raised private finance through special purpose vehicles for funding irrigation projects but failed to develop commensurate assets. It was realized that the cost of servicing the debt turned out to be burden on the state's exchequer. Unless the private sector is assured returns on its investment either through budgetary devolutions or user charges, private investment in the sector may not be easily accessible.

Often private sector has voiced concerns about land acquisition, rehabilitation, and re-settlement of large number of project affected persons (PAP), that result in longer gestation period and increased costs. Added to this, serving significant population of small and marginal farmers affect their revenue model. The other constraints include requirement of massive trained manpower to manage distribution of water and collection of fee from the users. Further, in times of abundant availability of irrigation water, the private party would have no rights to use excess water for commercial purposes. Hence, private sector is hesitant to participate in PPP transactions in the irrigation sector and feel that taking up of proper development activities prior to inviting private sector participation may address these concerns.

Areas of Private Sector Participation

Based on international experience in successful implementation of projects with private participation, state governments in India also need to examine the structuring of projects to attract private investors to initially participate in the development of the sector. This could be done by allowing the private sector to bring in efficient management practices and technology improvements. Large-scale investments from the private sector could come subsequently.

The working group on private sector and beneficiaries participation for the Tenth Five Year Plan[5] suggested that private sector participation in the irrigation sector could be considered by dividing selected projects in three different categories based on investment requirements. The first category of projects ranging from Rs 50 to 200 crore, the second from Rs 200 to Rs 500 crore, and the third type of projects are those that may require more than Rs 500 crore as investment. It was recommended that in the first and second category of projects private sector participation could be taken up while the third category may be considered only on a 'pilot' basis where there are no inter-state problems and security issues. For the first and second category projects, the following distinct components for which separate schemes were to be formulated were identified for private participation:

[3] Except a few failed attempts, such as the Nira Deoghar Irrigation Project in 2007 by the Maharashtra government and the concession granted to a private company to build a dam across the Sheonath river for supply of water to industries at Borai near Durg city in Chattisgarh, which was later cancelled due to public protests.

[4] Planning Commission (2007).

[5] Note on Private Sector Participation in Irrigation Sector for consideration of the sub-group (2) of the Working Group of Planning Commission on Water Resources for the XI Plan, Ministry of Water Resources and Government of India.

- Participation in construction and O&M of main and secondary canals or conveyance system.
- Participation in construction and maintenance of the distribution system below the minor distributaries of designated capacity.
- Participation in remodeling and renovating of existing projects.
- Participation in development of tourism and pisciculture.

The other areas of private participation in the irrigation sector could include the following:

- Canal/water conductor distribution system—till sufficient experience is gained, initially head work may be kept out of the PPP ambit.
- Construction and O&M of secondary channel canals or conveyance system.
- Construction and maintenance of distribution system below the minor distributaries of designated capacities.
- Remodeling and renovation of existing irrigation assets.
- Financing of new assets and meeting of costs towards O&M of existing assets.
- Improvement of existing technologies and introduction of modern technologies experimented elsewhere around the globe.
- Provide support services, such as marketing or contracted maintenance.
- As the Command Area Development programme is in operation with governmental efforts through WUAs on the principle of Participatory Irrigation Management (PIM), the responsibility of a private investor may end at bulk supply of water to WUAs and the latter could take up further work.
- At the time of awarding the project for private sector participation, a detailed interaction between the government, private entrepreneurs, and other stakeholders should take place with a view to taking into consideration the overall development of plans for water resources and ensuring safety of structures. Based on detailed interactions, MoUs should be signed between the government and private entrepreneurs.

Conclusions

The need and advantages of increased private sector participation (more than the current level of item rate contracts) are clearly demonstrated when one looks at the success achieved in terms of improved quality of service to users in other sectors, such as national highways, power, and telecom. Experience has shown that the private sector can bring efficiencies in service delivery with better management practices and fiscal discipline. The private sector also brings in the much needed investments both for capital work and for O&M of infrastructure assets. What may be required to attract private sector participation is creating an appropriate operating framework combined with an effective regulatory mechanism.

The government feels that private participation in the water sector could achieve a multiple set of objectives, such as capital mobilization, improvement of water use efficiency, better harnessing of renewable resources, access to better technology and professionalism, and provision of an improved service creating a demand for better quality service through the market mechanism. There is a need of identifying opportunities for private sector participation so as to improve O&M of assets on a long-term basis. Towards this end, steps have to be taken to improve the current legal/regulatory framework to facilitate such private sector involvement. Institutional strengthening is another important aspect that needs to be taken care of so as to make it amenable for establishing PPPs in the sector. An action plan needs to be prepared so as to address the challenges in PPP. It would be worthwhile to promote a dialogue between the governments and the users.[6] In order to finance and sustain O&M activities, collection of water charges/users' fee is an important factor. Therefore, steps needs to be taken by state governments to put in place suitable systems including charges based on volumetric consumption. This could be made possible by ensuring active participation of users.

[6] With respect to irrigation projects, it is WUAs and farmers. International experience from successful irrigation PPPs has shown that farmer/water users' involvement in the project design and implementation phase is vital.

As has been demonstrated in several other countries, projects in India too need to be structured in such a way so that the users benefit directly from the services provided by the private sector, which means that there should be a demonstrable and distinct change in the quality of service that the users receive from a project. Wherever necessary changes may need to be carried out during the implementation stage so as to achieve the desired outcomes.

There is a need for creating an enabling framework by the stakeholders, particularly the government to evince private sector interest in the sector. A favourable policy environment that provides for a level playing field, commercial discipline, and clear accountability by the private sector needs to be created. In addition, the policy must demonstrate the intention of the government to attract modern and changing technologies in the sector. One has to bear in mind that the sector has seen noteworthy improvements in technology in the past 20 years, such as introduction of ductile iron pipes, glass reinforced plastic (GRP) pipes with larger diameter, and medium density polyethylene (MDPE) pipes for household connections. Significant technological advances have been made in the meter reading and billing mechanism (spot billing and electronic bills).

In the near term the role of governments could be to continue making capital investments for creating basic infrastructure facilities by utilizing funding available from budgetary provisions, municipal bonds, Government of India grants, and multilateral lending. Private sector expertise may be sought for efficiency improvement by means of management or service contracts. Once the developers' concerns are taken care of and an adequate payment guarantee mechanism is set out,[7] contractual arrangements under BOT concession frameworks could be considered.

In the formation of contracts, it is suggested that the government may consider separating pricing risk from performance risks. While a private operator will have to comply with performance related obligations, the PPP contract must ensure that the operator is incentivized for better performance and penalized for underperformance.

Further, while structuring contracts it may be important to consider aspects that could invite strong public reaction. For instance, by switching from flat tariff to volumetric telescopic tariff, some consumers may have to pay higher user charges (based on their consumption), recovery of outstanding dues while legalizing illegal connections, economic/industrial recession affecting demand from consumers from trade and industry, public resistance for disconnecting water connections of defaulting consumers, and so on.

For ensuring payment guarantees and adequate recovery of investments in irrigation sector projects, governments could consider developing access roads to ease transport of inputs and farm produce, ensuring accessible market facilities and adequate and uninterrupted power supply, and generally establishing good communication systems, all of which would be important. In addition, governments would continue to provide support services, such as facilitating access to information and advisory assistance to stakeholders, in engaging with partnership with NGOs and research institutions, including agriculture universities, and building awareness and providing training to farmers in cropping patterns and technology options. Linking of traders and middlemen with suppliers is another crucial aspect in which the government's involvement would continue to be prominent. Finally, the government's role continues to be relevant in the setting up of delivery chains and storage facilities for agricultural produce.

The other frameworks that may be necessary are capacity building programmes for the benefit of implementing institutions, fiscal ability to support the projects over a longer tenure, a regulatory set up to monitor performance, and ensuring that the desired benefits accrue to all the stakeholders including water users.

The government would want social and economic equality principles to be adhered to, and at the same time want projects to be financially free standing, as much as possible. The private sector would want the risk allocation to be equitable and its concerns about performance and payments be unambiguously addressed. It may be required that a project encompassing

[7] Such as 100 per cent metering is already done and private sector efficiencies are required to improve upon billing and collection practices and financial support for subsidized water supply to urban poor, etc.

the entire chain of activities—civil work being only one component—from the inputs of the agricultural chain to the outputs (processed) is put out for private sector participation. This would mean addressing the fitment into the current agricultural value chain and the need for exclusivity.

Project preparatory studies, which clearly set out the boundaries, specifications and standards, performance benchmarks, and means to measure these, financial analysis of the proposed project, and the fiscal strength of the sponsoring agency and contractual documentation, would need to be undertaken prior to proceeding on a transaction. A point to note at this juncture is the understanding that the private sector needs. Should the need arise, a capacity building exercise involving participants from the private sector may be carried out.

Strong and open communication and stakeholder consultation programmes would also need to be undertaken simultaneously which could feed into project development. These are imperative as the private sector consortia might compare agricultural input and output service providers, civil contractors, lenders, experts on hydrology, cropping patterns, and other design specialists, who would focus on a scientific and commercially sustainable structure, while the government and other advocacy groups would focus on the benefits likely to accrue to end users (and the means to achieve them).

The approach would thus be to look at all possible opportunities that exist within the water sector as a whole; the sector should no longer be treated on a stand alone basis. To meet growing food requirements of the projected population of about 1.60 billion by 2050, additional investments, especially from the private sector could be explored. A paradigm shift is required in addressing the challenges in the sector based on demand and supply. The supply side would encompass water enhancement, policy re-alignment, and governance reform, while the demand side would be characterized by water productivity elements, urban management techniques, and community collaboration.

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Part II Water Sector—A Private Equity Perspective

Prasad Gadkari and Shishir Maheshwari

Introduction

The water demand-supply gap is worsening in India and many regions in the country are already facing water scarcity (see Chapter 1). The current water development and management system is not sustainable and there is a chronic need for huge infrastructure investments in the sector. A large part of the investments in the past were by the government but major financial resource gaps remain. Though a number of areas for private investment in water infrastructure exist, the level of private investments are far and few in between. In this section, we identify various bottlenecks that have constrained private investment in water infrastructure. The view presented here is from a private equity investor's perspective, which would typically be echoed by other kinds of financial investors interested in the sector. Private Equity (PE) funds provide capital during the early stages of a sector/project with an investment horizon of about 3–7 years. As project cash flows/company operations stabilize, companies are able to attract public market investors, in turn providing an exit for the private equity investors.

A typical water cycle is presented in Figure 15.2.1. Prima facie, a number of segments can be identified which may serve as business models for private equity investment. These are: bulk water supply, water treatment plants, desalination, distribution of water and

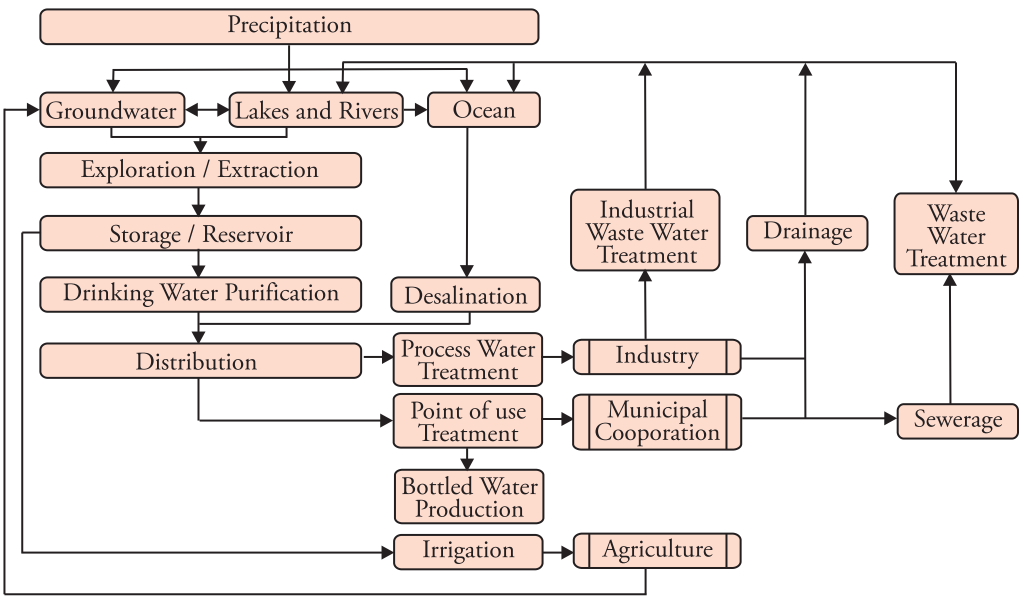

Figure 15.2.1 Schematic of Typical Water Cycle

Source: IDFC PE Research (2010).

allied activities, wastewater treatment, domestic filtration systems, and the bottled water and ancillary manufacturing business. Despite the numerous opportunities, the actual number of deals funded by private equity funds is only a handful in India.

PE in the Indian Water Sector—the Experience Till Date

PE investments in the water sector are feasible in most segments where the private sector is involved. Prominent areas which can readily witness a significant level of activity are: engineering, procurement and construction services (EPC), project SPV/holding companies (Holdcos), and equipment manufacturing.

However, in the past 5 years or so, there has been a cautious movement by PE investors towards this sector. A list of investments that have happened over this period are given in Table 15.2.1.

The overall amount is quite modest as compared to the other sectors. Additionally, it can be observed that most of the investment flow has happened towards the services segment. Another inference that can be drawn from Table 15.2.1 is that there has been limited PE investment that has directly flown into PPP projects. Compared to this, the power sector alone attracted $3.8 billion in investment in last 5 years from PE investors. Besides assets, the power sector has also seen investment across the value chain, including engineering services and value added products. This is largely a reflection of the fact that policies in the water sector have not succeeded in generating enough numbers of viable projects and fundamental investor concerns have not yet been mitigated.

On the other hand, several countries around the world have seen significant investment activity in core water projects. More often than not, the governments in these countries have encouraged corporates to provide high service levels to customers (that is, citizens) by improving efficiency of the existing systems and also investing in newer infrastructure. Along with enlisting the support of the private sector on the infrastructure side, these countries have also established appropriate regulatory mechanisms to govern the sector. Further, companies have been empowered to reduce water leakages/wastages, metering the connections, and billing and collecting tariffs from customers. Over a period of time, many companies that have been involved in this sector are regarded as large fundamental utilities that can provide a relatively stable yield to investors on a consistent basis. Overall, Europe can be considered to be at the forefront of the water management industry. A majority of the services, especially in UK and France are handled by private operators. But it is interesting to note that there are privatized (or semi-privatized) publicly listed players across the globe in countries, such as the US, Brazil, China, and Thailand (Table 15.2.2). And hence the encouraging point for India is that once we get our act right in terms of the policy framework, our water projects can attract funding not only from PE investors but also from global public market investors.

Table 15.2.1 Private Equity Deals in Indian Water Sector

PE Fund	*Amount ($ mn)*	*Company*	*Business*	*Date*
GEF	25	Saisudhir Infra	EPC	Feb 2011
Peepul capital	12	Aqua Designs India	EPC	Jul 2010
IVF	20	UEM	EPC	Jul 2010
Chryscap	22	Pratibha Industries	EPC	Oct 2010
Sage Capital	10	Concorde Enviro	EPC - Wastewater	Dec 2009
Axis PE	13	Vishwa Infrastructure	EPC + BOT	Jul 2008
Origo-Sino India	11.5	Halosource	Water Purification technology	Jul 2008
IDFC PE	8	Doshion	EPC + BOT	Nov 2007
ICICI Venture	12	VA Tech Wabag	EPC	Aug 2006

Source: VC Circle Deal Database.

Table 15.2.2 Market Capitalization of Global Water Companies

Sr	Company[1] (Country)	Market Cap (US$ mn)
1	Veolia Environment (France)	16,010
2	Northumbrian Water (UK)	2,720
3	China Water Affairs (China)	518
4	Manila Water Company (Philippines)	851
5	SABESP (Brazil)	6,420
6	California Water Services (US)	758

Source: Bloomberg (2011).

What Steps would the Investors Like to See?

From a macro perspective, the water sector presents a promising opportunity for investors. But despite the huge demand-supply gap, the sector has till date failed to attract the level of investment witnessed in other sectors. This is primarily due to the absence of certain key factors that investors evaluate prior to committing large pools of capital. The most important parameter for investment continues to be establishing a financially viable business model. Typically, a viable business model should be able to recover the initial capex as well as recurring opex from user charges. In certain sectors where a 'user pay' principle is not established clearly, the government may need to assure cash flows to the private sector against performance till the time that the sector matures. The roads sector where the government used the annuity model is a good example of this point.

Further, the water sector has a limited track record of successful private projects. And given the financial and political risks attached to project execution, it is considered to be a relatively risky investment. This is likely to lead to a Catch-22 situation where projects would face challenges in financial closure while investors will continue to look out for successful model projects from the sidelines.

The solution lies in a multi-pronged approach where on the one hand, states and urban local bodies (ULBs) need to establish a clear regulatory framework for service level requirements, tariff determination, and revenue risk mitigation, while on the other hand it should take steps to improve the cost recovery of water supply and distribution. Steps such as leakage detection, faulty pipeline replacement, metering of all connections, and regular billing and collections are vital not only from a private investor's perspective but also for restoring the financial health of ULBs.

Some of the measures that could change the overall attractiveness of the sector for PE investors are now outlined.

1. Reduction of Non-Revenue Water

Non-revenue water (NRW) is the quantum of water that is supplied but no revenue has been accounted for. The concept is explained in the schematic shown in Figure 15.2.2.

Indian ULBs are reported to have NRW as high as 50–60 per cent which combined with extremely low tariffs and poorly designed infrastructure results in huge operating losses. About 25 per cent of these losses occur in commercial water supply. Compared to this, developed countries have a typical NRW of 15 per cent of which only 3 per cent comes from commercial water supply.

Amongst the various action points that can be taken, the areas that can be tackled in the short term are:

- Metering
- Leakage detection

As observed in the utility benchmarking exercise conducted by ADB in 2007, the utilities that have a large proportion of connections metered (for example, Bengalure and Coimbatore) are able to recover their operating expenditure from the water revenue. Considering that there is a significant amount of funding involved, the government should invite established private players to invest and reduce NRW. The government should establish target service level standards against which it could pay an annual operating fee to a private player.

Such projects will improve the generation of water revenue thereby improving the profitability of the utility, generate data for designing financially viable projects, and provide private players a hands-on experience of

[1] The primary objective of this list is to illustrate the presence of listed water management companies. Some of them would have other businesses apart from water management.

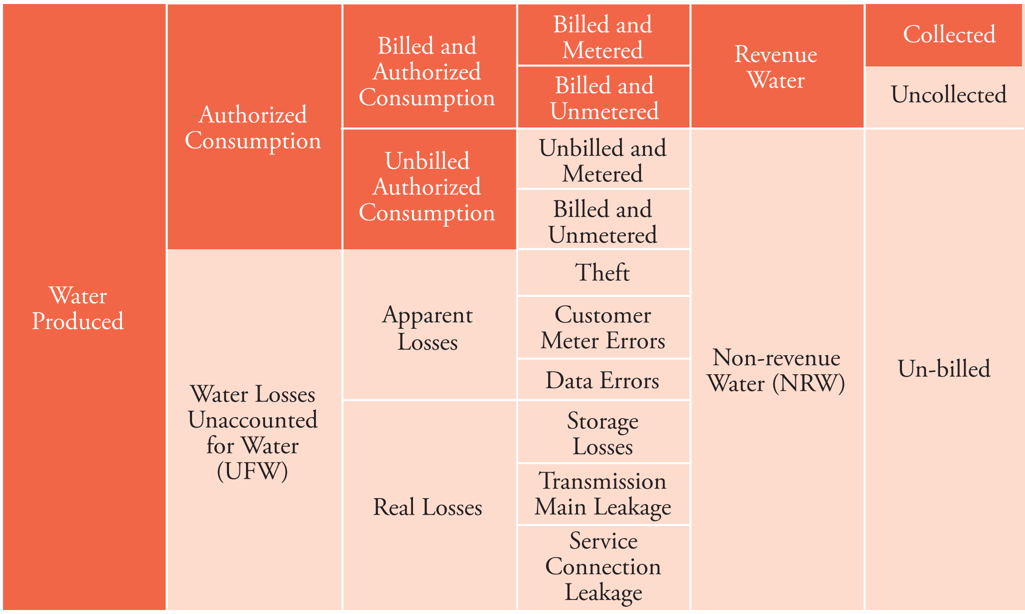

Figure 15.2.2 Schematic of Urban Water Supply

Source: IDFC PE Research.

managing water projects thereby making the sector attractive for larger private investments in the future.

2. Regulations Governing Tariff Determination

Given the multiplicity of institutions involved and the high political sensitivity of the sector, the tariff principles also vary (TERI 2010) across cities ranging from a volumetric based method (for example, Hyderabad, Chennai, and Delhi) where the metering infrastructure is available, to non-volumetric flat rates (for example, Raipur), or flat taxes (for example, Ahmadabad where 30 per cent of the property tax is being taken as water charges). However, there is no central regulatory body (for example, like OFWAT in UK) that determines the pricing and service quality for water supply. Since at times political pressure also plays a part in tariff determination there is little or no focus on cost recovery (both capex and opex) rendering a question mark on the financial viability of a project. To ensure private capital flows into the sector, the government needs to establish a transparent and financially viable tariff setting mechanism. To the extent that the government feels the need (say, for protecting the economically backward sections of society) for having lower tariffs, it needs to provide an explicit subsidy in order to support the financial viability of a project.

3. Bankability of Revenue

Water projects are capital intensive in nature and would require debt support from banks and other financial institutions. These institutions require security of cash flows to provide debt support for such projects. Given that most ULBs are in a poor financial health and largely dependent on support from the centre and the states to meet their operating expenditures, bankability of such projects would be suspect. ULBs and state governments need to establish payment mechanisms, such as escrow accounts and /or sovereign guarantees in favour of private operators to improve the bankability of the projects. Agencies can look at the power sector as an example where in the initial stages of private sector participation, power purchase agreements (PPAs) provided a 3-tier security mechanism (comprising bank LC and state government and central government guarantees) for project financiers to mitigate the risk posed by financially weak SEBs.

4. Model Contracts

Setting up of standardized procedures for contracting, procurement, and award of projects, with identified roles and responsibilities of both public and private agencies, facilitates the smooth award, financing, and execution of projects. Defining these aspects upfront in a transparent manner would also help in handling politically sensitive decision-making in the sector. Similar steps in other infrastructure sectors, such as power, roads, and ports have proved to be reasonably successful.

5. JNNURM—Phase II

The Jawaharlal Nehru National Urban Renewal Mission (JNNURM) programme has been one of the most important steps taken by the government for facilitating development of the entire urban sector. The reform linked funding of projects has spurred the states to at least initiate some measures of reforms (for example, levy of property tax). Whilst the programme can be hailed as a step in the right direction, the overall results of JNNURM appear to be mixed. To make the sector attractive and investible, the central government may consider coming up with the next phase of JNNURM and including some of the suggestions made earlier as part of the states'/ULBs' reform process. It may also consider stipulating[2] to the states that certain category of projects need to be necessarily implemented on a PPP basis.

Conclusion

Given the lack of basic infrastructure and the huge capital investment required to achieve minimum service levels, the water sector presents a potentially large opportunity for PE investors. Although India has witnessed few water projects on a PPP basis, even then the lack of demonstrated success stories, poor financial health of ULBs, and high degree of regulatory/political uncertainty has kept large PE investments away from the sector till date.

It is ironic that while the central government, through JNNURM, is attempting to channel funding for the urban water space, the private sector is largely waiting on the sidelines despite the huge demand-supply gap. The need of the hour is for the government to step up and initiate some of the key reform process outlined in this chapter. In domestic water supply, the government can invite private players to improve and renovate existing infrastructure measures, such as reducing leakages, , customer metering, and maintenance of other distribution infrastructure. The government can also invite private players in bulk water supply projects where it can initially tackle the customer end of a project, while the private players can focus on investing and implementing capital intensive projects expeditiously. Such initiatives are relatively less risky and can improve the financial health of ULBs, while also ushering in the private sector's expertise into the sector. The success of such projects will lay the path for bigger and more complicated projects in the future.

India has most of the ingredients in place for the water sector to see a take-off in activity. We have witnessed a strong political intent (across parties) with respect to overall reforms in infrastructure. Our entrepreneurs have shown the ability to develop world class infrastructure, competing against even the largest MNCs. We have a strong banking system thus providing ready project finance (which is absolutely critical) for long gestation projects. Alongside steady term funding, we have sufficient risk capital in the form of PE, which is ready to flow into the sector even at an early stage. The last few years have also shown the acceptance of capital markets towards core infrastructure stocks, thereby providing another deep source of funding. Indeed, the time is now ripe for the government to take note of and apply the learnings from other infrastructure sectors for the benefit of the water sector. If the water sector witnesses the measures articulated in this chapter, capital would surely not be a constraining factor for its growth.

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[2] In the roads sector, NHAI had taken a policy decision a few years ago to develop projects primarily on a BOT basis rather than as cash contracts.

16 Transforming Water Utilities

Policy Imperatives for India

Piyush Tiwari and Ranesh Nair

Introduction

The state of most urban water and sanitation utilities in India is catastrophic. No Indian city claims to provide adequate water to all its customers. Though some cities have recently piloted 24×7 piped water supply in some parts they are yet to reach the necessary scale and most cities still supply water only for few hours in a day (Table 16.1). Though the 74th Constitutional amendment assigned the obligation to provide water and sanitation services to local bodies, the necessary enabling framework is still in the process of being set up. Local bodies are not financially self-sufficient and depend on transfers from state and other grants from the centre to meet their capital investment and operations and management (O&M) expenditure requirements. The capacity to plan, manage, execute, and operate water and sanitation projects at the local government level is weak. Consequently, except for few local bodies, special purpose parastatals (state government entities), and public health and engineering departments of the state are involved in providing water and sanitation services in most states. Tariffs are low and insufficient to cover O&M costs in most cities. Though water utilities (the term is used for any entity that supplies water in cities comprising municipalities, state parastatals, and state Public Health and Engineering Department [PHED]) distributing water have the power to rationalize tariff structures, they often do not do so due to political pressure. All other parameters of sound financing management (like reduced non-revenue water (NRW), metering, efficient billing, and collection systems) perform poorly for most utilities.

The last few years though, have seen some momentum in the delivery of water supply in Indian cities. A central government led grant programme for cities, the Jawaharlal Nehru National Urban Renewal Mission (JNNURM), has motivated many cities to take up projects in the water sector. As of December 2010, nearly 60 per cent of the spending by JNNURM was in the water supply and sewerage sectors (HPEC 2011). The projects undertaken under JNNURM include source augmentation, upgradation of water distribution systems, and setting up and upgradation of wastewater treatment plants. Efforts are also being made towards developing continuous water supply system projects in line with the service level standards prescribed by the Ministry of Urban Development. This is particularly significant given the historic resistance among water utilities to consider continuous water supply projects in the country as a necessary component of service delivery.

The current state of water utilities in India is not any different from many water utilities in the developing world. There are, however, examples of many utilities from the developing world that have transformed

Table 16.1 Daily Hours of Water Supply

City	*Lpcd*	*Hours of Water Supply*
Goa	341	8
Mumbai	240	5
Delhi	220	4
Agra	220	4
Hubli-Dharwad	124	3
Ajmer-Pushkar	140	1–1.5
Vijayawada	157	4
Hyderabad	162	2
Surat	195	2–3
Nagpur	200	4
France	156	24
UK	135	24
Kuala Lumpur	132	24
Colombo	110	24
Dakar, Senegal	90	24
Jakarta	80	24

Source: Chary (2011).

themselves into better serving water utilities. This chapter reviews key reforms instituted by the utilities and the lessons that emerge from their experiences. These utilities are located in cities in diverse regions like Africa, Asia, and Latin America and have successfully been able to transform themselves into service oriented utilities. The chapter also reviews recent successful cases from Indian cities and the reforms that they have undertaken to achieve better performance.

The rest of the chapter is structured as follows. The next section presents an analytic framework that provides a necessary tool to understand the reform process. The next two sections discuss key components of the reforms undertaken by water utilities in international cities and India respectively. The last section provides a conclusion and summarizes the key lessons that emerge for India.

An Analytic Framework

An analytic framework that was undertaken to understand the key aspects of transformation that cities, which have been able to improve their water and sanitation services satisfactorily is given in Figure 16.1. Overall, these measures are dubbed as water governance

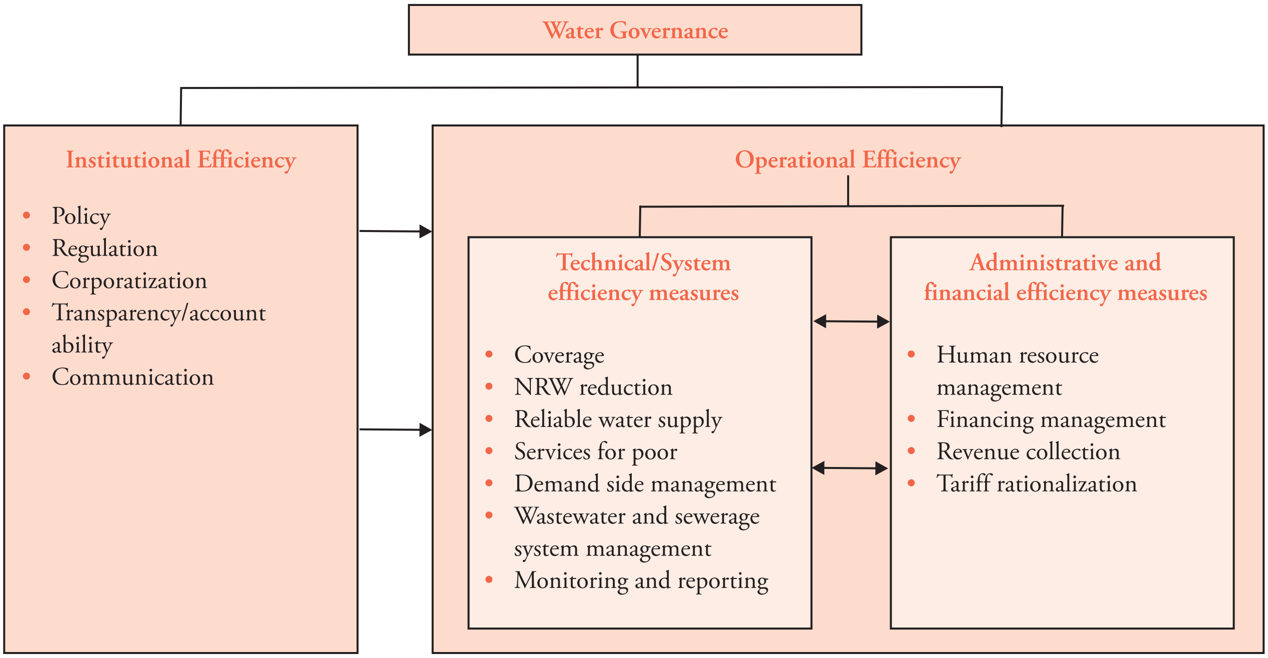

Figure 16.1 Requirements for Efficient Governance of Water

Source: Authors' own.

and have two interlinked components: measures that improve institutional efficiency and those that improve operational efficiency. It may, however, be pointed out that to achieve operational efficiency, it is necessary that the institutional structure is effective and efficient.

The fundamental requirements for the institutional efficiency of the water sector are an integrated water resource management policy, regulation that separates water utilities from government interventions and makes them accountable to the public, a well-functioning corporate approach in the delivery of services (this does not mean privatization), mechanisms for transparency and accountability in service delivery, and constant communication with the public (that is, participatory in nature) on various aspects of water resource management and service delivery.

Operational efficiency requires that utilities take an integrated, holistic service delivery approach, achieving which requires that utilities undertake technical/system efficiency measures and administrative and financial efficiency measures. Technical/system efficiency measures include increasing the coverage of supply including to the poor, reducing non-revenue water and improving supply reliability, and incentivizing demand side management and also undertaking wastewater and sewerage system management. Where efficiency benefits can be realized, public-private partnerships could be considered. Technical efficiency measures would need to be complemented by administrative and financial efficiency measures. These include a human resource management system that attracts, nurtures, retains, and incentivizes talent. Financial management is necessary to ensure that the utility is self-reliant and this is achieved through an improvement in revenue and an effective management of cash flows.

Transformation of International Water Utilities in Developing Countries

This section presents a brief discussion on the lessons that have emerged from the experiences of utilities which have achieved significant transformation in delivering improved urban water services. In doing so, we rely on a set of water utilities from developing countries in three continents: Africa, Asia, and Latin America. Seven Asian cities out of eight studied by ADB (2010), three African cities, and one Latin American city out of eight cities studied by USAID (2005) are included in this chapter. This chapter relies heavily on the material compiled by ADB (2010) and USAID (2005).

The measure of transformation is the service outcome in delivery or financial sustainability that the utilities have achieved. Table 16.2 presents key indicators of services for water utilities in the studied cities.

Performance is a function of a well-operating water governance system. In this context, this chapter explores various reforms undertaken by these utilities to achieve the results depicted in Table 16.2. The unit of assessment for reforms is at the level of the components of water sector governance as identified in Figure 16.2.

Institutional Efficiency

Leadership

One of the requirements for a successful water supply and sanitation system is leadership committed to the cause of an efficient water service system at the water utility and the community level and in the government, as demonstrated by Bangkok, Phnom Penh, and Singapore (ADB 2010). A strong leader in the government is required to institute enabling policies and strategic objectives, and allocating necessary financial resources and providing incentives for increased investment through clear regulatory and institutional frameworks (ADB 2010). Regulation is necessary to give autonomy to utilities and protect them from 'capture' by the government. In Phnom Penh, the Phnom Penh Water Supply Authority (PPWSA) was led by a very competent leader, Ek Sonn Chan and during its transformation, the authority was protected from political interference in the delivery of services and collection of water charges by Prime Minister Hun Sen. In Singapore too, water and sanitation measures were coordinated at the level of the Prime Minister, Lee Kuan Yew's office. This was coupled with heavy investments in the sector. The policy for the sector dominated every other policy (ibid). The Metropolitan Waterworks Authority (MWA) in Bangkok was transformed from a typical government entity to a business oriented utility committed to public service by the then head of MWA, Dr Arthit Urairat. He introduced necessary changes and obtained support from the government for projects, activities, and management measures, such as an upward revision in water tariffs. The Mayor of Cartagena, Columbia transformed the public water

Table 16.2 Select Indicators, 2008

Cities	*Piped coverage (% of population)*	*Average availability (hours)*	*Metered connection (% of total connections)*	*Non-revenue water (% of supply)*	*Staff (per 1,000 connections)*	*Operating ratio (Opex/ Op rev)*	*Wastewater sewerage coverage (% of population)*
Asia							
Bangkok, Thailand	99	24	100	30	2	0.7	54
Colombo, Sri Lanka	92	24	100	36	4	0.6	14
Kuala Lumpur, Malaysia	100	24	95	33	2	0.9	90
Phnom Penh, Cambodia	91	24	100	6	3	0.4	63
Shenzhen, China	100	24	NA	14		1.0	
Singapore	100	24	100	4*	3	0.9	100
Manila Water, Manila, Philippines	93	24	NA	20	2	0.5	44
Maynilad, Manila, Philippines	72	18	NA	64	2	0.6	42
Africa							
Alexandria, Egypt	92	24	97	30*	4	0.7	63
Kampala, Uganda	63	NA	97	38*	10	0.95	8
Borough of Dolphin Coast, South Africa	100**	24	NA	12*	9	0.91	NA
Latin America							
Cartagena, Columbia	91	24	99	41*	4	NA	72

Source: ADB (2010); USAID (2005).
Notes: * Unaccounted for water (UFW). UFW comprises of water losses due to pipe leakages, faulty metering, and illegal connections. NRW includes UFW plus other unbilled water consumption.
** includes public stand posts.

utility, Empreses Publicas Distritales (EPD) into a public-private enterprise, ACUACAR (Aguas de Cartagena) (USAID 2005). He had local and national political support.

Water policy

While it has been recognized that an integrated water management policy is necessary for sustainable development and allocation and monitoring of water resource use in the context of social, economic, and environmental objectives, it has proved difficult to develop such a policy in most cities in developing countries due to multiplicity of institutions involved in the water sector. Singapore and Shenzhen (China) overcame this problem by putting various water related functions under one authority. The Public Utilities Board (PUB), Singapore manages water supply, water catchment, and sewerage in an integrated manner in close collaboration with the Urban Development Authority and the National Parks Board (ADB 2010). Shenzhen combined all water related functions, including planning of water supply, wastewater treatment, and reclaimed water under the administration of one agency, the Shenzhen Water Resource Bureau (SZWRB) (ibid).

Regulation

Well-defined regulation is necessary for facilitating private sector participation in the water sector. Regulatory reform in Shenzhen has allowed SZWRB to regulate the industry without interfering with the normal operations of the water business (ADB 2010). In the case of ACUACAR, legal provisions allowed a creditor to directly access its revenue stream without its approval via a 'revenue intercept' mechanism, which made the utility bankable. Legal provisions were also made that required the utility to set tariffs to recover the full economic cost of service provisioning (USAID 2005). In Alexandria, an improved and simplified regulatory environment was created to convert the government water utility, Alexandria Water General Authority, into a public sector 'corporatized' utility, the Alexandria Water Company (AWCO). The regulatory oversight for AWCO is provided by the public sector holding company, governed by a board and the Egyptian Water and Wastewater Regulatory Authority (ibid). This autonomy from the government has allowed AWCO to plan and manage its investment activities and also in making staffing decisions.

Corporatization

Corporatization, which requires autonomy for a water utility (whether public or private) from political interference and operational arrangements like a business entity (comprising transparent management, reward for employees to perform, and internal control systems in the form of audits), is a necessary element that transformed water utilities embraced to deliver better public services. MWA, Bangkok is operated and managed like a business entity which focuses on work efficiency and pays bonuses to employees for better performance (ADB 2010). MWA has instituted internal control systems that help employees, units, and offices to perform in accordance with regulations, operational evaluations, and financial and accounting audits (ibid). The corporatization strategy of AWCO, Alexandria included developing systems for communication and coordination between AWCO and other stakeholders. These systems are executed efficiently and this has had a positive impact on the activities of the utility. AWCO carefully carried out the process of change management to instill a business culture in service delivery among its employees. The focus has clearly been on customer service and high levels of performance (USAID 2005).

The corporatization of the National Water and Sanitation Corporation (NWSC), Uganda required adjustments in the governance framework. The corporation's board of directors is now appointed in a manner that achieves an appropriate mix of relevant technical and commercial skills. The board is more independent and the roles of the board and of the management are well defined. There is also a transparent process for monitoring and reporting by the management to the board and by the board to the Government of Uganda (USAID 2005).

Public-Private Partnership

Despite the successful performance of public water utilities, such as PUB, PPWSA, and MWA, public water utilities face challenges, such as inadequate manpower, inadequate financial resources, costs overrun, huge infrastructure investment costs, and absence of accountability in revenue collection (ADB 2010). Proponents of PPP argue that these challenges could be addressed through the involvement of the private sector as it brings with it the business acumen which could be applied to efficient service delivery, better resource management, and cost efficiency. However, the experience with regard to PPPs in the water sector has not been encouraging as a number of private sector participation initiatives have either failed or were renegotiated (Harris 2003). The failures stem from a weak legal, institutional, and regulatory framework (see Chapter 15 for more discussion on key requirements in structuring PPPs). In recent PPPs better understanding of responsibilities and risks by both parties has helped deliver better outcomes. Shenzhen, for example, has set up a well-defined regulatory relationship between regulatory departments and private enterprises which has separated government interventions from business operations and asset management (ADB 2010). This has allowed transformation of a public entity to a public-private enterprise. The Shenzhen Water Group (SZWG), which was purely public has transformed into a PPP. Another realization that has happened is that the entire financial risk cannot be transferred to the private sector and hence a number of PPPs have emerged where capital cost has been borne by the public sector while the operations and management are carried out by the private sector.

The Maynilad Water Services concession in Manila failed because the project was financed using foreign funds. During the financial crisis of 1997, the peso depreciated substantially against US dollar, which hampered the ability of the utility to pay its debt and pursue capital expenditure. In 2002, the private company withdrew from the concession. Failure to identify the currency risk led to the absence of an appropriate risk mitigation mechanism. The failure also shows that inflexibility on the part of the government to accommodate regulated adjustments for political reasons had a detrimental effect on the private sector.

The importance of flexibility in a PPP contract is also demonstrated in the case of the Borough of Dolphin Coast, South Africa. Siza Water Company (SWC), which was awarded a concession for 30 years faced problems in the initial years due to inaccurate data, based on which the PPP was conceptualized, loans that had been raised from abroad and repayment of which became expensive due to currency fluctuations post 9/11, policy changes at the national level that required the utility to provide a certain minimum quantity of water at no cost to the poor, and an inaccurate assessment of revenue which posed problems for the payment of management fee to the French partner company and lease premium payment to Borough of Dolphin Coast. The concessional agreement allowed for essential revisions to be made in response to the changed circumstances (USAID 2005). This made it possible to increase tariffs, renegotiate management fee and lease premium payments, and downsize the investment needs in accordance with more realistic demand projections than what was assumed originally. The contract permitted rapid decision-making. Renegotiation led to the success of the project (ibid).

Transparency and Accountability

Transparency and accountability are key requirements for transforming utilities. Corporatization of many of the utilities studied in this chapter was aimed at improving transparency and accountability. In its attempt to improve governance, the board of NWSC, Uganda developed transparent processes for monitoring and reporting by the management. A number of performance targets (such as response time for complaints and the time required for new connections) were introduced for the staff in order to create a customer oriented culture and enhance accountability.

Collection of data is important to ensure transparency, accountability, and efficiency of utilities. In Bangkok, MWA conducts real time monitoring of water quality at every stage of the water supply system. The collected data is publicly available on its website.

Communication

Communication is important for the success of any change and these utilities demonstrate that they pursue a detailed internal and external communication strategy. SWC, South Africa liaises with the consumer community in many forms: newsletters, flyers, and face-to-face discussion (USAID 2005). SWC responds to customer complaints quicker than required by the concession agreement. The agreement requires SWC to submit a monthly customer service report detailing customer issues, new and closed accounts, disconnections, and number and type of complaints (ibid). ACUACAR, Columbia used consumer surveys, community committees, as well as citizen watchdog groups to enhance governance (USAID 2005). MWA, Bangkok conducts regular customer surveys on satisfaction. The results are used to improve service levels.

Operational Efficiency

A precondition for operational efficiency is institutional efficiency. Once a policy, regulatory, and institutional framework has been put together that allows utilities to operate in an environment that (i) is free from political intervention (ii) has direct accountability to the public and (iii) has policies that look at the water sector end to end, operational efficiency can be achieved. Successful utilities have demonstrated precisely this. For technical and system improvement, it is necessary that the utilities are financially well-managed and have sufficient funds to implement their capital investment programmes and to maintain their assets. Also, the quality of human resource plays an important role in service delivery. The capacity of employees to innovate, be accountable, and remain motivated depends on the human resource management strategies that are put in place.

Technical and System Efficiency Measures

While sound financial management and enhanced staff productivity are necessary for improving service delivery, a growth strategy to increase coverage and improve operations is critical for long-term sustainability.

The utilities covered in Table 16.2 have not only been able to increase their coverage substantially but have also been able to supply pressurized, continuous water supply, thereby demonstrating that 24×7 water supply is possible even in densely populated cities in developing countries (ADB 2010).

One of the important components of sound financial management is undertaking measures that reduce non-revenue water (NRW). Successful utilities have been able to reduce NRW through various technical and community measures. The first step towards reducing NRW is installing an accurate water metering system at the household level. Phnom Penh increased its metered connection coverage from 12.6 per cent in 1993 to 100 per cent in 2001. To ensure that leaks in the transmission of water did not happen, PUB Singapore ensures that all material and fittings used are of good quality. PUB has implemented a replacement programme to upgrade and renew the existing network (ADB 2010). It also has a comprehensive programme for leak detection and its cure. The Manila Water Company has developed a decentralized system based on a district metering area (part of the water distribution system that is separated from neighbourhood areas by means of closed sluice valves) for detecting problems like water leakages, pipe bursts, and faulty metering. The company has partnered with community organizations, which provide it information on leakages and other water problems in their areas. Phnom Penh introduced a system based on peer monitoring to detect illegal connections. If a meter reader did not find an illegal connection but her colleague did, the meter reader was penalized while the colleague was rewarded. Similarly, customers with illegal connections were severely penalized while those giving information about illegal connections were rewarded (ibid). Detecting, repairing, or replacing old leaking pipes could be a slow and costly affair. Colombo which has an old distribution network started by adopting measures like replacing public stand posts by households connections, replacing old pipes with new larger sized pipes to meet future demand, and ensuring hydraulic isolation of networks for forming district metering areas (ibid).

Given that the demand for water is increasing in most cities and supply side solutions are increasingly becoming expensive with cheaper resources already being exploited, a diversified solution to augment supply will be required. Singapore has diversified its water supply to include local catchments which harvest rainwater, imported water from Malaysia, recycled water, and desalinated water. Though recycled water has immense potential to contribute to the supply, negative public perception towards recycled water has been a major hurdle in its acceptability. In Singapore, the lower cost of recycled water (called NEWater) and its purity has slowly found acceptability among customers. This has happened over time due to a focused awareness campaign run by PUB.

Supplying water to low income households is a social obligation. Meeting this obligation comes at a cost to the utilities but not meeting this obligation also has a cost, which gets reflected in higher pilferage. Water utilities have adopted a number of measures to help the poor. PPWSA offers a 30–100 per cent subsidy to poor households on connection fee, depending on their need levels. The tariff structure also subsidizes the lowest slab of consumption. The Manila Water Company offers output-based aid subsidies for water connections and interest free amortization to pay for installation costs over an extended period of time (ADB 2010). Singapore does not lower the water price artificially, but the government provides direct and targeted financial assistance in the form of Utilities Save (U-Save) rebates to those living in public housing, which can be used to pay water bills (ibid).

Though utilities have resorted to supply side solutions to meet water demand to a large extent, there are some examples where the utilities have instituted measures for demand side management as well. PUB's water tariff structure, which takes into account the scarcity value of water and also includes a conservation tax, is designed to incentivize customers to undertake demand side management. Besides, PUB has also mandated technical measures, such as a limit on the maximum allowable flow rates for water fitting for domestic and non-domestic consumers. These measures have had some positive results. The per capita consumption in Singapore declined from 175 lpcd in 1994 to 156 lpcd in 2008.

The practice of disposal of untreated wastewater in rivers and seas in many cities in the developing world poses a problem for the availability and quality of the water resource. In Singapore, wastewater management is an integral part of the water policy. All used water is collected and secondary treated. The secondary treated water is then piped to NEWater plants for production of high quality treated water. Treated effluent that is not used for NEWater is discharged in the sea (ADB 2010). In Kuala Lumpur, a public company, Indah

Water Konsortium (IWK) has an elaborate network for treating wastewater (ibid).

Administrative and Financial Efficiency Measures

FINANCIAL MANAGEMENT

Financial efficiency requires that a utility is able to generate adequate revenue to cover its O&M costs and, if possible, surplus for capital servicing. Measures to ensure financial management are reducing unaccounted-for-water; setting an appropriate tariff structure, of course with equity considerations and; a billing and collection mechanism which covers all who are supplied water by the utility with incentive for on-time payments and penalty for late payments. Though these are straightforward principles for any business entity, most utilities in the developing world face problems in implementing them. The seven 'successful' utilities studied by ADB (2010) maintained their operating ratio (operating expenses/operating revenue) between 0.4 to 1, implying that they were able to cover at least their O&M expenses through the revenues that they collected. Some of them are even generating surpluses for capital expenditure.

An important lesson from Maynilad Water Services', Manila and Kuala Lumpur experience is that private sector involvement helped in improving the operating ratio. With private sector financing, the water systems have to be structured in way that makes them bankable all the time (ADB 2010). This pushes utilities to undertake measures, such as reduction in non-revenue water, improved collection efficiency, metering, and revisions in the tariff structure.

Measures to improve operating revenue are not limited to utilities that involve the private sector but to all utilities, irrespective of whether they are public or PPP. PUB Singapore, for example, charges for water to cover the entire cost of production and supply of water. In addition, the water charge includes a scarcity premium to reflect the higher incremental cost of supplying additional water and a conservation tax to promote water conservation. However, at the same time, to make water affordable to the poor they are provided with a direct subsidy separately (ADB 2010).

It may, however, be emphasized here that more than aiming at achieving full cost recovery for water supplies to begin with, a better option particularly when the willingness to pay and affordability levels are low, is considering a mix of options to ensure financial sustainability of water supply services. The option matrix could include grants, user charges, cross-subsidies, and taxes. Phnom Penh presents an interesting case in tariff rationalization. PPWSA revised tariffs gradually over a period of seven years. However, this was done by first improving services and then proposing an upward revision in tariffs. Once the customers saw improved delivery of services their willingness to pay increased. The increase in tariffs ended up being socially and politically acceptable.

Approaches towards financial management could generate different outcomes. Manila is a case in point where two private companies involved in supplying water (through two separate PPP concessions) witnessed different fortunes due to the approaches that they adopted for financial management (ADB 2010). The Manila Water Company performed better than Maynilad Water Services, which had to withdraw from the concession. The Manila Water Company charged its consumers the cost of connections by amortizing them over a long period of time while Maynilad Water Services continued to subsidize the cost. The result was opportunity loss for Maynilad for additional revenue that could have helped in improving its financial position. Manila Water Company's approach towards debt management was also better as it borrowed smaller amounts linked to sub-projects, unlike Maynilad which borrowed to finance the entire system. Moreover, the Manila Water Company borrowed in the local market while Maynilad raised debt abroad, the payment of which became a huge problem after the peso depreciated against the US dollar following the Asian financial crisis of 1997.

Financial management requires that utilities enhance their revenue collection efficiency. Successful utilities have been able to manage a collection efficiency of 95 per cent or more (Table 16.2). MWA, Bangkok has adopted two strategies to improve its collection efficiency. One, it imposes strict penalties for late payments and second, it offers many different and convenient options for customers to pay water bills. PPWSA has innovated in a number of ways to improve collection efficiency (which is about 100 per cent). Empowered by appropriate regulations, it disconnects water connections for non-paying customers and asks them to come and discuss their problems. Usually a solution is found but the reactivation is an expensive exercise for customers as they have to pay a late fee plus reconnection charges, which are high (ADB 2010).

The challenge before NWSC, Kampala in its financial management was its inability to generate adequate revenues. Improving revenues required a multi-faceted strategy comprising regularization of illegal connections, calibration or replacement of defective water meters, installation of meters where none existed, computerization of the billing system, rehabilitation of the distribution network, and more effective monitoring and motivation of field staff (USAID 2005). ACUACAR, Columbia's cost management strategy also involved removing non-essential staff and an increase in tariff. When ACUACAR took over the operations from EPD, it made all the staff redundant, and they were invited to reapply for their former jobs. Despite huge protests, out of a staff strength of 1800 only 270 were rehired (ibid).

Human Resource Management

The successful utilities have been able to improve the productivity of their staff enormously. For example, the number of staff members per 1,000 connections in Phnom Penh in 1999 was about 8, which came down to 3.3 in 2008. The improvement in productivity in Phnom Penh was the result of a concerted effort by the top management. These efforts included dismissal of corrupt and abusive staff members, recruiting new staff members, continuous investment in capacity building, and substantial improvements in the compensation (salaries increased by more than 10 times during 1994–2004). Good salaries have allowed PPWSA to retain talented and committed staff members. Staff salaries at PUB, Singapore are benchmarked to salaries for civil servants, which in turn are benchmarked to the salaries in the private sector. PUB has moved from a fixed salary structure to a performance-linked salary structure. The utility also has an excellent programme for capacity building. Consequently, it has been able to incentivize and retain talented staff members. The Manila Water Company reduced the number of staff members per 1,000 connections from 4.5 to 2.3 over 1999–2008. The utility instituted a competitive salary structure and provided opportunities for its staff members to attend local and international training programmes to hone their skills (ADB 2010).

NWSC, Uganda had an uphill task of improving staff productivity as staff members per 1,000 connections in 2000 was about 24. The utility instituted a system of interim targets which were set in light of current performance and a realistic assessment of what could be achieved within the timeframe (USAID 2005). A clear specification and monitoring of these targets, which is linked to monthly incentive payments, has motivated management and staff to achieve these targets. NWSC also created a system of internal competition among managers for postings in 14 service areas outside Kampala. The internal competition system requires staff members to bid a fee that will cover all operating costs except support services provided by the central office; the lowest bidding manager wins the posting. The lowest bidding manager in turn forms an informal partnership with the area management team and the partnership assumes responsibility for implementing the contract (ibid). Moreover, managers are given a high level of autonomy in staffing and allocating other resources. Productivity has improved and as of 2004 the number of staff members per 1,000 connections had come down to 10.

Transformation of Indian Water Utilities

This section presents select Indian experiences with water reforms. The purpose of these reforms was to enhance the service level of utilities. The most common instrument that was tried during the mid-1990s and early 2000s to transform water and sanitation services was to 'involve the private sector' with the hope that its involvement would solve the: (i) the capital deficit that the utilities faced, and (ii) improve service levels. In the absence of a necessary water governance framework, these experiments failed (Table 16.3). The problems that these projects faced stem from various components of institutional efficiency measures (see Figure 16.1). Moreover, the demand for PPP did not necessarily come from the utilities, instead state governments were keener to experiment but without putting in place the necessarily institutional frameworks. Hence, these projects were bound to fail.

The second half of the 2000s saw a number of initiatives being undertaken on part the of the utilities to improve their water services (Figure 16.2). This new momentum was a result of the changes in the overall institutional environment in the country. JNNURM

Table 16.3 Experience with PPPs in the Water Sector in India up to the Mid-2000s

City	*Project Components*	*Key Factors for Failure*
Mid-1990s		
Pune	Bulk water treatment & distribution	High political opposition to the project
Hyderabad	Bulk water	Bulk water tariff unaffordable Credit worthiness of utility was suspect
Goa	Bulk water	High bulk water tariff Need for the project was questioned
Bengaluru	Bulk water	Bulk water tariff unaffordable Project generated controversy
Up to the mid-2000s		
Sonia Vihar, Delhi	Treatment—design, construction, and O&M	Operator bears only technical risk Risk of bulk water availability rests with the utility (Delhi Jal Board)
Sangli	Bulk water, treatment, and distribution	Municipal council decided against the project
Bengaluru	Rehabilitation, distribution—O&M, collection	Project abandoned after two international firms submitted their proposals

Source: Authors' own.

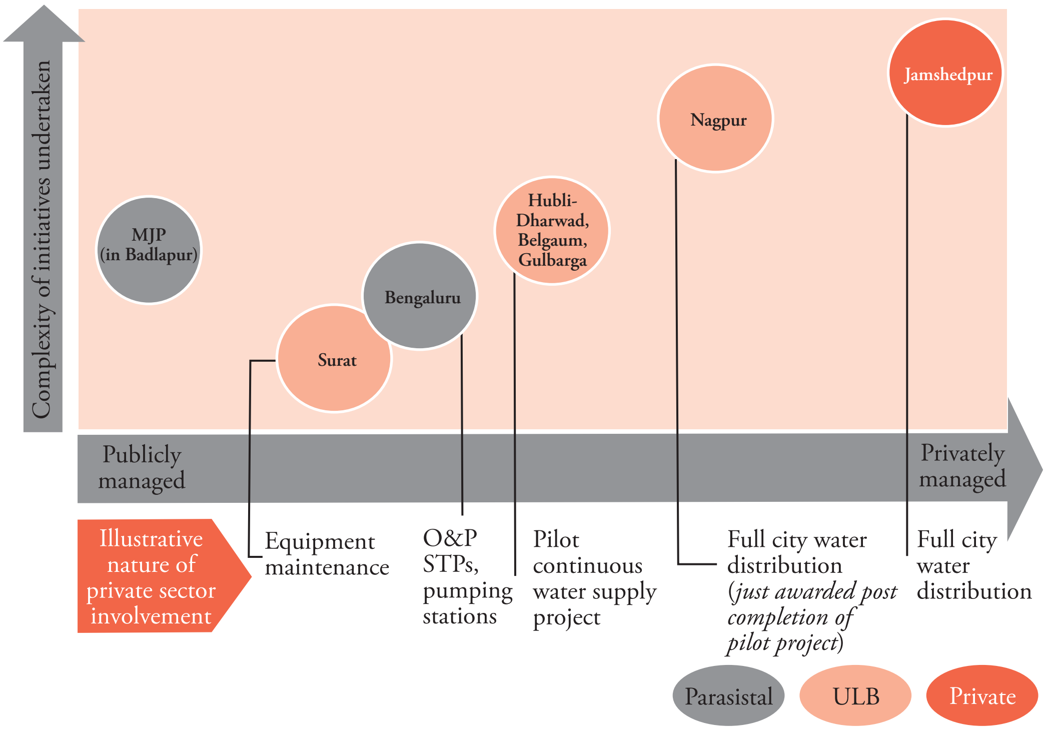

Figure 16.2 Successful Water Projects since the Mid-2000

Source: Authors' own.

Table 16.4 Water Service Performance Indicators for Select Cities

	Ahmedabad	Amritsar	Bengaluru	Bhopal	Chandigarh	Chennai	Coimbatore	Indore	Jabalpur	Jamshedpur
Water Coverage (%)	74.5	75.7	92.9	83.4	100	89.3	76.1	77.3	75.2	74.4
Water Availability (hours)	2	11	4.5	1.5	12	5	3	0.75	4	6
Consumption/ Capita (l//c/d)	171	86	74	72	147	87	109	87	139	203
Production/ Population (m3/d/c)	0.168	0.213	0.185	0.182	0.332	0.131	0.286	0.108	0.222	0.808
Unaccounted for Water (%)	nd	57	45	nd	39	17	41	nd	14	13
Connections Metered (%)	3	4	95.5	0	79	3.5	100	0.1	0	0.9
Operating Ratio	1.43	1.36	0.8	2.82	1.36	0.44	0.82	5.33	1.68	0.62
Accounts Receivable (months)	8	5.6	7.1	3.6	nd	1.1	3	5.2	3	0.3
Revenue Collection Efficiency (%)	67	69	112	178	94	152	75	89	75	100
Average Tariff (Rs/m3)	1.39	9.34	20.55	0.6	5.04	10.87	3.66	2.79	1.5	4.51
New Connection Fee (Rs)	100	950	1,740	1,500	530	1,930	3,000	2,500	1,984	300
Capital Expenditure/ Connection (Rs)	427	331	787	39	754	10,080	954	353	864	971
Staff/1,000 Connections (ratio)	2.2	4.8	5.2	20.7	8.6	13.3	4	18.7	0.4	5.6

Source: As 'ADB (2007)'.

Kolkata	Mathura	Mumbai	Nagpur	Nashik	Rajkot	Surat	Varanasi	Vijayawada	Visakhapatnam	Average
79	70	100	91.5	92.6	98.1	77.4	77.7	70.5	49.2	81.2
8.3	2	4	5	3.5	0.3	2.5	7	3	1	4.3
130	nd	191	100	93	101	Nd	147	158	124	123.3
0.246	0.16	0.246	0.267	0.248	0.146	0.188	0.217	0.22	0.305	0.244
35	nd	13	52	60	23	Nd	30	24	14	31.8
0.1	0	75	40	80	0.4	1.9	0	6	1.3	24.5
4.73	3.05	0.49	0.76	1.18	1.61	1.01	1.3	1.14	0.78	1.63
2.4	12.3	11.8	9.6	0.03	6.6	3.1	4.9	1.6	3.3	4.9
100	106	189	80	92	45	100	64	114	86	99.5
1.13	0.62	4.6	6.6	4.32	5.07	1.66	3.17	2.18	8.55	4.91
1,000	500	660	1,675	1,250	1,850	345	2,375	5,500	2,000	1,584
2,247	712	3,790	719	1,268	817	1,102	112	nd	3,891	1,591
14.7	6.5	17.2	3.2	3.4	1.1	1.7	5.9	5.7	5.4	7.4

Figure 16.3 Cities With 24×7 Water Supply Projects Underway (as of 2008)

Source: Chary (2011).

pushed utilities to start thinking in terms of reforms and service delivery. Moreover, there was a political/social realization of the imperative need for improving urban services. A number of legal instruments, such as Right to Information and public interest litigations were used by civil societies to demand better urban services. The Water Policy, 2002 and some states that have formulated their own water policies have placed emphasis on PPP. Besides, local capacities are improving and experience with regard to PPPs is building.

'The Benchmarking and Data Book of Water Utilities in India' (ADB 2007) examined the performance of water utilities in 20 cities, a summary of which is presented in Table 16.4 , and references to which have been made in reviewing Indian experiences. Among the parameters considered, average water availability of 4.3 hours per day, UFW of nearly 32 per cent, metered connections of 24.5 per cent, and an operating ratio of 1.63 all point towards the substantial improvements that are required (ibid). Some of the recent initiatives and pilot projects do, however, point towards cases where success has been achieved in a relatively short timeframe.

A 2011 technical paper by the Water and Sanitation Programme (WSP) of the World Bank highlights that significant revenue potential for utilities exits provided a number of operational issues are addressed (see Chapter 11 for more details).

One of India's early successes in continuous water supply was the pilot project in the three north Karnataka cities of Hubli-Dharwad, Belgaum, and Gulbarga. Nagpur, another frontrunner in water reforms in the country recently awarded a fully-city continuous water supply contract on the back of a successful pilot project which now delivers 24×7 water to 10 per cent of its population. No Indian city has yet achieved full-city 24×7 water supply.

The last few years have seen over 60 initiatives among urban local bodies in developing continuous water supply projects, up from none in the early 2000s. Among the cities that are working towards full-city 24×7 projects are Hubli-Dharwad, Belgaum, Gulbarga, Nagpur, Latur, KMDA, Mysore, Nagpur, Navi Mumbai, Udipi, Greater Hyderabad, Madurai, Salem, Coimbatore, Chandanagar, Malkapur, and Amravati (Chary 2011) (see Figure 16.3).

The Indian examples indicate that state government parastatals, urban local bodies (ULBs), and the private sector have been engaged in delivering water services and there is no unique model for their delivery. If the 3-city Karnataka project is an example of a state level intervention executed at the local level by three ULBs joining forces, Nagpur's city-led water management journey traverses a series of important milestones in putting in place an integrated water management strategy for the city. Surat's response has been the result of a proactive management team putting in place efficient systems and processes. The Maharashtra Jeevan Pradhikaran's (MJP) initiative in Badlapur and the Bangalore Water Supply and Sewerage Board (BWSSB) are examples of state agencies taking the lead in the delivery of water supply. Jamshedpur is clearly an 'atypical' city, with JUSCO, a private entity responsible for end-to-end water provision.

We apply the framework discussed in the section 'Analytical framework' for deriving lessons from the Indian cases.

Institutional Efficiency

Leadership

As highlighted in the section 'Transformation of international water utilities in developing countries', some international examples point towards individual leaders who have almost single-handedly led to the transformation of water utilities. The recent limited successes in India have largely been the result of collective leadership (both political and bureaucratic) at the state and local government levels. In the three cities in Karnataka, state level bureaucrats helped create an environment for local officials and councilors to implement the project. The Nagpur project has also seen joint efforts by local politicians and officials in implementing the project. The Alandur underground sewerage project was built under the leadership of the then mayor of Alandur, R.S. Bharathi who rallied public support in contributing financially towards the development of the project. Here again, a supportive state bureaucratic machinery helped create an enabling environment for the mayor to undertake the project.

Water Policy

Indian cities have suffered from the lack of integrated water management policies that look at both water and wastewater management in a holistic fashion. The Municipal Solid Waste (Management and Handling) Act, 2000 helped focus much needed attention to the solid waste management sector. A similar mandatory law that forces ULBs to address the issues of water will be helpful from economic, social, and environmental considerations. For example, The Clean Water Act, 1972 in the US provided the much needed trigger for local governments to revamp their water utilities and raise finances to meet the standards prescribed in the Act.

An example of a state legislation providing an enabling environment is the 3-city Karnataka case where the project objectives clearly aligned with the Government of Karnataka's Urban Drinking Water and Sanitation Policy, 2002.

Regulation

An amendment to the Karnataka Municipal Corporations Act making provisions for private sector participation in municipal water supply and allowing deputation of ULB employees to private companies in case of PPP projects was an important enabler for the project (MoF 2010). This facilitated the private sector to carry out operations, including collections, through ULB staff deputed for the project period, making the ULB the 'face of the project'.

Corporatization

The Nagpur Municipal Corporation has corporatized the delivery of water supply for the city by ring fencing the water supply function and creating a special purpose vehicle, the Nagpur Environmental Services Ltd. (NESL), for functional independence and bringing about accountability in the city's water operations. NESL, which is 100 per cent owned by the Nagpur Municipal Corporation, has been empowered with the task of developing and managing the city's water operations (NMC 2010).

Private Sector Participation

Indian water utilities have been cautious about inviting private participation in the delivery of water services, and the large BOT projects that were undertaken in some international cities have been absent in India.

In 1998, the Pune Municipal Corporation attempted to implement an urban environmental infrastructure project, valued at approximately Rs 7.4 billion (US$ 185 million) through construction and management contracts with a private sector firm. The project was to cover a 24-hour water supply and sewerage service to the city of Pune. The project was cancelled for a number of reasons, but the most critical was loss of political support (WSP 2000).

The Delhi Jal Board (DJB), a statutory body under the Delhi Jal Board Act, 1998 responsible for production and distribution of water and for treatment and disposal of wastewater, has faced stiff resistance from the public in its attempts to rope in the private sector in the delivery of water supply. The main obstacles to private sector participation are the absence of independent regulation, poor economic viability, lack of long-term policy support, and inertia and apprehension by DJB employees about private sector participation initiatives (ADB 2004). Private participation is now limited to smaller activities like O&M of water treatment plants.

Two successful cases of private sector participation have been in the three cities in Karnataka and in Nagpur, with the French water company Veolia being the lead private sector participant in both the projects. The 3-city Karnataka project was structured as a management contract with the private sector being responsible for developing an 'improvement plan', procuring and managing contractors for carrying out works as envisaged in the plan, and O&M of the new system. ULBs in the three cities in Karnataka, along with the Karnataka Urban Water Supply and Drainage Board (KUWSDB) and the Karnataka Urban Infrastructure Development Finance Company (KUIDFC) were the contracting authority for the project. A performance based management contract that linked 40 per cent of the payments against achieving project milestones was a key instrument in driving project efficiencies. Project funding was provided by the World Bank (76 per cent) and the Government of Karnataka (23 per cent), with KUIDFC as the nodal agency (Ahluwalia and Nair 2010a).

Nagpur has been at the forefront of using the private sector in managing its water services. All new assets created since 1999 are managed though service contracts. The pilot continuous water supply project involved a 5-year O&M with performance based targets to reduce UFW and improving the service level to customers. In the recently awarded full-city contract, the private party is responsible for operating, maintaining, repairing, refurbishing, and providing for replacing any granted facilities from source to connection plots and delivering water supply to consumers according to committed service level targets, with NESL retaining ownership of all fixed assets required to provide water supply services (NMC 2010).

In the case of the Bangalore Water Supply and Sewerage Boards (BWSSB), a state government entity responsible for water supply for Bangalore Mahanagara Palike and surrounding areas developed by the Bangalore Development Authority, the private sector is involved in O&M of the water treatment plant and pumping stations through service contracts. The Surat Municipal Corporation contracts out aspects like calibration, service, and maintenance works of instruments/equipment to authorized service agencies (NUWA 2009).

At the other end of the spectrum, and in a first of its kind in the country, the Jamshedpur Utilities and Services Company (JUSCO) was carved out of Tata Steel from its Town Services Division in 2004 into an urban infrastructure service provider. JUSCO, a private entity, provides water supply and sewerage services to the city of Jamshedpur which has a population of over

615,000; it is also responsible for water production, distribution, and source development (ADB 2007).

The Indian experience also points towards an interesting case of NGO-private sector participation in water supply. Covering 900,000 people in 731 villages in Anantapur district in Andhra Pradesh, the Sri Sathya Sai Drinking Water Supply Project involved turnkey contract arrangements, the creation of an autonomous water board, and contracts for O&M, with funding being provided by the Sri Sathya Sai Central Trust (ADB 2004).

Transparency and Accountability

Recent pilot projects have witnessed a number of transparency and accountability measures being put in place. At a full-city level, Bengaluru has initiated a number of measures like simplification of procedures for sanction of water supply and sewerage connections, customer charter, an informative website, monthly water adalats, and fully automated bill payment kiosks towards improving transparency and accountability in water services.

Communication

Given the sensitivities attached to water management, effective communication and stakeholder management cannot be understated in water projects. This is particularly important in the Indian context given the history of not charging users for providing water in most parts of the country.

In the case of the three cities in Karnataka, local NGOs played a leading role in taking the message of the benefits of the project to the communities. In Gulbarga, for the first six months, customers received their bills based on actual consumption, but only had to pay the old fixed charge, thereby presenting the benefits of the project to consumers (Ahluwalia and Nair 2010a). The implementation of a technical solution at Badlapur was supported by a stakeholder participation process led by MJP which involved local elected councilors, and also received appreciation from the media (NUWA 2009). JUSCO initiated a number of customer centric initiatives in Jamshedpur to manage public opposition and political interference in the new metering systems. This included intense engagement with the community, no billing based on meters for the first 3 months so that the consumers could compare consumption patterns, reduced meter rental costs, reduced tariff structures, and no penalties for unauthorized connections during the metering stage (Sarkar 2009).

The Nagpur pilot project ran into problems in spite of a marked improvement in service delivery because it did not focus sufficient attention towards stakeholder communication. The timing of implementation of the revised tariff after a gap of 9 years (provision has now been made in the bylaw for annual increment in tariffs), bills being sent for 6 to 9 month periods, and an accurate metering and billing system resulted in steep bills for consumers (Ahluwalia and Nair 2010b). The introduction of continuous water supply helped detect internal leakages at the consumer end, but it also meant more expenses for consumers (the corporation subsequently started internal leak tests for all major consumers). While the reasons for the increased billing could be clearly explained, the absence of a communication strategy meant that the basis for these changes could not be effectively communicated to the people on time. The pilot project, while designed for technical efficiency, did not pay adequate attention to stakeholder management, the lessons of which are now being implemented in the full-city project and can provide useful pointers for other cities. The opposition to tariff increases forced the corporation to reduce tariffs. Nagpur's example is a lesson on the importance of budgeting time and resources upfront while undertaking such projects. Another important lesson from Nagpur is the need to put in place customer service centres and grievance redressal mechanisms early in a project's life cycle and not after operations have started, as was the case in Nagpur.

Operational Efficiency

Indian water utilities leave a lot to be desired in achieving operational efficiencies, as indicated in the ADB (2007) study. Technical and system measures have been the predominant drivers of change. This section captures some of the operational initiatives undertaken by Indian water utilities.

Technical and System Measures

With the completion of the pilot project in the three cities in Karnataka, approximately 10 per cent of the population of each of these cities, that is, about 25,000 individual households or almost 200,000 residents have benefitted from continuous water supply. Against the 135 lpcd assumed for the project, average water consumption is actually 100 lpcd. Water losses due to leakages have been reduced from as high as 50 per cent in non-project zones to less than 10 per cent within the demo zones; 100 per cent metering has been completed. Customer service has improved substantially with almost 100 per cent complaint redressal through a 24×7 customer service centre.

In the case of Nagpur, the efforts of the Nagpur Municipal Corporation to augment bulk water supply in 2003 resulted in an increase in the volume of water input to the city by 32 per cent, yet the sales of water showed no increase, indicating leakages in the distribution network. It then undertook a water audit, along the lines of the recommendations of the Sukhantkar Committee, set up by the Government of Maharashtra in 2000 to review the efficiency of water supply in the towns and cities in the states. The audit results revealed losses in both transportation from the bulk source as well as in the 2,100 km long distribution network. This resulted in a series of projects that include source augmentation. The pilot continuous water supply project was the outcome of the corporation's continued focus on water management. For nearly 9,000 connections that were covered in the pilot project, UFW decreased from 40 to 23 per cent. The average pressure increased from 0.1–0.6 m to 0.5 m–15 mtr and 100 per cent metering in the demo zone has been achieved.

Surat has focused on strengthening its internal processes and upgrading its in-house capabilities in managing its water needs. Led by a charismatic municipal commissioner, it put in place a number of internal initiatives with minimal investments for O&M of its water supply network. Among others, operational functions of waterworks were standardized in accordance with Quality Management System ISO 9001: 2000, a dedicated electrical and mechanical maintenance team for preventive and predictive maintenance work was constituted, a quality control engineering department for quality monitoring of engineering materials departmentally was created, and an online water-quality monitoring system to monitor and judge the performance of water treatment plants was established. An emergency response centre was established to ensure uninterrupted water supply even during emergencies. A dedicated electrical and mechanical maintenance team was put in place which looked at both predictive and preventive measures and monitoring systems; this saw a sharp reduction in equipment failures and plant downtimes. The initiatives also led to revenue increase and improved customer satisfaction.

Badlapur's (in Thane district, population of 160,000, also known as Kulgaon-Badlapur) success with water management was through a technical innovation/intervention by the Maharashtra Jeevan Pradhikaran (MJP), a state government entity which owns and maintains the Badlapur water supply system. Thirty per cent of the city has now transitioned from intermittent supply to a continuous water supply system, with significant reduction in UFW. The transformation was brought about by the application of a technical innovation by MJP engineers. A 'hydraulic model' simulated the behaviour of the system and hydraulically isolated the operation zones. This was the first time in India when district metering areas were used. This enabled the engineers to repair visible leaks and also helped in devising a cheaper metering strategy (by using one meter where normally 2 to 3 meters costing Rs 400,000–500,000 each is required). MJP is now considering replicating this experiment across the state of Maharashtra for ULBs that carry out GIS mapping and digitized maps (MoUD 2008).

Administrative and Financial Efficiency Measures

JUSCO has implemented several measures to improve staff productivity. Being a private utility which is not governed by government pay scales, it is able to use compensation as a tool for attracting, retaining, and motivating talent. JUSCO also identifies training needs based on the gap between the competency needs of the position and the competency level of the employee, along with the employees' desires. Internal rotations, including postings at out-locations, provide officers with challenging assignments, which help develop their competencies and careers (ADB 2010).

The Bangalore Water Supply and Sewerage Board (BWSSB) has been able to achieve an operating ratio of 0.8 (ADB 2007). BWSSB has initiated a scheme called Ganakeekrutha Grahakara Seve for revenue billing and collection purposes. This initiative has helped consumers get error-free bills and a convenient time and place to pay the bills. GIS based customer details are maintained and the top management can get accurate demand collection and balance at any point of time. The project has led to a sustained increase in collection and greater transparency in the billing and collection process (Vasudevan 2009). In 2002, the Bangalore Water Supply, Sewerage and Environmental Sanitation Master Plan was commissioned which helped in ascertaining the status and adequacy of the existing infrastructure, condition of the assets, replacement schedule, investment requirements, availability of raw water, and institutional capacity. BWSSB has also commissioned a comprehensive GIS system.

In the three cities in Karnataka, revenue for ULBs through user charges has improved substantially with almost 90 per cent convergence achieved between the quantity of water supplied and billed as of 2009. Volumetric billing has been introduced in the project zone. The tariff structure includes pro-poor considerations like minimum lifeline supply of 8,000 litres per household and no deposit for availing new connections in cases of houses less than 600 sq ft in area.

Nagpur's pro-poor elements in the project include 100 per cent rehabilitation of pipeline network inside a slum, house-to-house service connections to all slum dwellers, and graded rates based on whether houses are kaccha or pucca.

In Jamshedpur, a series of measures were put in place immediately after the creation of JUSCO to drive efficiencies across the system. JUSCO has been operating well on all counts except for the availability of water. The UFW for JUSCO is merely 12.8 per cent and the operating ratio is 0.62 (ADB 2007). Both these indicate sound administrative and financial management at JUSCO.

Conclusion

A review of water utilities that have been able to transform themselves into better performing entities indicates that they were able to institute better water governance. A comprehensive strategy involving institutional and operational efficiency measures was undertaken by them, which resulted in financially sustainable, better performing utilities that are accountable to consumers, committed to service delivery, and are professional places to work in. Institutional efficiency measures comprise a committed leadership, a water policy that looks at water sector management in an integrated manner, a regulatory regime that is able to separate the utility from government intervention, a framework that allows utilities to operate in a 'corporatization' manner, internal and external 'audit' systems that allow the utility to be transparent and accountable, and a customer oriented communication strategy. Operational efficiency measures comprise of financial and administrative measures, such as financial management and human resource management and; system/technical efficiency measures. It is apparent from international case studies reviewed in this chapter that institutional efficiency measures and financial and administrative efficiency measures are necessary for better delivery of system/technical performance.

However, when we look at the reform process in Indian water utilities, it has largely focused on improving system/technical efficiency with either the involvement of the private sector or at the behest of some state government agency. Institutional, financial, and administrative reforms have always followed the system/technical efficiency improvement initiatives. The focus has always been project led rather than creating an environment within which projects could evolve. A consequence of this has been that the progress has been slow, marred with challenges and have often led to failures.

In the recent past there has been some progress to compel utilities to undertake institutional reforms. JNNURM mandated states and utilities to undertake a set of reforms before they could access grants for their projects. Cities were also forced to think holistically when they were required to prepare 'city development plans'. Another development, the adoption of service level benchmarks by the Ministry of Urban Development and its endorsement by the 13th Central Finance Commission and the High Powered Expert Committee on Urban Infrastructure (HPEC) places an onerous responsibility on water utilities to provide prescribed water supply standards to urban residents. The need to focus attention on the water sector given the water stress in the country is now well recognized. That water reforms are politically sensitive is also well understood. Reasonable successes in some Indian cities indicate that good operational practices coupled with an enabling environment can usher positive results.

As this chapter highlights, based on international and Indian experiences there is no one right model for the delivery of water supply. A host of factors, including history of water reforms, institutional capacity, political will, and funding play an important role in determining the mode of service delivery. The Indian examples are wide ranging—from a state entity leading a technical innovation to providing continuous water supply (MJP in Badlapur) to a private company responsible for end-to-end water management in a city (JUSCO in Jamshedpur), and a host of alternatives within the extremes.

The examples also point towards interesting transition paths towards the implementation of the 74th Constitutional amendment, wherein state governments step in to provide an enabling environment (and even finances) for ULBs (water service delivery being a part of ULB mandate) to then operationalizing improvements in water supply (as in the case of the three cities in Karnataka). Given that institutional reforms will take time, such arrangements may be required in the interim. With time, ULBs should be able to fully take over and lead water projects and run water services in a 'corporatized' manner. These measures are also important as in many cases the ULBs do not have the mandate for end-to-end management of the water chain (with 'source' management resting with the state government and in multiple departments of the state), which is necessary for integrated water resource management. Institutional reforms require a committed leadership as demonstrated by many international cases studied in this chapter. There is even more reason for the state to show leadership and work towards innovative transition arrangements that provide a roadmap for operationalizing the 74th Constitutional amendment in cases where ULBs are not equipped to take on water reforms. State financial intermediaries that serve to bridge both financial and technical constraints of ULBs could be useful institutions in implementing water reforms.

Private sector participation in the water sector has been gaining traction in recent years, especially since the start of JNNURM. However, water utilities have taken a guarded approach towards private participation, with most of its work being in the realm of O&M as opposed to turkey BOT type projects that were tried during mid-1990s with little success. Given the institutional constraints that the sector faces, this may possibly be a sign of things to come—with public sector entities roping in private entities to drive system efficiencies in select aspects of water supply provision. Such arrangements also create space for local entrepreneurs to build capacity and partner with international players in the delivery of water, and prepare themselves to take on larger roles in the future.

The New Improved JNNURM (NIJNNURM) proposed by HPEC could consider factoring in water plans for each city with clearly stated financial and operational plans, complete with an evaluation of the various modes of service delivery. High Powered Expert Committee's recommendations on revenue sharing between the state government and ULBs will provide the ULBs with much needed steady, predictable, and timely cash flows, a portion of which could be escrowed for water and sanitation projects, thereby better managing revenue risk and creating greater accountability among ULBs in the delivery of services.

Specific recommendations that emerge from the international and Indian experiences are:

(a) Institutional efficiency measures
- The Government of India could consider a mandatory water act along the lines of the Municipal Solid Waste (Management and Handling) Act, 2000, to force water utilities into fast tracking reforms.
- State governments to amend their municipal acts or enact overarching acts to facilitate PPPs and flexibility in use of ULB staff in PPP projects.
- Corporatization of service delivery to drive accountability and efficiency in operations, and for creating specialized professionals in the delivery of water services.
- Developing appropriate communication strategies through measures like preparation of citizen report cards and social audits while undertaking water and sanitation projects.

(b) Operational efficiency measures
- Using improved performance as an instrument to increase user charges, not the other way round, with NIJNNURM providing the necessary finances to undertake performance improvement measures.

- Focus on performance improvement through:
  - Water plans with clearly laid out long-term water considerations
  - Periodic water audits
  - NRW reduction targets
  - O&M improvement measures
  - Metering systems
  - Energy efficient solutions.
- Transparent search-cum-selection process in the appointment of managers to run water utilities, who could be selected from either within or outside the government service, including from the proposed municipal cadre.

Recent Indian successes, albeit limited, in most of these measures clearly indicate that turnarounds in water utilities are indeed possible in Indian conditions. With appropriate institutional arrangements, these can and should be fast-tracked.

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17 Water in Cities

Rethinking Services in Transformation

Marie-Hélène Zérah and Sylvy Jaglin

Introduction

Urban water supply systems and their management have undergone a considerable change in developing countries as a result of the neo-liberal policies adopted during the last 20 years. Among the changes taking place, diverse models that delegate the management of water supply systems to large international companies have drawn considerable attention. However, these models are not very widespread and have given rise to a differentiated mode of development and upgrading of urban spaces in a competitive environment. On the one hand, the big companies representing this model continue to be very selective about their geographical locations. And on the other hand, despite the strong influence of the neo-liberal paradigm existing urban realities can only be understood more clearly by taking into account the comprehensive set of local reforms that go much beyond simple sectoral reforms.

Several other processes are at work in transforming urban services at the city scale and under the influence of a variety of actors. Most often they are driven or promoted by reforms whose scope extends well beyond service networks. These include politico-administrative decentralization, liberalization and its consequences, decline of state monopoly in several fields of urban management, political democratization, and the uneven participation of city-dwellers—both individuals and organized groups—in decision-making processes. Although the effects of these shifts are somewhat overshadowed by the debate on 'privatization', they still contribute to the transformation of the relationship between networks and urbanized spaces.

This chapter raises questions about three main aspects that call for reflection: (i) What are the reasons for the persistent shortcomings of urban water supply services? (ii) What direction should efforts towards the modernization of public services follow? (iii) How can the proliferation and the robustness of both formal and informal alternatives be explained? It mainly argues that in most developing and emerging countries, water supply is characterized by a diversity of service delivery mechanisms. This diversity, rather than being understood as a failure, needs to be reconceptualized and integrated in a broader definition of water supply services, which raises issues in terms of regulation and governance of these systems. Based on a review of international literature, including the Indian case, this chapter aims at opening up the debate on future avenues for water services. It does not aim at providing policy recommendations (or disseminate best practices) and it also does not cover all geographical areas, in particular the Chinese case,[1] where rapid improvement of services took place in the last decades. Finally, it tries to reflect

[1] The case of China is dealt in chapter 12 of this *Report*.

on the potential lessons for the situation in India in times of reform.

Urban Water Supply Services

The improvement of services for drinking water and sanitation necessarily calls for a compromise between objectives that are a priori conflicting: (i) a service that is efficient at the operational and economic level (which raises the question of its funding), and (ii) social and territorial equity (which raises questions of redistribution). Because of their key role in the urban fabric, these services figure among the Millennium Development Goals framed in 2000 to reduce by half the number of people deprived of access to drinking water and sanitation. However, achieved results are very uneven (Dagdeviren and Robertson 2009; UNDP 2006) and have not provided any solution to the failure of universalization and the weakening of the developmentalist model for the expansion of services. Due to long periods of chronic underinvestment, the development of water supply systems, built during the colonial period or soon after independence, is still lagging in many cities in the South, with the exclusion of fairly large but uneven sections of urban society, either because of the lack of infrastructure or because the quality and quantity of water provided is inadequate. The ideal model of public services capable of satisfying the needs of the entire population, based on a Weberian type of government, with mechanisms for spatial and social cross-subsidies, centralized planning processes, and technical as well as financial capacities for ensuring an adequate supply (to follow planned urban expansion according to normative average needs), has reached its limits. Inefficient public management (technical, organizational, and financial), absence of supply to poor neighbourhoods for objective reasons (such as a rapidly expanding population and unauthorized settlements) as well as discriminatory treatment on the part of the post-colonial administration and the resultant socio-spatial inequality in accessing water and sanitation services, have together undermined the legitimacy of public monopolies. In the 1980s, the shortcomings of public management were widely criticized and measured against supposedly more efficient and better managed private companies (The World Bank 1994). The result of this international 'consensus' led to the proliferation of public-private partnerships (PPPs) involving big private international companies which were awarded different types of delegated management contracts (Goldman 2007) and led to numerous studies (for a recent summary, see Bakker 2009). This debate has, however, ignored many of the issues related to water supply systems (such as the importance of legal machinery, peculiarities of local socio-technical and political cultures, geographical features of territories and water resources systems. and new policies for mobilizing sources of supply). A scrutiny of PPPs has understood the sector through a simplistic institutionalist approach, which needs to be questioned and calls for an examination of the 'blind spots' in reforms as well so as to better qualify the numerous changes that have occurred outside the areas covered by privatization.

Big PPPs: A Less and Less Commendable Model

PPPs in urban water supply are more controversial (Estache and Fay 2007) than those in other sectors because of the specific values attached to water. The partial and ideological nature of numerous existing studies, combined with the lack of homogeneous and comparable data, makes it more difficult to reliably assess their results. Seven per cent of the urban population of developing countries is now supplied by private operators (Marin 2009; Gassner et al. 2009). However, none of the existing empirical assessments provide an accurate and undisputable estimate of the capacity of the private sector to invest and to improve management while expanding the service, particularly in poorer neighbourhoods (Kirkpatrick et al. 2006; Prasad 2006; Trémolet 2006).

Nowhere have PPPs been able to fulfil the exaggerated promises made by their advocates. The recent study by Marin analyses the performance of more than 65 major PPP contracts in the developing world on the basis of four indicators (coverage expansion, quality of service, operational efficiency, and tariff changes). It shows that very few of these contracts are satisfactory in more than one or two of these criteria (Marin 2009). In terms of access, even though 24 million people have been provided access to water since 1990, the results are mixed and inconclusive. Private operators, even when they are able to raise the level of access, have not invested as much as planned and have fallen short of reaching their contractual targets. According to Marin (2009: 45–68), expansion of service was more successful when private investment was supported by public funding and lease contract performed better than the larger concession contracts. On quality of service and operational efficiency, the outcomes are more positive. PPPs have improved operational efficiency. In particular they have been able to reduce non-revenue water, improve bill collection as well as enhancing labour productivity. Regarding the last criteria of tariff levels, this large study remarks that the impact of PPPs on tariff levels is inconclusive: tariffs have often been raised but this increase, as demonstrated by more ethnographic work, can be related to a number of other factors. This supports the results of other less exhaustive studies. First, contractual flaws, well analysed in the North, are often amplified in the South: contractual frameworks have proven inadequate for the effective sharing of risks (either because the public sector attempted to transfer all risks to private partners or because of the private sector anticipating renegotiation), leading to delays in securing investments in time and foreseeing adequate responses for macroeconomic risks. In addition, the regulation of these contracts, most often implemented by specialized and centralized regulatory agencies, has not been very effective (information asymmetry, pliant regulators, lack of competence, primacy of economic regulation over consumer protection, and environmental issues). Second, the economic equilibrium of contracts has been difficult to achieve. Tariff policies recommending higher rates have met with political and public opposition while investment and expansion programmes have to deal with the difficulty of mobilizing 'cheap' capital. Third, contrary to the claim that private operators are better placed to innovate to serve the poor, and despite several localized successful experiments (Botton 2007), private operators have not been very successful. They had to contend with a number of constraints: obligatory high standards agreed upon in the contracts limited their options for innovation and they faced the problem of rapidly expanding settlements in poor neighbourhoods with issues of illegal land tenure. Further, commercial and social policies (for example, lower charges for new connections, and staggering of payments, etc.) were unsatisfactory in addressing equity and poverty issues (Boccanfuso et al. 2005; Kayaga and Franceys 2007). All these factors (technical, economic, and legal), taken together point to the importance of the macroeconomic and social environment (poverty and growth) in which these projects are inscribed, as well as their fragility in times of monetary (as the crisis of the Buenos Aires and Manila contracts following the devaluation of the currency demonstrate) and social crises (one well-known example being the termination of the La Paz-El Alto concession following the repercussion of major social movements in Cochabamba).

It is necessary to look at these persistent failures together with obstacles created by the apparent inability of sectoral reforms to reconcile formal institutions with informal ones, such as perceptions and beliefs, and customs and values. While formal institutions are often subjected to relatively rapid changes, informal institutions, which influence the behaviour and decisions of a majority of the actors in the water sector, change more slowly and imperceptibly. Conflicts, which have led to the termination of some management contracts, disagreements on tariffs, differences in estimating the actual demand, and diverging stances on the usage value of drinking water, testify to the importance of local political ethos in the successful execution of contracts. These failures have revealed the limits of a minimalist institutionalist approach recommended by the advocates of reforms who are guided by a narrow and sectoral understanding of institutions. These reformers are essentially interested in 'organizations' within the sector with little or no concern for other institutions, such as belief systems and social structures (Hibou and Vallée 2007).

Some important and disturbing political factors are responsible for the disappointing performance of major PPPs. In many countries, the government's financial and political involvement in the water sector, and more particularly in the sanitation sector, is negligible and people without access to water have no means of making themselves heard. Local circumstances can exert a considerable influence on the terms and conditions of reforms as well as their implementation schedule (Alcazar et al. 2002; Verdeil 2010). It can occasionally lead to a paradoxical success, as in Havana, where the political management of PPPs by the communist state legitimized the change of model. In 2000, the Government of Cuba entered an agreement with Aguas de Barcelona to create a mixed capital joint venture[2] whose objective is a constant improvement of services. The government owns the infrastructure and part of the investment is public while the operation (and some of the investment) is the company's responsibility. Though the contract does not have specific targets, it is close to a lease contract with a sharing of responsibilities. To some extent, it increased inequalities since eight of the 15 municipalities of La Havana are managed by the mixed company while three public companies provide services to the remaining seven neighbourhoods. Nevertheless, this reconfiguration also restored some elements of social justice by ensuring strong regulation of the contract (Pinceau 2010). International organizations now agree that access to essential services is essentially a political issue (Estache and Fay 2007) and that the provision of connections to basic infrastructure is often used as a means of legitimizing power (Bennasr and Verdeil 2009) as well as a tool for social regulation. For instance, it enables the de facto recognition of illegal settlements (since bills are used as a 'proof' of identity), their eventual inclusion in a citizen's community, and access to the water supply network (Benjamin 2005; Zaki 2009).

However, operational performance has often been improved, which prompts the advocates of the PPP model to claim that it remains a viable option for developing countries, provided it pays more attention to local contexts (Marin and Izaguirre 2006) and to better defining the terms of contract (Breuil 2004). Others stress the advantages of 'hybrid' contracts, shorter and less risky than the concession agreement (Marin 2009), or of smaller and less ambitious projects (Gómez-Ibáñez 2008). First, lease and management contracts have performed better than concession contracts. Second, contracts that experimented with innovative solutions, such as mixed ownership, partial government grants, and a stepwise approach so that direct revenues raised from users finance investment, rather than following textbook lease and management contracts clauses were the most successful. These are interesting developments, especially in the case of emerging countries, with the entrance and resilience of local large-scale private operators in Brazil and in India. In Brazil, for instance, the water sector remained unchanged since the 1970s and was dominated by public water management. However, two recent laws—in 2007 concerning water service management and in 2005 concerning the regulation between different types of operators—led to a restructuring of the water sector. On the one hand, it supported a process of modernization and competition among city utilities that can compete for contracts in other cities in response to calls for procurement contracts. On the other hand, it led to the emergence of local private players, more familiar with the local context than private international companies (Britto 2010). These private players are mostly public works companies, at times entering into joint ventures with companies more specifically specialized in the construction of urban networks. Though the types of contracts differ, the assets remain in the public domain. Nevertheless, the pace of granting major new contracts for urban water supply has slowed down considerably and these are limited to a very small geographical area.[3] There is no doubt that the PPP model can still be a credible alternative in some big cities in emerging countries. PPPs can improve quality and operational efficiency and can enhance public financing. They serve as a useful reference for benchmarking services and provide incentives for improving public utilities 'threatened' by privatization. We endorse the conclusions of Marin (2009) that PPPs are not suited to all situations, nor can they be envisaged in all situations. Consequently, a call to innovate and invent varied new 'arrangements' is necessary.

[2] The structure of the capital of the joint company is shared between the Cuban government (50 per cent), Aguas de Barcelona (45 per cent), and a single Spanish investor (5 per cent).

[3] The latter data obtained from the World Bank's databank on private investments in the realm of infrastructure (http://ppi.worldbank.org/features/July2011/2010-Water-note-final.pdf last accessed on 20 September 2011) draw attention to this phenomenon during 1990–2009. The geographical distribution of contracts has changed due to a considerable decline in investments in Latin America in favour of Asia (essentially China) with marginal changes in North Africa and the Middle East. Nevertheless, a majority of these investments focuses on the creation of production and treatment facilities and no longer, as in the case of major PPPs earlier, on the management of water supply and sanitation services.

Examining Links between City Governance and Water Supply Systems

The debate on the respective merits of public and private management of public utilities has missed the point that the real problem is not ownership but the difficulty faced by utility managers to find sustainable solutions for achieving universal water provision (Budds and McGranahan 2003). In view of the 'ideological' vacuum and the lack of innovative ideas following the Washington Consensus,[4] the widespread use of PPPs is unlikely and so is unconditional return to public utilities without any significant change in the policy framework. Nevertheless the temptation for an adequate 'model' persists. While the return to municipal management in countries (France and emblematically Paris, Atlanta in the US, Hamilton in Canada, Bolivia, and Argentina) where private participation took pace is celebrated, the process of 'remunicipalization' is arduous. A remarkable example is the case of La Paz where the cancellation of the concession contract with a large international private operator was central to the reform programme of Evo Morales. The La Paz-El Alto concession was terminated in December 2006 after the success of a very strong social movement that became instrumental in the larger national anti-privatization wave. The main conflicts concerned the level of investment of the private operator, its ability to expand services,[5] and the increase in connection fees. Further, in the city of Cochabamba, another contract was cancelled after a strong opposition movement and this had considerable repercussions (or consequences) on the social climate in the La Paz-El Alto concession. The private company became a public and social enterprise and its central objective was to reduce inequalities. However, first, management norms and practices of the private operator were maintained; second, the public utility faced similar challenges with regard to conflicts between municipalities in the metropolitan region as well as conflicts with the surrounding rural communities; and, third the issue of financial shortage remained (Poupeau 2010). The return to public management raises questions about the legal framework, service obligations, governance structure (government controlled body, public limited company, mixed company), and relationship with users. These issues need to be debated for risk of an overhyped enthusiasm for public-public partnerships (PUPs). Boag and McDonald (2010) reviewed existing PUPs and they also raise words of caution since PUPs have very heterogeneous management methods and at times, they are closer to private models. Finally, the development of 'community-based' solutions, such as partnerships between NGOs and citizens' action groups, heralded by some as the solution, raise similar problems of equitable service improvement when they are accompanied by a naïve belief in the existence of 'good' institutional arrangements (Bakker 2008).

The attention given to 'governance failures' (Bakker et al. 2008) reaffirms the importance of politics since it addresses the relationship between unequal access to water services and inequitable urban governance. However, the present state of research does not unbundle this articulation sufficiently to provide an adequate view of the ongoing changes. On the one hand, the simplified view of a dual city (citizens and squatters, those with water connections and those without, the well-off and the poor) does not capture the urban diversity, made of multiple in-between (Flux 2004) and multilayered communities. These communities have diverse and unequal skills to influence (or not) service provision. They harness political and social networks more or less effectively. These complex and shifting relationships between individuals, groups, and networks are often analysed as the resilience of a patronage structure but they reflect the inability of poorer sections to access formal state procedures. On the other hand, very few studies have shown an interest in the long-term social construction of water supply institutions and the legacy of historically constructed inequalities (Swyngedouw's

[4] The Washington Consensus led to a series of structural adjustment programmes, which often included privatization of utilities.

[5] Access was expanded but there was a fierce debate about the manner in which access was calculated and the manner in which service was expanded through condominial systems that required people's participation and were technically not in conformity with the terms of the contract. Further, areas located outside the limits defined by the concession contract were excluded from access and part of the opposition was also about including them, which the company was reluctant to do as it would undermine further their already difficult financial situation.

1995 analysis of Guayaquil is an exception). Often the common reasons for explaining the failure of 'governance' include institutional shortcomings, the absence of inclusive mechanisms, and the problems of coordination and overlapping institutions. In our view, these are insufficient explanations that depoliticize[6] the issue of very complex power equations in urban societies. They also rely on an oversimplified binary vision of the actors by opposing those engaged in institutional changes against those contesting them.

In essence, the problem is political in nature: it refers to the social construction of water supply services, collective responsibility, and the definition and legitimacy of rules and governance frameworks (Coing 2010). The compromise reached between the diversity of demands and social justice, which can be deduced from investment plans and projects, is an indication of the ability (or its absence) to address general interest, social cohesion, and inclusion in fragmented and pluralistic societies, which are sometimes characterized by competing interest groups to gain access to urban resources (Jaglin 2005a). The misalignment between water supply services and cities is due mainly to the unsuitability of water networks in terms of technical infrastructure, organizational mechanisms, and management and funding methods, as well as the type of actors and skills they mobilize, including their political goals and values.

In addition, besides the conventional piped system, other modes of supply exist, and even expand. They are governed by different rules and norms, accepted by many people as part of accessing basic services. Therefore, we argue that the existing explanatory framework that leads to a set of institutional recommendations on improving the governance of water supply systems is too narrow. On the contrary, a closer look at the linkages between cities and their water services could provide varied solutions better suited to local conditions and rooted in urban social structures. To rethink water services, two main directions can be followed, namely the 'in situ' modernization of public services and the proliferation of unorthodox solutions. These two different, but complementary trajectories could bring about sustainable changes in services. The challenges they pose in terms of coordination, control, and regulation need to be analysed seriously since we assume that problems of water supply in cities will not be solved in the near future only through piped water.

Modernization of Public Services

Despite the apparent unchanging nature of water services, a more or less coherent process of modernization of public services has taken place. It is therefore necessary to understand the limits as well as the potential of this process for progressing towards a more equitable access to essential services.

An important development in the modernization of public utilities is the introduction of reforms in accounting (adoption of new procedures, computerization, and use of software packages for integrated management) and financial (ring-fencing) systems, changes in the management of human resources and skills (including salary scales), revamping of tariff policies and cross-subsidies mechanisms, and revision of user service norms and 'customer' relations (Caseley 2003; Davis 2004). Inspired by the 'new public management', these reforms are widely shared and accepted, especially in emerging metropolises, by various scales of governments, and the new local economic elites, such as local industries' associations or resident welfare associations that welcome such change of facilitated consumer services (Dubresson and Jaglin 2011; Lorrain 2011; Zérah 2011). These reforms are responsible for the increased commodification of public services and have changed the conditions for public decision-making. The results of such reforms, though, in terms of efficiency are not always favourable, if accompanied by disinvestment (Dagdeviren 2008). A second dimension of this modernization process is the impetus given to 'participation and transparency'. The growing importance of consumer rights and the desire to involve users in the regulation and even the management of services led to the creation of new tools (citizen charters, hot lines, benchmarking, and complaint centres). The

[6] Coing points out that the principal approaches to governance are based on an 'idealized view of social relationships where everything is settled by consensus and where, by learning to cooperate, it is possible to reconcile divergent interests' (Coing 2010: 17).

obligation to publicize consumer rights has also altered the relationship between operators, the organizing authority, and users (Jaglin 2005b). On the flip side, these changes can strengthen some groups, especially the middle class, and contribute to elite capture at the cost of the poor (Zérah 2009).

Overall, the scope and sustainability of these changes owe as much to their political use by public authorities as to the efficiency of these new institutional mechanisms.

One example concerns the relationships between users and governments in a context of increased diffidence. A relationship of trust can be rebuilt if a number of conditions are met. The works of Barrau and Frenoux (2010) for Haïti, Connors (2005) for Bengaluru, and Botton (2007) in the case of Buenos Aires all point to common factors for participatory mechanisms to be successful. They need to be developed over a long period of time through building of trust and understanding the subtleties of existing social relationships. Thus, in the long run, it might be more efficient to rely on existing local leaders with knowledge and some form of legitimacy in their neighbourhood than on creating new institutions. The reliance on committees and community leaders rather than on setting up ad hoc committees with less legitimacy proved successful in Bengaluru and despite the larger set of problems faced by the Buenos Aires concession, the utility managed to expand services in lower income areas by engaging in a sustained and reciprocal dialogue with local mayors. This requires long-term commitment as well as a trial and error approach, which entails the nurturing of new competence within public utilities.

One more example concerns another sensitive aspect of reforms—tariff policies. The Tunisian example clearly shows both the limitations of territorial and social cross-subsidies devised in the late 1950s and the difficulty in their 'restructuring' (Touzi et al. 2010). The authors point out that political compromises made at various junctures were instrumental in the conduct of public policies (regional and development policies, poverty reduction, and growth promotion through tourism, etc.). The compromises reached have become out-dated in the face of present problems (mobilization of new water resources at a high cost, transformation of demand, distortions created by the tariff structure, and emergence of environmental issues, etc.). Therefore, it is up to political decision-makers to openly discuss the ways and means of implementing new forms of equity and political compromises.

These two different examples briefly illustrate the great diversity of methods that can be used to reach new compromises related to service management and to urban social cohesion. The importance of political choice urges us to look beyond the narrow water domain for factors responsible for the numerous changes that have de facto contributed to the remodelling of water supply systems. Decentralization and legislative changes have transformed the relationship between governments and municipalities. In the Brazilian case, they have empowered local governments and encouraged cooperation between local councils (Britto 2010). In India, despite the limits of the 74th Constitutional amendment on decentralization and the limited role of city policymakers, conflicts around the implementation of the Ganga Action Plan in Varanasi (where local political leaders and a vocal NGO were able to partly alter the project), point towards an ongoing reorganization of roles and powers (Vincent and Forest 2010). Some democratization instruments have altered the rules of the socio-political game. These include the Right to Information Act, introduced in India to create greater transparency. This has brought about a significant change in the relations between users and water utilities. It has also been used by anti-privatization forces (for the case of Delhi, see Bhaduri and Kejriwal 2005). Similarly, the inclusion of the right to water in South Africa's Constitution has strengthened the movements opposed to the installation of pre-paid water meters in Johannesburg (Aubriot 2009). As a result, power equations in urban societies have been subtly altered, even though the consequences are not always immediately felt nor are they always palpable. In Brazil, for instance, decentralization efforts were slowed down by customary political manoeuvring and in India, the deepening of decentralization remains a central objective of urban reforms. All these changes contribute to making urban governance even more complex and contested: most reforms and projects require engaging in prolonged negotiations, facing protests, and accepting second opinions, as new tensions and conflicts emerge around the notion of rights of a growing number of stakeholders.

Proliferation of Unorthodox Water Supply Systems

In nearly all cities, unfulfilled needs imply that conventional water supply systems coexist alongside other commercial modes of water supply systems, which are mostly uncontrolled and often illegal. Users most often combine non-conventional and conventional systems on the basis of criteria, such as use, price, taste, and accessibility. These alternative small-scale providers mainly fill the gaps in service provision. Their services can overlap and compete with the water utility and often their expansion is inversely proportional to that of the conventional system. Small-scale providers do not receive any government subsidies and are financially autonomous. They embody all the features of the informal economy (unregistered, untaxed, weakly capitalistic, and legally vulnerable). They mostly operate in the distribution sector but are sometimes water producers if they rely on groundwater extraction. Although they have become standardized as a result of imitative behaviour, these commercial supply systems are very diverse, close to cottage-type enterprises, and more costly, since the unit price charged to consumers is higher than that in conventional systems.

These characteristics do not preclude the non-conventional system from being part of the water supply system. Specifically, the proliferation of these decentralized modes of supply provide access norms that are compatible with the absence of adequate supply and users become part of social and commercial systems that offer a range of customized usages (potable and non-potable water, paid and free of cost) and services (doorstep delivery, supplied through public taps or private connections, with or without a guarantee of quality and regularity, with or without subscription). However, this integration should not prompt us to ignore the fact that consumers are seldom in a position to weigh various offers. Being utterly dependent on unregulated suppliers, they are obliged to pay 10 to 20 times more per unit of water than households having a regular water connection, and given the catastrophic inadequacy in the provision of sanitation, they have only partial access to sanitary facilities usually associated with the use of potable water.

These commercial services can include small local private operators (Conan 2004; Kariuki and Schwartz 2005; Kjellén and McGranahan 2006; van Dijk 2008), forms of 'community-based privatization' in poor neighbourhoods (De Bercegol and Desfeux 2011; Jaglin and Bousquet 2011), and sophisticated alternative sources of supply by local urban entrepreneurs in well-to-do neighbourhoods (Maria and Levasseur 2004). For long, small private operators were criticized for being non-competitive, costly, and unregulated. However, their 'entrepreneurial' skills, flexibility, and responsiveness have led to a renewed interest in their ability to complement deficient conventional system (Botton and Blanc 2010; Valfrey-Visser et al. 2006). Locally managed arrangements in middle-class colonies and in newer localities may turn into a reality the much-heralded emergence of a 'post-network' society (Coutard and Rutherford 2009; Giraud et al. 2004; Maria 2007) based on integrated and environment-friendly resource management and adapted to the diversity of demand and the peculiarities of urban expansion. Similarly, individual (quasi-wholesale domestic users) and collective arrangements (users' committees and associations) have shifted the boundary line between public and private, legal and illegal, and commercial and non-commercial suppliers. All these approaches open up new avenues for collective action in the domain of water supply services.

As they provide part of the solution to water access, these unorthodox systems contribute to redefining the role and the competence of actors who constitute the city. As such, they are not a substitute for formal reforms and improvements of the conventional system, but they need to be seen as a means of supplementing conventional water supply sources. This gives rise to two important questions.

The first question, related to the organization of water services, concerns their institutionalization and the specific problems raised by their coordination within 'composite' supply systems (Jaglin 2010). This calls for a review of all the rules governing water supply systems in order to define their perimeter, service norms, actors, as well as regulatory tools. It is also necessary to anticipate the effects of the spatial expansion of cities on the basis of these new equilibriums that involve conventional and non-conventional systems while taking care not to rigidify the system that would recreate de facto an informal sector on its fringes. Such changes in the organization of water services disrupt corporate and professional interests (for example, engineers in conventional water supply systems), perceptions (regarding norms that can be considered 'acceptable' in a city), and power equations (between the conventional operator and small-scale operators). They should be subjected to viable long-term agreements as they face the risk of being weakened very rapidly, and also demand new methods of governance.

The second question pertains to the links between these non-conventional systems and the urban government. Undoubtedly, small-scale providers indicate the agility and ability of urban societies in the South to innovate, which is reflected in the diversity and multiplicity of the urban entrepreneurs involved, but they may also lead to the flagging of public interest. On the one hand, the high-priced solutions devised in middle class and affluent neighbourhoods may lead, in some circumstances, to the complete or partial exit from the conventional system. The resultant fall in revenue for utilities would undermine the capacity of the public system[7] to cross-subsidize poorer groups. This can disrupt the urban social compact. On the other hand, small private operators can also be part of power networks (and even mafia networks) that have a negative impact on access to services. This is the case in the periphery of Mumbai where some local elected representatives also own water tankers. Consequently, they are in a position to control (or at least influence) both the formal and informal conditions of water supply (Angueletou 2008). Unorthodox solutions might also create disincentives to invest in the expansion of the networked water supply system. This note of caution calls upon the remaining importance of a functioning multi-level governance framework, where different levels of government carry out their respective responsibilities, and in particular the task of investing in the system's expansion or ensuring that urban local bodies are able to carry out investments in decentralized contexts.

Lessons for India

Within this context, two questions arise for the Indian case. First, is India distinctly different from the situation that the review presents? Second, can lessons be drawn from reform efforts that have been made, in particular the Jawaharlal Nehru National Renewal Mission (JNNURM)? In an attempt to answer these, we discuss three main points.

What are the Reasons for Shortcomings in Water Supply Services?

In the case of India, along with rapid and constant economic growth, one should expect a concomitant rise in investment and fast improvement of urban infrastructure. However, this does not seem to be the case. Despite an aggregate figure that indicates that urban India will achieve the MDG, the story is less rosy if one looks at the percentage of households with a house connection. As argued by Mehta and Mehta (2010) in their assessment of the JNNURM programme, the decline in the percentage of in-house connections from 52 to 48 per cent in the last 20 years demonstrates the weak link between higher investment in infrastructure and better services for all. India's case is exemplary of the mutual persistence of inadequate and unreliable water supply by public utilities along with more informal and private means of accessing water. First, water supply is unreliable: supply is restricted at best to a few hours per day, at worst on selected number of days even for households with in-house connections; quality is inadequate and this problem is further aggravated by unreliable supply that leads to sewage infiltration in water supply system. The consequences of highly unreliable water supply systems are considerable: households have to wait for water, reschedule their activities, and spend time to fetch water; they also invest in costly coping strategies, such as overhead tanks, pumping systems, and tube wells (Zérah 2000). Moreover, unorthodox systems, often the result of a collective action process, also tend to expand. They take various forms. On the one hand, sophisticated water supply systems in posh areas, which potentially lead to the creation of a 'club good' and the exit of wealthier consumers from the public system expand (Maria and Levasseur 2004). On the other hand, poor users diversify their strategies by accessing the state through mediators (local councillors, slum leaders, community workers), by relying on private

[7] Public system can be privately managed.

small-scale operators and water tankers (Conan 2004), and by devising collective systems of water services with the support of NGOs, local, and state politicians[8] (De Bercegol and Desfeux 2011). Similar to other countries, an array of reasons explain this low level of service: chronic underinvestment, legal and administrative barriers, and in particular the link between land tenure and service provision that often prevent expansion of water to slums and squatter settlements, high cost of connections (as well as the numerous procedures to obtain a connection), and the inefficiency of existing cross-subsidies to reach out to all sections of the population. Overall, the 'urban network' model has mostly benefitted middle class households that are the main recipients of existing subsidies for the sector and the piece-meal reforms of the last two decades have made no dent in the dual system of service provisioning. In the last few years and mostly since the launch of JNNURM, new thinking on reforms has emerged, which calls for renewed interest in PPPs to provide round the clock services, innovative mechanisms to serve the poor, and larger urban reforms.

What Direction should Efforts Towards the Modernization of Public Services Follow?

This then brings us to a second point related to the ongoing reform process. Public utilities have been under pressure to reform and they have engaged in a significant modernization process through better interface with users, better accounting systems, and experiments with service contracts for metering and bill collection. JNNURM has also put a large emphasis on enhancing urban water supply systems and on encouraging PPPs. Investment figures confirm the importance of water supply: up to September 2010, 38 per cent of JNNURM funding had been directed towards water supply.[9] The renewed interest in PPPs, following the failures of introducing large concession contracts in the end of the 1990s, is based upon a better understanding of local specificities, such as the vicious circle of low tariff, low maintenance, and low investment. This led to a focus on shorter management contracts based on pilot zones, such as the experience with 24-hours supply in Hubli-Dharwad.[10] Though this experiment has been criticized because it isolates one area of the city from the rest, it has highlighted the potential for modernization and seems to have led to a growing interest among firms (both international and domestic) in investing in urban water supply systems. However, questions remain in terms of the replicability of such projects, especially in terms of costs. In pilot projects, part of the funding is often borne either by international organizations or exceptional state funding. Another important concern is that JNNURM funded projects are traditional ones aimed at enhancing water resources through the construction of new dams and large water transport systems. As such, it perpetuates the classical approach of large hydraulic systems for increasing water resources instead of focusing on the failures of the distribution networks. In this regard, the ongoing (and at times successful) modernization process has not led to a paradigm shift. This is clearly seen in the inability of Indian cities to engage with small-scale providers, despite their importance and the role that they play in deprived neighbourhoods. This most probably pertains to the remaining importance of public monopolies and the apparent commitment to enhance water services. Nevertheless, contrary to Latin America and Africa, where many cities have given some thoughts to how to integrate these operators, it also reflects a distressing lack of understanding and knowledge on a significant part of Indian cities.

The third and final remark brings us back to the linkages between city governance, urban spaces, and water services and the importance of the political nature of water supply networks. First of all, despite the claimed importance of cities in India's economic transformation, urban local bodies remain weak financially and politically. With the exception of a few metropolitan cities, urban local bodies' finances are anaemic and the hope placed in the decentralization process as a tool for empowering local political leaders has dwindled. Cities seem to be unable to act as a

[8] Local and state politicians can fund small private water supply systems through the MC/MPLAD fund (Municipal Councillor/ Member of Parliament Local Area Development).

[9] If one includes wastewater projects, such as the construction of new sewage treatment plants, the figure is even higher.

[10] This pilot project is discussed in Chapter 16.

collective actor able to debate major local issues as well as to devise innovative solutions based upon the reality of their urban fabric despite the present day emphasis on urban reforms pushed by JNNURM. Reforms are either adopted without any adaptation to local situations or they are rejected outright. Second, along with the rise of a more vocal middle-class which is able to rely on tools, such as PILs and RTI, and the emergence of a project-based form of urbanism, the overall macro perception towards the poor has worsened with large scale evictions of slums that has in some cities (in particular in Delhi but also in Mumbai) impacted access to basic services. With this background, attempts to evolve new delivery service mechanisms (such as the Bengaluru experience to delink service provision from the status of land tenure) are bound to be marginal. Finally, reforms are widely contested and the anti-privatization movement is gaining ground. In Delhi, a large coalition of resident welfare associations and NGOs managed to derail a project of delegated management contract and similar coalitions have emerged in Mumbai and Bengaluru. This is clear evidence that water supply reforms have to be debated in the political arena and are not simply sectoral reforms that should be guided by economic efficiency. They raise a number of critical issues about the sharing of resources, the affordability of a basic urban service, and the collective choices made by all urban dwellers.

Conclusion

This chapter shows that the actual policies guiding the transformation of water supply systems cannot be dissociated from the conditions affecting decision-making processes controlled by collective action in cities. It is therefore necessary to redefine their position in the context of the wider changes in the areas of urban management and governance following decentralization and liberalization, the redistribution of roles, and the blurring of boundaries between public and private services, democratization, and reallocation of powers among technical and political élites.

In addition to analysing injunctions and reforms obtained from the same sources, this chapter drew attention to the diversity of methods of production (ranging from public monopoly to fragmented competition) and management (public, private, partly, or totally controlled by the community, etc.) of water supply systems. This patchwork reality is neither the outcome of 'flawed' implementation of models nor is it a simple compensation for the shortcomings of the public service. It is part and parcel of the water supply systems in developing cities and provides a partial solution to the problem of universalization. It is therefore necessary to question ourselves about the issues raised by this diversity: How does one take account of it? Should it be regulated? If so, in what way? What powers, what urban institutions, both formal and informal, are required to perform the difficult task of regulation?

Finally, the question of investments and 'sustainable' funding of services is of crucial importance as these are essential services and, for the most part, the answers have to be thought out afresh or rethought out without normative a prioris.

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18 Industrial Water Demand in India

Challenges and Implications for Water Pricing

Suresh Chand Aggarwal and Surender Kumar

Introduction

In India, industry is the second highest consumer of water. The main sources of water for the industrial sector are groundwater and surface water. Groundwater has emerged as an important source to meet the water requirements of industries. Choice of source of water depends on the availability of sufficient and regular supply of water and the cost of water from the source. While the running cost of surface water is mainly the price paid to the supplier—the municipal bodies; the cost of groundwater is the extraction cost—energy used (electricity/diesel). Since the prices of all the inputs, water, electricity, and diesel are administered or regulated by the government, the inefficient use of water remains a normal practice. Since the surface water supply from municipal sources is not sufficiently guaranteed, industrial units tend to depend on groundwater.

Industrial water demand has been increasing with the pace of industrial development. The growth in some of the water intensive industries has been quite significant, putting further pressure on the industrial demand for water. While the annual growth in the chemical industry and construction has been around 9 per cent, it has been around 6 per cent in textile and food since the 1990s and 5 per cent in paper and paper products industry.

Quantity Dimension

In India, there are no accurate estimates of water consumption by the industrial sector. Different agencies report different figures of water use by the industrial sector. For example, according to the Ministry of Water Resources, the industrial sector accounts for about six per cent of the total freshwater abstraction at the beginning of this century, and the Central Pollution Control Board (CPCB) reports that the figure may be eight per cent. The allocation of freshwater resources is given in Table 18.1. However, the World Bank estimates that the current industrial water use in India is about 13 per cent of the total freshwater withdrawal in the country and the water demand for industrial uses and energy production will grow at a rate of 4.2 per cent per year, rising from 67 billion cubic metres in 1999 to 228 billion cubic metres by 2025. All these estimates reveal that the industrial water demand is not negligible in India and that it is bound to grow in the coming years.

Quality Dimension

Industries not only consume water but also pollute it. According to the *World Development Report* (WDR) of 2003, in developing countries, 70 per cent of industrial wastes are dumped without treatment, thereby polluting the usable water supply. Note that industrial water

Table 18.1 Estimates of Sectoral Water Demand in India

Category	*1990 billion cubic metres (per cent)*	*2010 billion cubic metres (per cent)*	*2025 billion cubic metres (per cent)*	*2050 billion cubic metres (per cent)*
Irrigation	460 (88.6)	536 (77.3)	688 (73)	1008 (70.9)
Industries + Energy	34 (6.6)	41.4 (6)	80 (8.5)	143 (10.1)
Total (including others)	519	693	942	1422

Source: National Commission for Integrated Water Resources Development Plan, Ministry of Water Resources, 1999, as cited in Centre for Science and Environment [CSE] (2004).

demand is not the demand for water as in other sectors, as a large part of the water withdrawn for industrial use is discharged as polluted water by the industries. According to CSE (2004), on an average, each litre of wastewater discharged further pollutes about 5–8 litres of water which raises the share of industrial water use to somewhere between 35–50 per cent of the total water used in the country, and not the 7–8 per cent that is considered as the industrial water use. Polluted water is very rarely used by industries. Table 18.2 provides estimates of water consumption and wastewater generated by different industries in India.

There is rampant increase in water use and wastewater disposal due to a lack of clear environmental policies as well as fragmented responsibility and control over water used for industrial purposes (CSE 2004). The future demand will inevitably put pressure on the available freshwater resources, both due to water consumption and water pollution. To add to this, India scores poorly in terms of industrial water productivity which at US$ 3.42 m^3, is among the lowest in the world (Table 18.3). Current effluent standards use concentration as the measure of contamination, encouraging the practice among industries to dilute polluted water until acceptable norms are met, rather than controlling pollution at the source and limiting the total load discharged in water bodies. Relatively clean or reusable water polluted by industrial effluents renders this unfit for irrigation or other consumption and effectively represents a consumptive loss.

Table 18.2 Wastewater Generation and Water Use by Different Industries in India, 2004

Industrial Sector	*Annual wastewater discharge (million cubic metres)*	*Annual consumption (million cubic metres)*	*Proportion of total water consumed in industry (per cent)*
Thermal power plants	27,000.9	35,157.4	87.87
Engineering	1551.3	2019.9	5.05
Pulp and paper	695.7	905.8	2.26
Textiles	637.3	829.8	2.07
Steel	396.8	516.6	1.29
Sugar	149.7	194.9	0.49
Fertilizer	56.4	73.5	0.18
Others	241.3	314.2	0.78
Total	30,729.2	40,012.0	100.0

Source: CSE (2004).

Table 18.3 Industrial Water Use Productivity for a Group of Select Countries, 2000

Country	*Industrial value added (IVA), 2001 (in billion constant 1995 US$)*	*Industrial water use, 2000 (km^3/year)*	*Industrial water productivity (IWP), 2000 (US$ IVA m^3)*
Japan	1890	16	119.62
Korea, Republic of	286	3	93.66
UK	340	7	47.28
The Netherlands	120	5	25.17
Germany	748	32	23.43
USA	2148	221	9.73
China	594	162	3.67
India	120	35	3.42

Source: United Nations Educational Scientific and Cultural Organization (UNESCO) and World Water Assessment Programme (WWAP) (2006) as cited in Van-Rooijen et al. (2008).

Industrial Water Pricing and Price Elasticity of Demand

Price Elasticity of Demand for Water in India

Water is used by many industries as an input, like all other inputs during the process of production. Therefore, the demand for water depends, among other factors, on the demand for the final products and hence is a derived demand. The relationship between inputs and the final products is explained by the economic theory of production. It provides a useful framework for examining industrial water use and its sensitivity to the prices that is, its elasticity[1] (Spulber and Sabbaghi 1994; Renzetti 2002; and Kumar 2006) Moreover, the industrial sector may have substantially more choice over some aspects of water use than typical households, and may have ready availability of different qualities of water, including intake water, water recycling, treatment of water prior to use, and water discharge. However, the price of water that a firm pays for its use determines the demand for it to a large extent.

Poor water pricing is one of the main reasons for its inefficient use by the industrial sector. In India the cost of water has three components: Water Cess paid to the pollution control boards, cost of buying water from the suppliers such as municipalities, and cost of extracting water from the sources such as rivers or groundwater (CSE 2004). According to the Water Cess Act, 1977 (Prevention and Control of Pollution) which has been revised a couple of times, the industrial sector is required to pay a price for the use of water. However, the rate of cess is very low and the purpose of the cess is not to encourage efficient use of water but to collect resources for financing state pollution control boards. Even from the point of view of the total production cost, the water cess is insignificant. For instance, in two major water consuming industries, pulp and paper and iron and steel, even with at new rates the water cess will constitute only about 0.1–0.2 per cent and 0.02–0.05 per cent of the total value turnover, respectively (CSE 2004).

Similarly, the water supplying agencies such as municipalities do not charge according to the marginal cost of supplying water, and charges at most follow the simple average cost pricing rule which ignores the opportunity cost of water. The extent of implicit subsidy

[1] This sensitivity of demand for water to these factors is described as elasticity of demand of water. Own price elasticity provides the response of quantity demanded to its own price while cross price elasticity gives the response with respect to the price change across products. Generally all own price elasticities have a negative sign, implying an inverse relationship between the price of an input and its quantity demanded. The cross elasticity may be negative (for substitutes) or positive (for complements) depending on the substitutability of inputs.

becomes apparent when we compare the price charged by these public water supplying agencies to the price paid by industries in water-scarce regions to commercial water suppliers. In water-scarce areas of Gujarat and Tamil Nadu some firms are already paying Rs 25–60 per kilolitre (CSE 2004). Similarly, the cost of negative externalities arising from the damages caused by industries in polluting surface water and groundwater are ignored in determining water tariffs. Instruments that charge negative externalities such as pollution taxes and/or effluent charges do not exist. As a result, from an economic viewpoint, excessive quantities of water are used, and excessive pollution is caused. Goldar (2003) finds that on average industry pays just Rs 1.94 per kilolitre.

To find the opportunity value of water, Kumar (2006) estimates the shadow price of water for industrial use in India for major water polluting industries.[2] A shadow price is the maximum price that a firm is willing to pay for an extra unit of a given limited resource, that is, water. The value of the shadow price can provide a powerful insight into the gap between the price of water which is actually being paid by the firms and the price which the firms may be willing to pay to meet the demand. He estimates the average shadow price of water to be Rs 7.21 per kilolitre. It is also found that there is a wide variation in price across firms and industries (see Table 18.4). The variation may be due to the difference in water intensity, as measured by the ratio of water consumption to sale value, among the industries. The correlation coefficient between the shadow price of water and water intensity is 0.32. While the correlation is 0.68 for firms in which the intensity of water is more than one kilolitre/unit of output (million Rs), it is 0.14 for firms in which the water intensity is less than one kilolitre/unit of output (million Rs). This implies that higher the water intensity, higher would be the shadow price. The difference between the actual price paid and its opportunity value, therefore, indicates the existence of ample scope for introducing a higher water price for the industrial use. This also implies that water shortage in industries would constitute a significant cost in terms of lost industrial output.[3]

Table 18.4 Shadow Price of Water

Name of Industry	*Number of observations*	*Shadow Price of Water (Rs/Kl)*
Leather	09	1.161
Distillery	18	6.752
Chemicals	48	3.164
Sugar	114	4.862
Paper and Paper Products	33	30.535
Fertilizers	18	2.465
Drug and Pharmaceuticals	06	3.919
Petrochemicals	09	1.396
Misc.	21	3.026
All	276	7.209

Source: Kumar (2006).

Kumar (2006) also estimates the cross elasticity and own price elasticity for industrial use of water. Since firms use different inputs such as labour, capital, materials, and water, for each of these inputs, both own price elasticity and cross price elasticity have been calsculated. Table 18.5 presents these elasticities at their mean values. All own price elasticities have the expected negative sign, implying an inverse relationship between the price of an input and its quantity demanded. It should be noted that the own price elasticity of industrial water use, contrary to the domestic sector, is quite high, –1.11 at the sample mean. This result suggests that demand for water is very sensitive to its own price and hence a suitable pricing policy can be a potential instrument for water conservation.

Elasticity of Demand for Water—An International Comparison

The estimated elasticity of water in the present analysis is close to that obtained by Wang and Lall (2002) for the Chinese economy, at approximately -1.0 and by Feres and Reynaud (2003) for the Brazilian economy

[2] Kumar (2006) uses the data collected for a sample of water polluting industries by the Institute of Economic Growth. For details, see Murty and Kumar (2004).

[3] The serious adverse effect that water shortage has on industrial production has been analysed by Bhatia et al. (1994) in the context of India and some other developing countries.

Table 18.5 Mean of Cross and Own Indirect Price Elasticity of Input Demands

	Materials	*Wage bill*	*Capital stock*	*Water*
Materials	–3.73	6.94	8.55	125.00
Wage bill	3.42	–1.92	4.55	142.86
Capital stock	3.70	3.05	–1.70	–111.11
Water	1.27	0.81	–3.19	–1.11

Source: Kumar (2006).

(see Table 18.6). However, since Wang and Lall (2002) adopt a marginal productivity approach and Feres and Reynaud (2003) adopt a cost function approach to derive elasticity estimates, any comparison between the two has to be made with caution.

The estimates of own price elasticity of industrial water for India (Kumar 2006), China, and Brazil are higher than those obtained by Onjala (2001) for India. These differences are largely due to methodological differences between the studies. The water price used by Kumar (2006) corresponds to the marginal cost whereas the prices paid by Indian firms are far below this level. This may have led to an upward bias in his estimates. The same upward bias could be present in Wang and Lall (2002) and Feres and Reynaud (2003). Moreover, the three studies of India, China, and Brazil are related by and large to medium and large plants, which tend to have higher water price elasticity than small ones. Since large firms withdraw high volumes of water, they face high incentives to invest in water-recycling/conservation activities if the pricing of water is efficient. Water recirculation being a substitute to water withdrawal, these firms would have higher water withdrawal price elasticity (Reynaud 2003). In developing countries, it should be noticed that water is not a scarce resource in the sense that firms do not face any stringent water resource constraint. Water is often an under-priced or un-priced intermediate input in these countries. In such a context, firms are likely to overuse water resources and the marginal productivity of water tends to be low, as reported by Wang and Lall (2002). This may result in high responsiveness to water prices, since any increase in water prices would lead to substantial cut in water withdrawals.

Table 18.6 Price Elasticity of Demand for Water in Selected Countries

Name of the Country (Source)	*Price Elasticity*
India (Kumar 2006)	–1.1
China (Wang and Lall 2002)	–1.0
Brazil (Feres and Reynaud 2003)	–1.08
Kenya (Onjala 2001)	–0.60 to 0.37
India (Goldar 2003)	–0.64 to –0.4
US manufacturing (Grebenstein and Field 1979)	–0.80 to –0.33
Canadian Manufacturing (Babin, Willis, and Allen 1982)	0.59 to –0.15
French Manufacturing (Reynaud 2003)	–0.29

The cross price elasticities as shown in Table 18.5 (off-diagonal cells) indicate that water is found to be a substitute for capital and a complement to materials and labour. Substitution between capital and water was also observed by Dupont and Renzetti (2001) and Feres and Reynaud (2003), in contrast to previous results from Grebenstein and Field (1979) and Babin, Willis, and Allen (1982), where water was found to be a substitute for labour and a complement to capital.

The substitutability between water and capital implies that as the price of water increases the industry employs more of capital. As the price of water increases the industry may try to reduce water consumption by investing in water conserving/recirculation technologies. Water conservation/recirculation is generally accompanied by reduction in energy costs, recapturing valuable raw materials and reduction in effluent stream (Dupont and Renzetti 2001). Therefore, the complementarity between water and materials found by Kumar (2006) is in conformity with Dupont and Renzetti.

The estimated price elasticities of water point to the fact that despite different estimates, demand for water in India is not only highly sensitive to its own price but also to the prices of other inputs such as capital, labour, and materials. While own price elasticities of water in India are higher than those in developed countries, they are comparable to other similarly placed developing countries. A suitable water pricing policy and incentive structure for efficient use of water may go a far way in rationalizing the use of water by the industrial sector in India.

Industrial Water Regulations

The problem of industrial water (mis)management is fairly obvious. First, there is a lack of effective regulations and coordination between regulatory bodies. Second, there are few incentives provided to industry for efficient water use. Water tariffs, where they exist, are very low and otherwise ignored. As a result, conflicts between industry and local communities are on the rise over water allocation and water pollution. Depletion of groundwater by industries, diversion of water meant for irrigation to industries, and preferential treatment given to industries by the government are some of the major reasons for the conflict between industry and community over water use (CSE 2004). Protests and public interest litigations have become quite common on this issue. In India, where every segment of the economy is growing rapidly, and domestic, agricultural, and industrial water needs are pitted against each other, the conflict will become unmanageable if it is not addressed now.

In India there is a multiplicity of authorities/ministries with different mandates which are often vaguely defined and overlapping, for example, the Ministry of Water Resource (MoWR) is the principle agency responsible for water in India but water pollution does not fall under its purview, nor does the industrial use of water. Similarly, the Ministry of Industry (MoI) is concerned with the planning and development of water resources for industrial use. It has no mandate to control or regulate water use by industries. The Central Groundwater Board (CGWB) is meant to regulate the groundwater quality and quantity in the country. Though they have mandate to do what they can with groundwater, they have so far only mapped the groundwater status. They have no mandate to charge for industrial groundwater use. While the CPCB and state pollution control boards (SPCBs) regulate industrial water pollution and charge water cess based on the amount of wastewater discharged by the companies, they have no mandate to control sourcing of water from various sources. As a result, water conservation and pollution control measures have not shown any significant success.

Groundwater Regulations

In India, as of now, there is no law determining the exact amount of water meant for consumption by the various industrial sectors. Though CPCB has prescribed water consumption levels for some industrial sectors, they are mere recommendations and cannot be enforced by laws. Laws related to groundwater extraction are also obsolete. As per the law, the person who owns the land also owns the groundwater below. Though this law has some relevance as far as the domestic groundwater use is concerned, it is illogical for industrial and commercial use. The consequence of such laws is that industries withdraw groundwater that remains unregulated and un-priced.

The Scheme on Artificial Recharge of Groundwater through dug wells in hard rock areas in seven states is facing problems due to the overexploitation of groundwater. Pursuant to the announcement made by the Honourable Minister of Finance in his Budget Speech, 2007, a State Sector Scheme on 'Artificial Recharge to Groundwater through dug wells' during the Eleventh Plan is under implementation in 1180 over-exploited, critical, and semi-critical blocks in the seven states namely, Andhra Pradesh, Maharashtra, Karnataka, Rajasthan, Tamil Nadu, Gujarat, and Madhya Pradesh at an estimated cost of Rs 1798.71 crores. The scheme aims to facilitate improvement in the groundwater situation in the affected areas, increase the sustainability of wells during lean period, improve quality of groundwater, and involve the community in water resource management in the affected areas.

Industrial Water Recycling

The effluent discharged by industries in rivers leads to many health related problems and causes loss of agricultural production to the villagers who live downstream. Industries must be made to invest in the up-gradation of their pollution control equipment for effluent treatment. They should be motivated to reduce their water consumption through regulation or incentives. However, water use and water pollution in industries can be reduced only if water pricing is such that it encourages industries to conserve water. There are instances which clearly prove that proper pricing of natural resources is essential for proper management of natural resources and this, in turn, has a direct bearing on efficient water management.

Industrial Wastewater Management

The wastewater treatment system by most of the industries are essentially installed to meet the wastewater discharge norms, which are concentration based, that is, they measure the concentration of pollution in a given quantity of water. The result is that an industry can meet the required standard merely by diluting the effluent with clean water. Since the cost of water is low, it makes more economic sense for an industry to dilute the effluent than to treat it to meet the standards.

The industries do not have the incentives to recycle and reuse the wastewater. Water once used is generally thrown without any further use, even if it can be reused. Segregation of wastewater from various processes into clean wastewater (that can be reused), and contaminated water, is not commonly done. The result is that even the uncontaminated water gets contaminated after mixing and is discharged as effluent.

Conclusion

Industrial water demand in India is on the rise. Also water use in Indian industry is very high due to a combination of factors including obsolete process technology, poor recycling and reuse practices and poor wastewater treatment. There is very low level of awareness about the problem and needs for wastewater treatment by industry.

Efficiency of utilization in all the industrial uses of water should be optimized and an awareness of water as a scarce resource should be fostered. The water resources should be conserved and its availability increased by maximizing retention, eliminating pollution and minimizing losses. Conservation consciousness should be promoted through education, regulation, incentives and disincentives. Though some of the issues related to the industrial water have been addressed in National Water Policy (NWP) 2002 but no clear vision for regulating and controlling industrial water use has been given.

The key to the problem lies in effective management of water resources. Suitable measures including improved process technology; effluent treatment; reuse of process water for more than once; re-circulating of process water in the same use for a number of times; rainwater harvesting; waste-minimization must be adopted. Coordination among different authorities/ Ministries is a must if the future water conflicts are to be avoided.

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Section IV

Wastewater

19 Water Pollution in India

An Economic Appraisal

M.N. Murty and Surender Kumar

Introduction

Water pollution is a serious problem in India as almost 70 per cent of its surface water resources and a growing percentage of its groundwater reserves are contaminated by biological, toxic, organic, and inorganic pollutants. In many cases, these sources have been rendered unsafe for human consumption as well as for other activities, such as irrigation and industrial needs. This shows that degraded water quality can contribute to water scarcity as it limits its availability for both human use and for the ecosystem.

In 1995, the Central Pollution Control Board (CPCB) identified severely polluted stretches on 18 major rivers in India. Not surprisingly, a majority of these stretches were found in and around large urban areas. The high incidence of severe contamination near urban areas indicates that the industrial and domestic sectors' contribution to water pollution is much higher than their relative importance implied in the Indian economy. Agricultural activities also contribute in terms of overall impact on water quality. Besides a rapidly depleting groundwater table in different parts, the country faces another major problem on the water front—groundwater contamination—a problem which has affected as many as 19 states, including Delhi. Geogenic contaminants, including salinity, iron, fluoride, and arsenic have affected groundwater in over 200 districts spread across 19 states.

Water as an environmental resource is regenerative in the sense that it could absorb pollution loads up to certain levels without affecting its quality. In fact there could be a problem of water pollution only if the pollution loads exceed the natural regenerative capacity of a water resource. The control of water pollution is therefore to reduce the pollution loads from anthropogenic activities to the natural regenerative capacity of the resource. The benefits of the preservation of water quality are manifold. Not only can abatement of water pollution provide marketable benefits, such as reduced water borne diseases, savings in the cost of supplying water for household, industrial and agricultural uses, control of land degradation, and development of fisheries, it can also generate non-marketable benefits like improved environmental amenities, aquatic life, and biodiversity.

Using available data and case studies, this chapter aims to provide an overview of the extent, impacts, and control of water pollution in India. It also tries to identify the theoretical and policy issues involved in the abatement and avoidance of water pollution in India.

Extent of Water Pollution in India

The level of water pollution in the country can be gauged by the status of water quality around India. The water quality monitoring results carried out by CPCB particularly with respect to the indicator of oxygen consuming substances (biochemical oxygen demand, BOD) and the indicator of pathogenic bacteria (total coliform and faecal coliform) show that there is gradual degradation in water quality (CPCB 2009). During 1995–2009, the number of observed sample with BOD values less than 3 mg/l were between 57–69 per cent; in 2007 the observed samples were 69 per cent. Similarly, during this period of 15 years between 17–28 per cent of the samples observed BOD value between 3-6 mg/l and the maximum number of samples in this category were observed in 1998. It was observed that the number of observations remained unchanged and followed a static trend in percentage of observations having BOD between 3–6 mg/l. The number of observed BOD value > 6 mg/l was between 13 and 19 per cent during 1995–2009, and the maximum value of 19 per cent was observed in 2001, 2002, and 2009. It was observed that there was a gradual decrease in the BOD levels and in 2009, 17 per cent had BOD value > 6 mg/1. The worrying aspect of this trend is the high percentage (19 per cent) of sampling stations exhibiting unacceptable levels of BOD, which might either mean that the discharge sources are not complying with the standards or even after their compliance their high quantum of discharge contributes to elevated levels of contaminants (Rajaram and Das 2008). However, the status of water quality cannot be adequately assessed through monitoring of basic parameters in the current inadequate number of sampling stations.

Another aspect of water pollution in India is inadequate infrastructure, comprising of monitoring stations and frequency of monitoring for monitoring pollution. Monitoring is conducted by CPCB at 1,700 stations, (Figure 19.2), under a global environment monitoring system (GEMS) and Monitoring of Indian National Aquatic Resources (MINARS) programmes (CPCB 2009). There is an urgent need to increase the number of monitoring stations from their current number, which translate as one station per 1,935 km^2 to levels found in developed nations for effective monitoring. For example, in the state of Arkansas in the US there are monitoring stations per 356 km^2 (Rajaram and Das 2008). CPCB (2009) also reports the frequency of monitoring in the country. It is observed that 32 per cent of the stations have frequency of monitoring on a monthly basis, 28.82 per cent on a half-yearly basis, and 38.64 per cent on a quarterly basis. This indicates the need for not only increasing the number of monitoring stations but also the frequency of monitoring.

The water quality monitoring results obtained by CPCB during 1995 to 2009 indicate that organic and bacterial contamination was critical in the water bodies. The main cause for such contamination is discharge of domestic and industrial wastewater in water bodies mostly in an untreated form from urban centres.

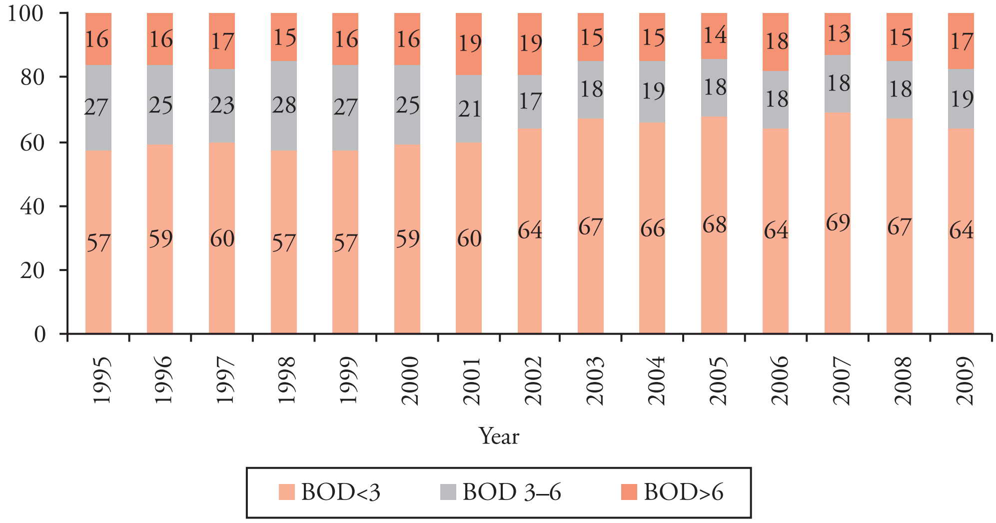

Figure 19.1 Trend of Biochemical Oxygen Demand (BOD), 1995–2009

Source: CPCB (2009).

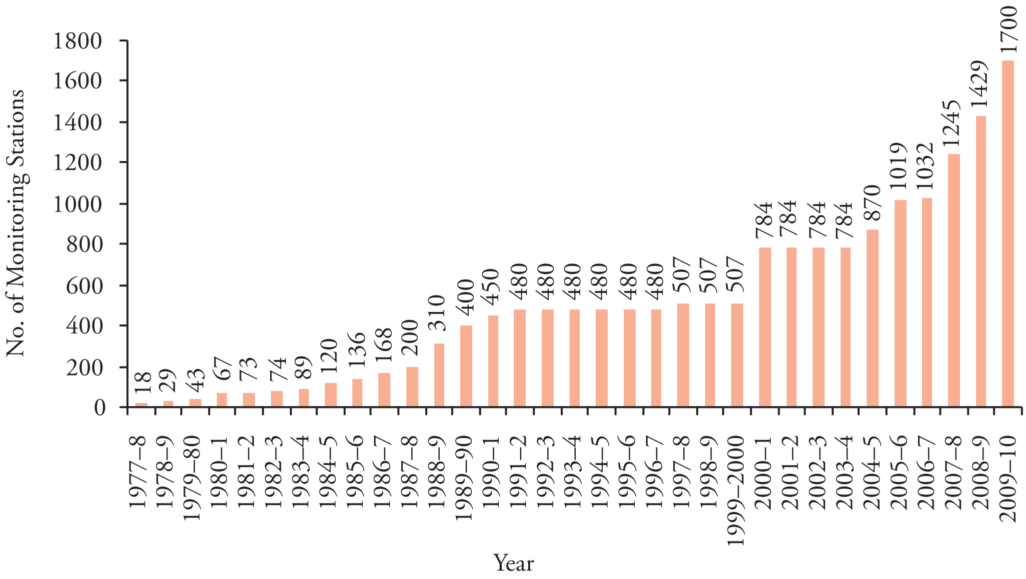

Figure 19.2 Growth of Water Pollution Monitoring Network in India

Source: CPCB (2009).

Secondly the receiving water bodies also do not have adequate water flow for dilution. Therefore, the oxygen demand and bacterial pollution is increasing.

Household borne effluents contribute a substantial proportion of water pollution in India. Untreated effluents from households pollute surface and groundwater sources. Local governments (city corporations, municipalities, and panchayats) have the responsibility of water supply and sanitation and are supposed to treat the effluents as per national water pollution standards or minimal national standards (MINAS) However, about 70 per cent of the effluents are not treated and disposed off into the environmental media untreated. Table 19.1 provides the summary statistics of wastewater generation and treatment in India in 2008. This table shows that cities, which have a population of more than one lakh (Class-I), treat only about 32 per cent of the wastewater generated. Note that out of the total effluent treatment capacity of 11554 MLD in the country, about 70 per cent (8040 MLD) has been created in 35 metropolitan cities. Metropolitan cities treat about 52 per cent of their wastewater. Delhi and Mumbai account for about 69 per cent of the treatment capacity of metropolitan cities. This indicates that smaller towns and cities have very little wastewater treatment capacity. Meanwhile, only 3.15 per cent of the rural population has access to sanitation services and 115 million homes have no access to toilets of any type.

CPCB provides source-specific pollution standards for industries with respect to pollution concentration of major water pollutants: (BOD), chemical oxygen demand (COD), suspended solids (SS), and pH. CPCB

Table 19.1 Wastewater Treatment Capacity in Urban Areas in India, 2008

Category	*No. of cities*	*Total water supply (in MLD)*	*Wastewater generation (in MLD)*	*Treatment capacity (in MLD)*
Class-I City	498	44,769.05	35,558.12	11,553.68 (32%)
Class-II town	410	3,324.83	2,696.7	233.7 (8%)
Total	908	48,093.88	38,254	11787.38 (31%)

Source: CPCB (2008).

launched a water pollution control programme in 1992 for industries. It identified 1,551 large and medium industries, and gave a time schedule to these industries for compliance with prescribed standards. It was found that many of these industries have effluent treatment plants (ETPs) but despite these they did not comply with prescribed pollution standards. In the industrial sector only 59 per cent of the large and medium industries had adequate effluent treatment in 1995. There are 0.32 million small-scale industrial units in India and due to the presence of scale economies in water pollution reduction, it is uneconomical for these units to have ETPs of their own (Murty et al. 1999). These small-scale units contribute almost 40 per cent of the industrial water pollution in India. However, small-scale units located in many industrial estates in India have gone for common effluent treatment plants (CETPs).

Agricultural run-offs affect groundwater and surface water sources as they contain pesticide and fertilizer residues. Fertilizers have an indirect adverse impact on water resources. Indeed, by increasing the nutritional content of water courses, fertilizers allow organisms to proliferate. These organisms may be disease vectors or algae. The proliferation of algae may slow the flow in water courses, thus increasing the proliferation of organisms and sedimentation. WHO has defined a permissible limit of concentration of nitrates of 45 mg/L of NO_3, which is also accepted by the Indian Council of Medical Research (ICMR). In the agricultural sector, fertilizer use increased from 7.7 MT in 1984 to 13.4 MT in 1996 and pesticide use increased from 24 MT in 1971 to 85 MT in 1995 (Bhalla et al. 1999). It has been observed that in states, such as Haryana, the NO_3 concentration has exceeded the permissible limits (Maria 2003).

Effects of Water Pollution

Lack of water, sanitation, and hygiene results in the loss of 0.4 million lives while air pollution contributes to the death of 0.52 million people annually in India (WHO 2007). Environmental factors contribute to 60 years of ill-health per 1,000 population in India compared to 54 in Russia, 37 in Brazil, and 34 in China. The socio-economic costs of water pollution are extremely high: 1.5 million children under 5 years die each year due to water related diseases, 200 million person days of work are lost each year, and the country loses about Rs 366 billion each year due to water related diseases (Parikh 2004).

McKenzie and Ray (2004) also observe similar effects of water pollution; however, the magnitude of the effect was modest. The study shows that India loses 90 million days a year due to water borne diseases with production losses and treatment costs worth Rs 6 billion. Poor water quality, sanitation, and hygiene result in the loss of 30.5 million disabilities adjusted life years (DALY) in India. Groundwater resources in vast tracts of India are contaminated with fluoride and arsenic. Fluoride problems exist in 150 districts in 17 states in the country with Orissa and Rajasthan being the most severely affected. High concentration of fluoride in drinking water causes fluorosis resulting in weak bones, weak teeth, and anaemia. The presence of arsenic, a poison and a carcinogen, in the groundwater of the Gangetic delta causes health risks to 35–70 million people in West Bengal, Bihar, and Bangladesh.

Murty and Kumar (2004) estimated the cost of industrial water pollution abatement and found that these costs account for about 2.5 per cent of industrial GDP in India. Parikh (2004) shows that the cost of avoidance is much lower than damage costs (Table 19.2). According to one estimate (Parikh 2004), India lost about Rs 366 billions, which account for about 3.95 per cent of the GDP, due to ill effects of water pollution and poor sanitation facilities in 1995. If India had made efforts for mitigating these effects in terms of providing better sanitation facilities and doing abatement of water pollution the required resources had ranged between 1.73 to 2.2 per cent of GDP. It may however, be emphasized that these damage costs do not fully reflect the loss in social welfare. These estimates only suggest that the abatement of pollution is socially desirable and economically justified.

Regulation of Water Pollution

Environmental policies are designed to alter the behaviour of economic agents, either individuals or group of individuals, in such a manner that the environmental externalities generated during the course of individual actions are internalized. As shown in Figure 19.3 policy responses can be classified into two categories: formal and informal. A legislative response requires policy responses mandated by the state. These policy responses

Table 19.2 Alternative Estimates of Costs of Water Pollution (Rs millions/year at 1995 prices)

A. Damage costs		
a	Value of annual loss of 30.5 million DALYs @ average per capita GDP of Rs.12000	366,000 3.95% of GDP (1995–6)
B. Avoidance costs		
a	Pollution abatement in organized industry	10,120
b	Pollution abatement in small-scale industry	45,980
c	Wastewater treatment in 3,696 cities/towns	3,620 to 10,540
d	Provision of toilets to 115 million households	35,300 to 56,630
e	Provision of safe drinking water	39,300
Annualized cost (assuming operations and maintenance costs of installed facilities at 20% of capital costs) Annual costs (capital + O&M)		134,320 to 162,550 26,860 to 32,510 161,180 to195,060
Annual cost as per cent of GDP (1995)		1.73 to 2.1%

Source: Parikh (2004).
Note: a, b, c, and d at 15% discount rate and 15 years life.

may originate from the government to achieve the given objective of maximizing social welfare or from society itself, as it feels the heat of externalities and exerts pressure on governments to bring out legislations to control externalities. Actions by the state to control externalities without public pressures can be put into the category of formal regulations and actions that emerge in response to civil society pressures to control individual behaviour in social interest are classified as informal regulations. Environmental regulations do not remain confined within the preview of governments in modern economic structures because firms are not individually governed units, they have to depend on markets to get investment capital and to sell their products. Markets also help in altering individual behaviour in a socially desirable manner. In India we find both formal and informal regulations in the area of environmental externalities (Figure 19.3).

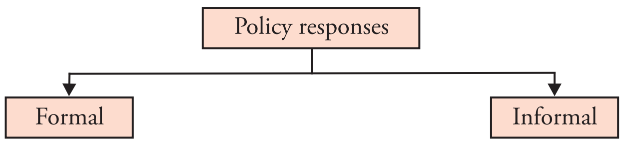

Figure 19.3 Environmental Regulations in India

Formal Regulations

Historically, there have been policy responses for prevention and control of environmental degradation in the country since the 1970s. The environmental policy in recent times has recognized the importance of the role of incentive based policy instruments in controlling and preventing environmental pollution. Formal regulations may be classified into two categories (Figure 19.4). State intervenes in the form of legislations and policies, and public investments for environmental cleaning activities, such as the Ganga Action Plan (GAP) and the Yamuna Action Plan.

Laws for Controlling Water Pollution in India

The acts that directly concern water pollution in India are the Water Act (1974), the Water Cess Act (1977 and 1988), and the Environment (Protection) Act or EPA (1986). While the first two are foundational legislations in the context of water pollution in the country, EPA is designed to fill the gaps still remaining in the legal framework for the control of industrial pollution. The act related to water cess is more of a revenue-generating legislation than a measure to restrict the consumption of water by industrial units. Pollution control boards at the central and state levels are empowered to prevent, control, and abate water pollution, and to advise governments on matters pertaining to such pollution. CPCB is to coordinate the activities of the state boards. Note that these laws have mainly remained confined to controlling industrial water pollution. CPCB has also

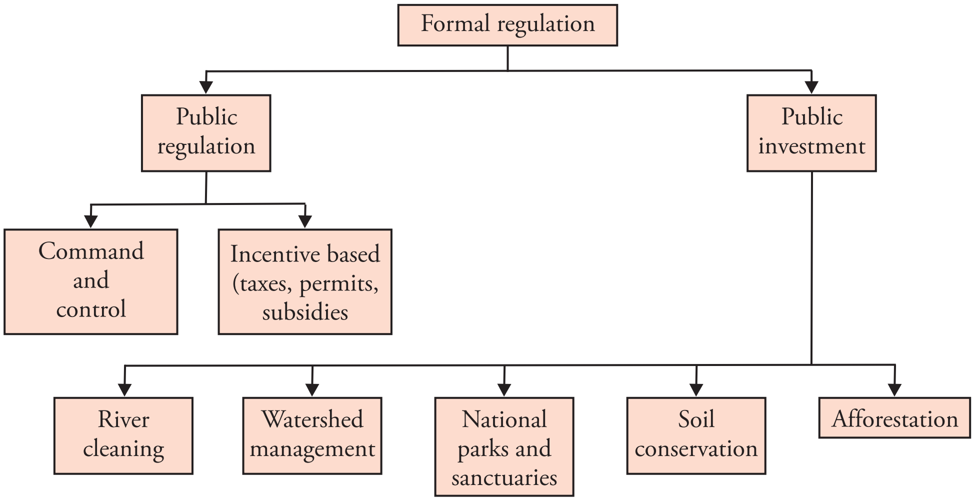

FIGURE 19.4 Formal Environmental Regulations in India

prepared a list of polluting industries in India. The acts also specify that industrial units have to provide, on demand, all information regarding their effluent and treatment methods. These laws however, do not cover the regulation of water pollution originating from the household and agriculture sectors. The legislative framework followed in India for the regulation of water pollution is summarized in Table 19.3.

Fiscal Instruments for Pollution Control in India

The government's approach towards prevention of pollution has been mostly through legislation-based command and control measures while natural resource management has been largely carried out through programmes supported by allocations from central (for example, programmes of the Ministry of Environment and Forests, Ministry of Non-conventional Energy

TABLE 19.3 Water Regulation Framework in India

Sl.no.	*Polluting sources*	*Effect on ecosystem*	*Specific standards*	*Current status*
1	Domestic sewage from towns and cities	Organic pollution of rivers, eutrophication of lakes, spread of water borne diseases	MINAS	Out of 26,500 mld of sewage from Class-I cities and Class-II towns treatment capacity exists only for about 7,000 mld (26%). Out of 271 STPs inspected by CPCB only 150 (55%) were complying with MINAS
2	Industrial effluents (point discharges)	Organic and inorganic pollution, toxic chemicals in food chain	MINAS (industry specific)	No comprehensive statistics on compliance exists as it is dealt mainly by SPCBs Widespread damage of ecosystem around industrial areas is well documented by CPCB
3	Industrial and mines run-off	Organic and inorganic pollution, toxic chemicals in food chain	No standards/ legislation	No comprehensive study as stored hazardous waste, mine spoils, etc. contribute large quantum of contaminants which pollute surface and groundwater
4	Agricultural run-off	Fertilizers leading to eutrophication pesticides in the food chain	No standards/ legislation	Nation wide studies have not been conducted, apart from regular news articles on pesticides in water and food items

Source: Rajaram and Das (2008).

Sources, and the Ministry of Agriculture, etc.) and state budgets. The use of fiscal instruments (other than the expenditure policy) in the environmental policy has been limited, even though the need to employ economic and fiscal policy instruments for the control of pollution and management of natural resources has gained recognition since the 1990s (Datt et al. 2004).

A task force was constituted by the Ministry of Environment and Forests (MoEF) in 1995 to evaluate the scope for market based instruments (MBIs) for industrial pollution abatement (Government of India 1997). The task force recommended explicit incorporation of MBIs in pollution control laws, greater reliance on economic penalties in the short and medium term, and completely replacing criminal penalties by MBIs in the long run. It also recommended modifying the existing water cess to make it a genuine effluent-based tax based on pollution load rather than the amount of water consumed, as also abolishing tax concessions on installation of pollution control equipment. It recognized the need for systematic data collection to estimate marginal abatement costs and the regulatory burden and called for the introduction of additional MBIs.

The actual use of fiscal incentives in the country has, however, been rather limited. These take the form of tax concessions for the adoption of pollution control equipment. Tax incentives are usually specified for identified abatement technologies and activities, not providing dynamic incentives for technological innovation and diffusion. Also, since most of these are end-of-the-pipe treatment technologies, these incentives do not promote more efficient use of resources. There are some provisions for the use of levies, cess, fines, and penalties, etc. for polluters, but their implementation and effectiveness needs strengthening (Kumar and Managi 2009).

Although it is widely known that command and control measures do not provide necessary incentives to polluters for the choice of least cost methods of pollution control, the Government of India has so far resorted only to such measures for controlling industrial pollution in India. On the other hand, fiscal instruments, such as pollution taxes or marketable pollution permits though also coercive, provide incentives to factories for adopting least cost pollution abatement technologies. Ironically, there have been no serious attempts in India to use such instruments for the abatement of industrial pollution. The current water cess, whose objective is to raise revenue to pollution control boards, is very nominal (Rs 0.015 to 0.07 per kilolitre [Kl]). Some of the recent research studies on water pollution abatement in India conclude that the rate of pollution tax on industrial water use should be several times higher than the prevailing rate of water cess if we want to realize the prescribed water quality standards in the country. One study carried out in 1989 (Gupta et al. 1989) estimated the cost of treatment per a Kl of residual water at 1987–9 prices at Rs 3.60 for the paper and pulp industry, at Rs 2.61 for oil refineries, Rs 2.21 for chemicals, and Rs 1.64 for sugar. Another study (Mehta et al. 1994) carried out in 1994 estimated the marginal cost of abatement for the reduction of 100 mg of bio oxygen demand in the residual water for the paper and pulp industry at Re 0.38 at 1991–2 prices. Yet another study published in 1999 (Murty et al. 1999) found that the pollution tax per 100 mg reduction of COD by the Indian manufacturing industry for realizing the standard of 250 mg per litre of residual water was Re 0.32 at 1995–6 prices.

MoEF also commissioned several case studies to examine issues relating to economic instruments for pollution abatement. These studies estimated abatement costs of pollutants and recorded wide variations across different industries. The studies pointed out the inefficiency of the current legislation, which requires all polluters to meet the same discharge standards, and called for the introduction of economic instruments for cost effective pollution control. They emphasized the need for regulators to allocate their monitoring resources more efficiently by targeting industries characterized by relatively high discharges and low costs of pollution abatement. These studies also observed that taxes and incentives based on efficiency instruments better align pollution control agencies with polluters than the command and control regime.

Some studies[1] give some information about the rate of tax to be levied on industries for making them comply with the prescribed water standards. Mehta

[1] See Gupta et al. (1989); Mehta et al. (1994); Murty et al. (1999); Pandey (1998); Misra (1999); World Bank (1999); and Murty and Kumar (2004).

et al. (1994) considered an abatement cost function for an effluent treatment plant in paper and pulp units in India, and concluded that marginal abatement costs of relatively high cost producers should serve as the basis for setting charges/taxes so as to ensure that producers find it cheaper to abate than to pollute. They recommended four options for experimenting by policymakers: (i) abatement charges with the government undertaking cleaning up, (ii) abatement charges with cleaning-up contracted out based on competitive bidding, (iii) a tax proportional to excess pollution on firms violating standards and subsidies for those going beyond the prescribed abatement standards, and (iv) a private permit trading system.

The water polluting firms in Indian industry are supposed to meet the standards set for pollutants (35mg/l for BOD, 250mg/l for COD, and 100mg/l for SSP) by the Central Pollution Control Board. A survey[2] of a sample of water polluting industries in India shows that most of the firms have effluent treatment plants and in addition some firms are using process changes in production and input choices to achieve effluent standards. However, there is a large variation in the degree of compliance among the firms measured in terms of ratio of standard to effluent quality. The laxity of formal environmental regulations by the government and the use of command and control instruments could be regarded as factors responsible for large variations in complying with pollution standards by firms. Using this data, Murty and Kumar (2004) provide estimates of taxes on one tonne of BOD, COD, and SS as Rs 20,157, Rs 48,826, and Rs 21,444 respectively.

Informal Regulation and People's Participation

Economic instruments and command and controls are instruments of formal regulation. The designing and implementation of these instruments involves a top-down or a centralized approach. The success of these instruments in controlling pollution depends upon the quality of governance and its ability to incur high transaction costs. A bottom-up or decentralized regulation involving civic society and local communities and with a very limited role of the government could save transaction costs and get rid of political and bureaucratic corruption. This approach draws theoretical support from the Coase Theorem (Coase 1960). The Coase Theorem states that the optimal level of pollution control could be realized through the bargaining between the polluters and the affected parties, given the initial property rights to either of the parties in the absence of transaction costs. Even with positive transaction costs, the bargaining could result in the reduction of externality though not to the optimum level. Recent empirical experiences show that the bargaining between the communities and polluters helped in reducing the water pollution when the government had been protecting the property rights to the environmental resource to the people (Murty et al. 1999; Paragal and Wheeler 1996; World Bank 1999).

The management of environmental resources can no longer be taken as the responsibility of a single institution like a market or the government (Murty 2008). The now well-known limitations of either the market or the government in managing the environment have paved the way for a mixture of institutions. Market agents, consumers, producers, and stockholders have incentives for controlling pollution. Consumers regulate the market for pollution intensive commodities by expressing preferences for green products or commodities produced using cleaner technologies. Investors also have incentives to invest in industries using cleaner technologies. Higher level of observed pollution in a firm is an indication to the investors that the firm uses inefficient technology resulting in the loss of profits. Profit losses may occur because of reduced demand for its products by green consumers, increased costs due to higher penalties imposed by the government for non-compliance with pollution standards, and the settlement of compensation to victims. In this case there may be a downward revaluation of the firm's stocks in the capital market. On the other hand, a good environmental performance by a firm may result in an upward evaluation of its stocks (Murty 2008).

Some recent studies have shown that stock markets in both developed and developing countries react to the environmental performance of firms. Also studies about firms' behaviour with respect to environment performance related changes in stock prices show that

[2] 'A Survey of Water Polluting Industries in India' (1996) and 'A Survey of Water and Air polluting Industries in India' (2000), Institute of Economic Growth, Delhi.

firms react to such changes by reducing pollution loads. Recent studies about this phenomenon in some developing countries like India (Gupta and Goldar 2005), Argentina, Chile, Mexico, and Philippines show that stock prices are even more volatile to news about the environmental performance of firms. The average gain in stock prices due to good news about environmental performance is found to be 20 per cent in these countries.

There is now evidence about a number of industries in the developing countries complying with environmental standards even in the absence of formal regulations by the government. One interesting example is the success story of PT Indah Kiat Pulp and Paper (IKPP) in Indonesia (World Bank 1999). IKPP is the largest and the cleanest paper producing company in Indonesia. A clean up started in some of its mills in the 1990s with pressures from local communities. Local villagers claimed damages from the mills with the help of local NGOs. Indonesia's national pollution control agency, BAPEDAL, mediated an agreement in which IKPP acceded to the villagers' demands. Further, the need for going to western bond markets for financing the expansion of IKPP to meet the growing export demand, made the company go in for cleaner technologies. The good performance of the company in pollution management has resulted in an increase in its stock value in comparison to Jakarta's composite stock index. Figure 19.5 describes the structure of informal environmental regulations in India.

Take for example pollution abatement by small-scale enterprises located in industrial estates in India. Use of command and control instruments by the government in an environment of non-availability of economically viable technological options for pollution abatement has been causing considerable hardships to small-scale enterprises. The government managed public sector has been the fountainhead of industrial development. But the government has not made any sincere efforts to promote economically viable pollution abatement technologies for small-scale enterprises via R&D in the public sector. The presence of scale economies in pollution abatement, especially in water pollution abatement, has compounded problems for industrial estates. In such a situation, it is not economical for the small-scale enterprises to have their own individual effluent treatment plants to comply with the command and control regulation. Collective action involving all the relevant parties for water pollution abatement (factories, affected parties, and the government) is now seen as an institutional alternative for dealing with the problem of water pollution abatement in industrial estates, especially in India (Murty et al. 1999). Collective action in industrial water pollution abatement is meant to bring about necessary institutional changes that are compatible with the choice of cost saving technologies. For example, a CETP can be adopted if necessary legislation is in place to define the property rights of the factories and the affected parties. A CETP for an industrial estate confers the benefits of saving in costs to the factories and the reduction in damages to affected parties. There are many incentives for polluters, affected parties, and the government for promoting collective action in industrial water pollution abatement.

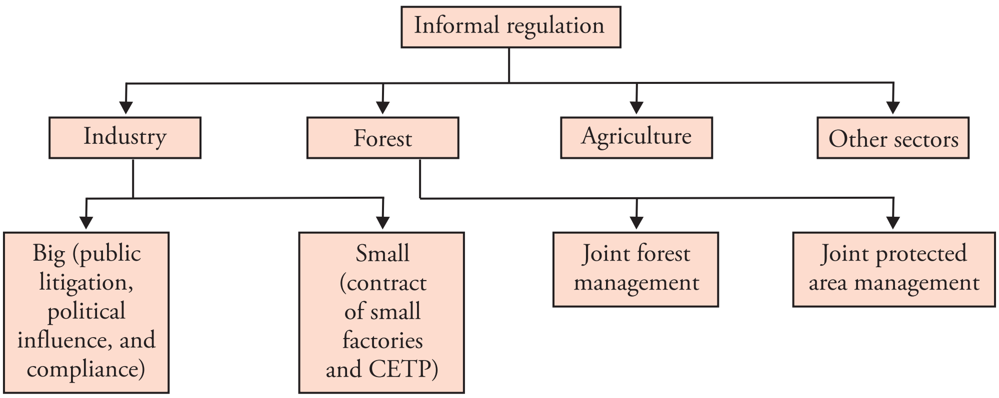

Figure 19.5 Informal Environmental Regulation in India

Source: Kumar and Managi (2009).

Historical developments leading to the adoption of CETP technologies by some of the industrial estates are clear evidence of the success of collection action approach. In this case collection action involves factories (polluters), people affected from pollution, NGOs, and government (see Murty and Prasad cited in Murty et al. 1999). There are three processes involved in the collective action for control of water pollution in an industrial estate. These are: (i) collective action of affected parties; (ii) collective action of factories, and (iii) the bargaining between a coalition of affected people and a coalition of factories. Collective action by affected people is possible if the damages from pollution are substantive enough to justify the transaction costs of coalition and bargaining. Factories in an industrial estate have to take recourse to pollution abatement methods taking into account possible collective action by the affected people. The available pollution abatement technologies may provide small factories a broad spectrum of technological choices out of which the common effluent treatment plant may be the least cost technology. Therefore, collective action by factories can be technology driven. Finally, the bargaining between a coalition of affected people and a coalition of factories produces the end result of collective action that is the realization of prescribed environmental standards.

Murty et al. (1999) reported the results of a survey of a number of industrial estates and an all-India survey of large-scale water polluting factories providing evidence of local community pressure resulting in the industries complying with standards. A number of agencies, such as local communities, elected representatives (members of Parliament, state assemblies, and municipal committees), industries, NGOs, and the government are found to be involved in the processes leading to the establishment of common effluent treatment plants in industrial estates. There are also several examples of physical threats, and public litigation cases against factories for claiming damages from pollution by the local people resulting in the big factories complying with the standards. Take, for example, the Pattancheru industrial estate in Andhra Pradesh. Local opposition to the pollution started in 1986 when about 3,000 villagers marched to the Chief Minister's office after suffering large-scale crop losses and health damages due to contamination of groundwater and the pollution of nearby river. In 1989, about 5,000 people held a demonstration before the state assembly, demanding an end to industrial pollution. In the same years farmers blocked the highway running through Pattancheru for two days. The villagers also filed court cases by jointly sharing the cost with contributions of Rs 200 per household. This legal action through the collective effort of the people ultimately forced the factories in the industrial estate to have a CETP for complying with water pollution standards. Similar experiences are reported from many other industrial estates in the region.

Informal regulation by local communities is resulting in factories complying with standards as explained by the examples given earlier. The amount of influence that the local communities exert on factories to undertake pollution depends, among other factors, upon their affluence, the degree of political organization, education, and environmental awareness. Pargal and Wheeler (1996) found a negative relationship between BOD load in a factory effluent and per capita income and educational levels of local communities in a sample of 243 factories in Indonesia. Similarly, Murty and Prasad (1999) found a negative relationship between the BOD effluent-influent ratio and a relative index of development of local community, and the political activity of the local community measured in terms of percentage of votes polled in the recent elections to the Indian Parliament.

Collective action constitutes costs to factories, the government, and affected parties. Factories incur the cost of abatement to meet standards. The effected people incur the cost of public litigation cases and the cost of organizing themselves as a society. The government incurs the cost of financial incentives provided to the factories. We now discuss a method of estimating cost to factories is given with a case study.

Given a threat of closure or legal action by an association of affected people, small-scale industries in an industrial estate are made to reduce pollution to meet prescribed standards. The industries have a choice between the following technologies for meeting the standards: (i) in house treatment, (ii) CETP, and (iii) a mix of both. Given the scale economies in water pollution abatement, in house treatment is not economical for small-scale enterprises. A survey of pollution abatement practices of isolated industries (Murty et al. 1999) shows that the capital cost of an effluent treatment plant for meeting water pollution standards for small-scale enterprises is almost equal to the capital cost of the main plant. Therefore, industries may prefer to go for a CETP, which is possible only if they are located as a cluster in an industrial estate. They can have a CETP only if there is a contract among the factories about (i) sharing capital and the operating costs, (ii) the prices charged for treating the pollutants, and (iii) the quality of influent accepted by CETP.

Industrial estates normally contain heterogeneous factories belonging to different industries with varying pollution loads and concentrations. As the members of the CETP, the member factories are required to supply wastewater of a standard quality, therefore, some of the factories may have to do some 'in house treatment' of their wastewater to bring the water pollution concentration at the agreed level before standing to the CETP for effluents treatment. Therefore, the cost of water pollution abatement in an industrial estate may also consist of in house treatment costs and the cost of CETP.

In this model, government regulators have still a role to play. But their role is not creating and enforcing environmental standards. It is merely a catalytic role of providing information about the environmental programmes designed and available cleaner technologies, and providing some financial incentives to local communities. Therefore, this new model constitutes a regulatory triangle consisting of the local community, the market, and the government.

Economic Instruments and Institutions

The discussion so far indicates that choices for policy responses will involve some mix of regulatory and market-based instruments, but this policy analysis must be done with respect to specific problems that need to be solved. Based on an analysis of the application of incentive based policies in other countries, Table 19.4 provides an inventory of economic instruments available and the targets that they are supposed to address.

The first three policy options are suited for municipalities' to reduce water pollution and the remaining policy options are better suited for reducing industrial water affluent. To address the problem of urban wastewater treatment for better handling of organic wastes coupled with chronic revenue shortages for such investments, introduction of wastewater user fees could be a strong consideration. Similarly, as a potential corollary to enhanced revenues from higher service fees (and possible partial privatization), considering increased government subsidies for wastewater treatment system development—common in many countries—is also deemed to merit a careful analysis. Groundwater contamination has been observed from leaking septic fields and the dumping of waste from cesspits into canals. It was considered timely for the government to explore providing technical assistance and possibly subsidized sanitation technologies to municipalities to encourage small-scale environmentally acceptable ways of

Table 19.4 Summary Evaluation of Economic Instruments for Water Quality Management

Economic instrument	*Principal problem addressed by the instrument*
User fees for wastewater treatment	Pollution of rivers, canals, and aquatic systems
Subsidies for wastewater treatment facilities	Pollution of rivers, canals and aquatic systems
Subsidized pollution control equipment	Pollution of rivers, canals, and aquatic systems
Subsidized sanitation	Surface and groundwater pollution plus offsite impacts
Industrial pollution discharge fees	Adverse impacts of industrial pollution
Tradable effluent discharge permits	Adverse impacts of industrial pollution
Voluntary agreements for environmental improvements	Potentially address wide range of water quality problems
Environmental damage charges and fines	Potentially address wide range of water quality problems
Environmental performance bonds	Potentially address wide range of water quality problems
Public environmental information disclosure	Potentially address wide range of water quality problems

disposing off household sewage in areas unlikely to be served by sewage treatment plants.

For reducing industrial water pollution, the government is providing tax rebates on the use and implementation of pollution reduction equipment. This is analogous to the subsidization of water-saving technologies. Note that the reduction of tariffs on the import of pollution control equipment could create incentives for increased pollution abatement and higher quality domestic production of environmental technologies. Similarly, various voluntary agreement options, such as enhanced self-monitoring of effluent discharges by industry, hold promise for introducing positive new relationships between the government and individual enterprises, municipalities, industry associations, community groups, and/or other entities to encourage a less polluting behaviour. The Indian experience shows that most of the action for reducing pollution is the result of public interest litigation (PIL) cases filed by various organizations in courts. Therefore, public environmental information disclosure can be an important tool for addressing the environmental problems in India. Greater disclosure of environmental information—perhaps starting with public dissemination of data from Environmental Impact Assessments and ambient environmental quality data collected by various agencies—can be used to hold those damaging the environment more accountable to the public and their financiers.

Effluent discharge tax or fees and tradable effluent discharge permits are the most popular incentive based policy options for reducing industrial pollution. Fees for industrial effluent discharge help in raising revenues and encourage the polluters to reduce pollution. Similarly, maximum discharges could be established for various types of discharges and tradable permits allocated among dischargers to lower compliance costs for achieving specified goals.

At present the country is considering the implementation of economic instruments for reducing air pollution, both domestic and global. The country is looking at avenues of controlling air pollution to reduce pollution through schemes like renewable energy certificates (RECs) and perform, achieve, and trade (PAT). Pilot schemes are also being conducted for pollutants like sulphur dioxide (SO_2) and nitrogen oxide (NO_x). The implementation of these schemes requires the setting up of meaningful emission caps and allocating permits; establishing an accurate monitoring mechanism; establishing the appropriate baseline based on the data that is currently available; identifying the appropriate institutional framework to manage the mechanism; and creating a legal framework necessary to manage emission of pollutant through market mechanism. However, unlike air pollution tradable permit schemes, water affluent trading programmes require spatial distribution of non-uniformly mixed pollution. Though theoretically this issue has been addressed in literature, establishing trading ratios that vary by each potential trading partner pair is difficult in practice.

Significant institutional adjustments are required that will take time to address and, therefore, warrant immediate attention. Within MoEF and pollution control boards, there appears to be an acute shortage of professionals with training in resource and environmental economics required for conducting a further analysis of economic instruments. Further, information is needed on the availability of staff in the context of a broader needs analysis for institutional strengthening. The same constraints and needs would seem to apply to other government agencies with water management responsibilities. In the meantime, consideration should be given to creating capacity for economic analysis within the MoEF and pollution control boards, perhaps by adding an environmental and resource economics section. This section could also be tasked with coordinating the needs assessment and even be drawn upon to help with in house training, where warranted. A second set of institutional adjustments is needed to build a stronger working network of agencies responsible for water management within the country. If acceptable, it would seem appropriate for MoEF and the pollution control boards to take the lead. With MoEF remaining as the lead authority in the water pollution sector, much stronger outreach to and engagement of related ministries and their associate bodies is needed if the recommendations relating to specific economic instruments identified as promising are to be acted upon in the interest of improving water resource management in the country.

Policy Implications

Measuring water pollution, estimating benefits from reduced pollution, and designing regulatory instruments for environmental improvements require interdisciplinary approaches. Detailed studies are needed to establish relationships between pollution at sources and ambient pollution of surface water bodies and groundwater resources. Some useful work on river quality modelling has been already going on in India but many more studies are needed for identifying the changes in water quality due to anthropogenic activities. Data of physical accounts of environmental changes are needed for the valuation of environmental services and the design of environmental policy instruments.

Environmental valuation is central for natural resource management. It is required for designing an environmental policy and environmental accounting for estimating a green GDP. Environmental value could be measured either as cost of abatement of environmental changes or the value that the households place on these changes. There are already a few studies about benefits and costs of water pollution abatement in India but many more detailed studies are needed.

There is an urgent need of increasing the number of monitoring stations in India to levels found in developed nations for effective monitoring. Moreover, presently the scope of monitoring is limited to conventional compounds (such as BOD, total suspended solids, faecal coli form, and oil and grease), which needs to be expanded to non-conventional pollutants, such as ammonia, chlorine, and iron also which have hazardous health impacts. Effective regulation requires that the monitoring responsibilities should be devolved to the states and further down to local bodies.

An effective industrial water pollution regulation policy requires the use of a combination of regulatory instruments consisting of economic instruments of pollution taxes and marketable permits, informal regulation by local communities, and direct public investments for environmental improvements. India still uses command and control regulatory instruments for water pollution abatement resulting in some big industries having effluent treatment plants and many industrial estates housing small-scale industries having common effluent treatment plants. However, their effectiveness in reducing water pollution is unclear. The top-down regulatory approach, in which the government plays a central role, has become ineffective in India because of high monitoring and enforcement costs and the quality of the regulator or the government. Some recent developments in India show that informal or voluntary regulation by local communities has resulted in some big industries complying with safe pollution standards.

In India, municipalities have the treatment capacity only for about 30 per cent of the wastewater generated in urban areas. This evidently indicates a gloomy picture of sewage treatment, which is the main source of pollution of rivers and lakes. To improve the water quality of rivers and lakes, there is an urgent need to increase the sewage treatment capacity and its optimum utilization. Moreover, as recognized by CPCB (2008), operations and maintenance of existing plants and sewage pumping stations is also very poor. Municipalities lack financial resources and skilled manpower capacity and as a result the existing treatment capacity remains underutilized in a number of cities. Municipal authorities should realize the problem of pollution of water bodies and pay attention to their liability to set up sewage treatment plants in cities and towns to prevent this pollution. Conditioning intergovernmental fiscal transfers from state governments to local bodies on the basis of wastewater treated could be an effective instrument for strengthening the financial position of municipalities (Kumar and Managi 2010). It will not only strengthen the financial position of local governments but also help in addressing the problem of domestic water pollution.

India should give emphasis on developing a 100 per cent treatment capacity up to the secondary level of treatment (CPCB 2008). Treated water can be used for irrigation purposes and for recharging replenishing groundwater. Industries should be encouraged to re-use treated municipal wastewater. Revenue obtained from the sale of treated wastewater for irrigation and industrial purposes could be used to supplement sewage treatment costs.

Note also that though India has defined wastewater discharge standards for the domestic and industrial sectors, there are no discharge standards for the pollution emanating from agriculture. Agriculture is the source of non-point water pollution and agricultural water pollution is linked, among other things, to the use of fertilizers and pesticides. Therefore, corrections in fertilizer and pesticide and electricity pricing policies could be an instrument for addressing the non-point water pollution in India.

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20 Municipal Wastewater Management in India

J.S. Kamyotra and R.M. Bhardwaj

Introduction

Water is vital to the existence of all living organisms, but this valued resource is increasingly being threatened as human populations grow and demand more water of high quality for domestic purposes and economic activities. Among the various environmental challenges of that India is facing this century, fresh water scarcity ranks very high. The key challenges to better management of the water quality in India are temporal and spatial variation of rainfall, improper management of surface runoff, uneven geographic distribution of surface water resources, persistent droughts, overuse of groundwater, and contamination, drainage, and salinization and water quality problems due to treated, partially treated, and untreated wastewater from urban settlements, industrial establishments, and run-off from the irrigation sector besides poor management of municipal solid waste and animal dung in rural areas.

India, being an economy in transition from a developing to a developed nation, faces two problems. On the one hand there is a lack of infrastructure and on the other, an ever-increasing urban population. The urban population in India has jumped from 25.8 million in 1901 to about 387 million (estimated) in 2011. This has thrown up two self-perpetuating problems, viz. shortage of water and sewage overload. It is estimated that by 2050, more than 50 per cent of the country's population will live in cities and towns and thus the demand for infrastructure facilities is expected to rise sharply, posing a challenge to urban planners and policymakers.

Public services have not been able to keep pace with rapid urbanization. Water supply, sanitation measures, and management of sewage and solid wastes cover only a fraction of the total urban population. There is clear inequity and disparity between the public services received by the inhabitants, depending on their economic strata. Slum dwellers have always received least attention from the civic authorities. The rapid growth of urban population has taken place due to huge migration of population (mostly from rural areas and small towns to big towns) and inclusion of newer rural areas in the nearest urban settings, apart from natural growth of urban population. The majority of towns and cities have no sewerage and sewage treatment services. Many cities have expanded beyond municipalities, but the new urban agglomerations remain under rural administrations, which do not have the capacity to handle the sewage. Management of sewage is worse in smaller towns. The sewage is either directly dumped into rivers or lakes or in open fields.

Wastewater Generation and Treatment

It is estimated that about 38,254 million litres per day (mld) of wastewater is generated in urban centres comprising Class I cities and Class II towns having population of more than 50,000 (accounting for more than 70 per cent of the total urban population). The municipal wastewater treatment capacity developed so far is about 11,787 mld, that is about 31 per cent of wastewater generation in these two classes of urban centres. The status of wastewater generation and treatment capacity developed over the decades in urban centres (Class I and Class II) is presented in Table 20.1. In view of the population increase, demand of freshwater for all uses will become unmanageable. It is estimated that the projected wastewater from urban centres may cross 120,000 mld by 2051 and that rural India will also generate not less than 50,000 mld in view of water supply designs for community supplies in rural areas (see Table 20.2). However, wastewater management plans do not address this increasing pace of wastewater generation.

Central Pollution Control Board (CPCB) studies depict that there are 269 sewage treatment plants (STPs) in India, of which only 231 are operational, thus, the existing treatment capacity is just 21 per cent of the present sewage generation. The remaining untreated sewage is the main cause of pollution of rivers and lakes. The large numbers of STPs created under Central Funding schemes such as the Ganga Action Plan and Yamuna Action Plan of National River Action Plan are not fully operated. The operation and maintenance (O&M) and power cost in some of the typical sewage treatment plants is presented in Table 20.3.

The development process in India is gaining momentum and the rural population which is devoid of basic infrastructural facilities will have to be given parity in terms of water supply and sanitation. This process of change is likely to generate huge volume of wastewater in rural areas as well. It would be appropriate to design water and wastewater management plans optimally so that competing pressures on water resources can be eased.

There is a need to plan strategies and give thrust to policies giving equal weightage to augmentation of supplied water as well as development of wastewater treatment facilities, recycling, recovery, recharging, and storage. The future of urban water supply for potable uses will depend majorly on efficient wastewater treatment systems, as the treated wastewater of upstream urban centres will be the source of water for downstream cities. This chapter tries to deal with the various issues of sanitation and health.

Present Practices of Wastewater Reuse

The volume of wastewater generated by domestic, industrial, and commercial sources has increased with population, urbanization, improved living conditions, and economic development. The productive use of wastewater has also increased, as millions of small-scale farmers in urban and peri-urban areas of developing countries depend on wastewater or wastewater polluted water sources to irrigate high-value edible crops for urban markets, often because they have no alternative sources of irrigation water. Conventionally, sewage is

Table 20.1 Wastewater Generation and Treatment Capacity in Urban Centres

Parameters	*Class I cities*					*Class II towns*				
	1978–9	*1989–90*	*1994–5*	*2003–4*	*2009*	*1978–9*	*1989–90*	*1994–5*	*2003–4*	*2009*
Number	142	212	299	423	423	190	241	345	498	498
Population (millions)	60	102	128	187	187	12.8	20.7	23.6	37.5	37.5
Water Supply (mld)	8638	15,191	20,607	29,782	44,448	1533	1622	1936	3035	3371
Wastewater Generated (mld)	7007	12,145	16,662	23,826	35,558	1226	1280	1650	2428	2696
Wastewater treated (mld) (per cent)	2756 (39)	2485 (20.5)	4037 (24)	6955 (29)	11,553	67 (5.44)	27 (2.12)	62 (3.73)	89 (3.67)	234
Wastewater untreated (mld) (per cent)	4251 (61)	9660 (79.5)	12,625 (76)	16,871 (71)	24,004	1160 (94.56)	1252 (97.88)	1588 (96.27)	2339 (96.33)	2463

Source: Bhardwaj (2005).

Table 20.2 Wastewater Generation from Urban Centres, Projections for 2051

Year	*Urban population (million)*	*Wastewater generation lpcd*	*Gross wastewater generation (mld)*
1977–8	72.8	116	7007
1989–90	122.7	119	12145
1994–5	151.6	130	16662
2003–4	243.5	121	26254
2009	316.15	121	38254
2051	1000 (Projected)	121 (Assumed)	120000 (Projected)

Source: Bhardwaj (2005).
Note: lpcd–litres per capita per day.

collected through a vast network of sewerage systems and transported to a centralized treatment plant, which is resource intensive. Instead of transporting it long distance for centralized treatment, the Central Pollution Control Board is promoting decentralized treatment at the local level using technology based on natural processes. After proper treatment, sewage can be used in pisciculture, irrigation, forestry, and horticulture. Its conventional treatment generates sludge, which acts as manure. The sludge can also be used for energy recovery. Some STPs in the country are recovering this energy and utilizing it.

Municipal wastewater can be recycled for irrigation purposes or for usage in industry/thermal power stations as utility water (cooling towers/boilers). The wastewater may be given some form of terminal treatment before its application on land. The remaining nutrients, organics, and water enter the natural system of recycling and are used by plants and microbes in soil or are retained by the soil. In the process, excess water percolates through the soil medium, gets renovated, and ultimately recharges the groundwater. The principal of reuse/recycling of wastewater differs from the age-old sewage farming practices as the present technology, that is, 'Land Treatment' means a controlled application of pre-treated wastewater on land surface to achieve a designated degree of treatment through natural bio-geochemical process wastewater reuse. This involves: (i) slow rate (SR)—(a) treatment of applied wastewater based on assimilative capacity of soil, (b) economic return from reuse of water and nutrients to produce marketable crops, (c) water conservation; (ii) rapid infiltration (RF)—(a) groundwater recharge, (b) recovery of renovated water; and (iii) overland flow (OF)—(a) wastewater treatment with the help of low permeable and sloping land, (b) recycling of renovated water from the system, (c) crop production.

New generation of sewage treatment technologies such as membrane bioreactor (MBR) can treat the wastewater near to the quality of river water. With suitable renovation this treated sewage can also recharge flood plains of riverine systems to ensure perennial flow of rivers. It is pertinent to mention that the cost for activated sludge process is around Rs 90 lakh to 1 crore for 1 MLD sewage while that for MBR is Rs 1.3–1.5 crore for 1 MLD sewage. If the treated sewage from MBR technique is recycled to industry as a substitute of fresh water for non process uses the revenue generation shall be significant.

In fact there shall be a paradigm shift with respect to sewage management; that is, from sewage treatment to sewage reuse and recycling.

There are several opportunities for improving wastewater irrigation practices via improved policies, institutional dialogue, and financial mechanisms, which would reduce risks in agriculture. Effluent standards combined with incentives or enforcement can motivate improvements in water management by household and industrial sectors discharging wastewater from point sources. Segregation of chemical pollutants from urban wastewater facilitates treatment and reduces risk. Strengthening institutional capacity and establishing links between water delivery and sanitation sectors through inter-institutional coordination leads to more efficient management of wastewater and risk reduction.

Health Aspects

Undesirable constituents in wastewater can harm human health as well asthe environment. Hence, wastewater irrigation is an issue of concern to public agencies responsible for maintaining public health and environmental quality (see Box 20.1). For diverse reasons, many developing countries are still unable to implement comprehensive wastewater treatment programmes. Therefore in the near term, risk management

TABLE 20.3 STP—O&M and Power Costs (per m³ of sewage treated)

Plant	*MLD*	*Technology*	*O&M cost annual in Rs lakh*	*Rs /m³*	*Power cost (Lakh) units/day*	*per day*	*Rs/m³*	*Total cost Rs/m³*	*Remarks*
Sen Nursing Home and Delhi Gate Nala Plants—Delhi	2 × 10	Densadeg + Biofor	126	1.73	5,680	0.26	1.28	3.01	With chemical dosing
STP at Raja canal—Bengaluru	40	Extended aeration	83	0.57	7,863	0.3	0.74	1.31	With Nitrification and Denitrification
TTP at V Valley—Bengaluru	60	Biotower + Densadeg + Biofor-F	269	1.14	8,650	0.32	0.54	1.68	With Chlorination
STP at Rithala—Delhi	182	HLASP + Biofor-F	550	0.87	15,000	0.9	0.38	1.25	No Chlorination
TTP at Lalbagh- Bengaluru	1.5	Classical Tertiary Treatment+UV+Cl	28	5.11	1450	0.05	3.63	8.74	From raw sewage to TTP + Chlorination
TTP at Cubbon park—Bengaluru	1.5	MBR + UV+Cl	30	5.48	1650	0.06	4.13	9.61	From raw sewage BOD/TSS<3, Coliform<23mpn

Source: Grover (2011).

Box 20.1
Sewage Irrigated Vegetable Production: Water Reuse or Abuse

In many Tier II and smaller cities and towns in India, untreated sewage water is being used for the irrigation of vegetables. Most farming geared to supplying urban areas takes place on peri-urban fringes where sewage is easily accessible. While planned use of sewage water is estimated to be large in many countries,—for example, 67 per cent of the total effluent in Israel, 25 per cent in India, and 24 per cent in South Africa—unplanned use is reportedly much higher (Blumenthal et al. 2000). It is primarily unplanned use, where the water is not treated adequately prior to use, that poses significant health and ecological problems.

There are numerous benefits to using treated sewage water (STW) in agriculture.

1. In the face of growing water scarcity, using STW for agriculture alleviates the competing demands on freshwater from industry and households. In particular, it frees up potable water for the growing drinking water demands.
2. By diverting sewage that would otherwise be pumped into freshwater bodies or the sea, STW helps reduce pollution and its attendant health risks.
3. Some studies indicate that using STW with its high nutrient content can increase crop yields between 10–30 per cent (Asano 1998, cited in Afifi et al. 2011).
4. STW provides an easily accessible, cost-effective option for small urban and peri-urban farmers and is of particular value during the dry season when other sources of water dry up. Bradford et al. (2003) estimate that using *untreated* sewage water is considerable cheaper than constructing a borehole for pumping groundwater.

At the same time, there are numerous risks involved with using STW. However, it appears that the most serious risks relate to using untreated sewage rather than STW. Numerous studies have shown evidence of intestinal nematode infections and bacterial infections as a result of eating crops grown with untreated sewage water. Diseases such as cholera and typhoid are also transmitted through this route as are non-essential heavy metals that in the long term can lead to kidney disease (Ghafoor et al. 1995; Nriagu 1990; Ferrecio et al.1984; and Shuval et al. 1986 cited in Blumenthal et al. 2000). Farmers coming in constant contact with untreated sewage water are also at risk of contracting a host of water-borne and water-vector diseases even if they do not ingest the crops they grow. Last, irrigation with untreated wastewater often leads to soil structure degradation (soil clogging or 'sewage sickness) and problems such as salinization, phytotoxicity (plant poisoning) (Bradford et al. 2003). The high nutrient content also encourages the growth of weeds and pests which consequently increases both labour costs and pesticide usage (Ibid.)

Fortunately, most of these risks can be abated by treating sewage water properly. A manual for use of treated sewage for vegetable production has been prepared by the Food and Agriculture Organization (FAO) of the United Nations as reported in a paper entitled 'Wastewater Treatment and Use in Agriculture', available at http://www.fao.org/docrep/T0551E/t0551e00.htm#Contents. The technologies suitable for meeting the stipulated guidelines include waste stabilization ponds (WSP) or wastewater storage and treatment reservoirs (WSTR). These technologies are land intensive, but have negligible energy requirements and O&M are minimal. While more expensive technology can also be used for better quality output, the costs of using the WSP and similar more basic technologies can be easily recovered in the sale of produce. However, care should be taken to ensure consistent output quality.

Suitable policy measures need to be formulated to encourage the reuse of treated sewage for irrigation purposes. Measures may include incentives to Urban Local Bodies (ULBs) to construct treatment devices using relevant technology, instituting a State Level Water Sector Regulator to regulate tariff and quality standards of fresh and reuse water, and water users' committees responsible for the operation and management of the STPs in the respective ULBs. Last, municipalities could treat sewage as per their CPCB obligations and supply it to famers to leverage this nutrient rich waste and potentially even turn it into a revenue stream for themselves.

Source: Afifi et al. (2011); Blumenthal et al. (2000); and Bradford et al. (2003).

—Palash Srivastava

and interim solutions are needed to prevent adverse impacts from wastewater irrigation. A combination of source control, and farm-level and post-harvest measures can be used to protect farm workers and consumers. The World Health Organization (WHO) guidelines (revised in 2006) for wastewater use suggest measures beyond the traditional recommendations of producing only industrial or non-edible crops; as in many situations it is impossible to enforce a change in the current cash crop pattern or provide alternative vegetable supply to urban markets.

Developed economies regard wastewater treatment as vital for protecting human health and preventing the contamination of lakes and rivers. However, for most developing countries this solution is prohibitively expensive. In this case, applying wastewater to agricultural lands is a more economical alternative and more ecologically sound than uncontrolled dumping of municipal and industrial effluents into lakes and streams. Obviously, the short-term benefits of wastewater irrigation could be offset by the health and environmental impacts. The first step is to scientifically evaluate these. Once the actual risks are clear, we can work towards reducing them. This means, for example, finding affordable ways of monitoring the presence of harmful contaminants in wastewater, such as heavy metals that can accrue in soil and crops. It also means looking at farming practices and crops grown to find ways of minimizing risks of infection for farmers.

Raw domestic wastewaters normally carry the full spectrum of pathogenic microorganisms—the causative agents of bacterial, virus, and protozoan diseases endemic in the community and excreted by diseased and infected individuals. While recycling and reuse of wastewater for agriculture, industry, and non-potable urban purposes can be a highly effective strategy for developing a sustainable water resource in water-scarce areas, nutrient conservation, and environmental protection, it is essential to understand the health risks involved and to develop appropriate strategies for the control of those risks. There is need to concentrate on the control of pathogenic microorganisms from wastewater in agricultural reuse since this is the most widely practiced form of reuse in India. However, more and more water specialists, natural resource planners, and economists see water as an economic good and, as time goes on, there will be an increased motivation to divert recycled wastewater from low income agriculture to areas where the added value of water is greater, such as industrial and non-potable urban uses including public parks, green belts, and golf courses. As time goes on and water shortages in arid areas increase, there will undoubtedly be an expansion of the reuse of purified wastewater for industrial and a wide variety of urban non-potable purposes. Concern for human health and the environment are the most important constraints in the reuse of wastewater. While the risks need to be carefully considered, the importance of this practice for the livelihoods of countless small holders must also be taken into account. There is need for research on wastewater irrigation to maximize the benefits to the poor who depend on the resource while minimizing the risks. Many wastewater irrigators are not landowning farmers, but landless people that rent small plots to produce income-generating crops such as vegetables that thrive when watered with nutrient-rich sewage. Across the country, these wastewater micro-economies support countless poor people. Stopping or over-regulating these practices could remove the only source of income of many landless people.

Wastewater Treatment Technologies

Wastewater Treatment Plant is a facility designed to receive the waste from domestic, commercial, and industrial sources and to remove materials that damage water quality and compromise public health and safety when discharged into water receiving systems. The principal objective of wastewater treatment is generally to allow human and industrial effluents to be disposed off without danger to human health or unacceptable damage to the natural environment.

Conventional Wastewater Treatment Processes

Conventional wastewater treatment consists of a combination of physical, chemical, and biological processes and operations to remove solids, organic matter, and sometimes, nutrients from wastewater.

Preliminary Treatment

The objective of preliminary treatment is the removal of coarse solids and other large materials often found in raw wastewater. Removal of these materials is necessary to enhance the O&M of subsequent treatment units. Preliminary treatment operations typically include coarse screening, grit removal, and, in some cases, communication of large objects.

Primary Treatment

The objective of primary treatment is the removal of settleable organic and inorganic solids by sedimentation, and the removal of materials that will float (scum) by skimming.

Secondary Treatment

The objective of secondary treatment is the further treatment of the effluent from primary treatment to remove the residual organics and suspended solids. In most cases, secondary treatment follows primary treatment and involves the removal of biodegradable dissolved and colloidal organic matter using aerobic biological treatment processes. Aerobic biological treatment is performed in the presence of oxygen by aerobic microorganisms (principally bacteria) that metabolize the organic matter in the wastewater, thereby producing more microorganisms and inorganic end-products (principally CO_2, NH_3, and H_2O). Several aerobic biological processes are used for secondary treatment differing primarily in the manner in which oxygen is supplied to the microorganisms and in the rate at which organisms metabolize the organic matter. Common high-rate processes include the activated sludge processes, trickling filters or bio-filters, oxidation ditches, and rotating biological contractors (RBCs). A combination of two of these processes in series (for example bio-filter followed by activated sludge) is sometimes used to treat municipal wastewater containing a high concentration of organic material from industrial sources.

Various commonly used treatment technologies in India for treatment of sewage and industrial effluents are summarized here.

Activated Sludge Process

The most common suspended growth process used for municipal wastewater treatment is the activated sludge process. The municipal wastewater treatment is the Biochemical Oxygen Demand (BOD) removal. The removal of BOD is done by a biological process, such as the suspended growth treatment process. This biological process is an aerobic process and takes place in the aeration tank, in which the wastewater is aerated with oxygen. By creating good conditions, bacteria will grow fast. The growth of bacteria creates flocks and gases. These flocks are removed by a secondary clarifier. In the activated sludge process, the dispersed-growth reactor is an aeration tank or basin containing a suspension of the wastewater and microorganisms, the mixed liquor. The contents of the aeration tank are mixed vigorously by aeration devices which also supply oxygen to the biological suspension. Commonly used aeration devices include submerged diffusers that release compressed air and mechanical surface aerators that introduce air by agitating the liquid surface. Hydraulic retention time in the aeration tanks usually ranges from 3 to 8 hours but can be higher with high BOD wastewaters. Following the aeration step, the microorganisms are separated from the liquid by sedimentation and the clarified liquid is secondary effluents. A portion of the biological sludge is recycled to the aeration basin to maintain a high mixed-liquor suspended solid (MLSS) level. The remainder is removed from the process and sent to sludge processing to maintain a relatively constant concentration of microorganisms in the system. Several variations of the basic activated sludge process, such as extended aeration and oxidation ditches, are in common use, but the principal is similar.

Trickling Filters

A trickling filter or bio-filter consists of a basin or tower filled with support media such as stones, plastic shapes, or wooden slats. Wastewater is applied intermittently, or sometimes continuously, over the media. Microorganisms become attached to the media and form a biological layer or fixed film. Organic matter in the wastewater diffuses into the film, where it is metabolized. Oxygen is normally supplied to the film by the natural flow of air either up or down through the media, depending on the relative temperatures of the wastewater and ambient air. Forced air can also be supplied by blowers but this is rarely necessary. The thickness of the bio-film increases as new organisms grow. Periodically, portions of the film slough off the media. The sloughed material is separated from the liquid in a secondary clarifier and discharged to sludge processing. Clarified liquid from the secondary clarifier is the secondary effluent and a portion is often recycled to the bio-filter to improve hydraulic distribution of the wastewater over the filter.

Rotating Biological Contactors

Rotating biological contactors (RBCs) are fixed-film reactors similar to bio-filters in that organisms are attached to the support media. In the case of the RBCs, the support media are slowly rotating discs that are partially submerged in flowing wastewater in the reactor. Oxygen is supplied to the attached biofilm from the air when the film is out of the water and from the liquid when submerged, since oxygen is transferred to the wastewater by surface turbulence created by the rotation of the discs. Sloughed pieces of biofilm are removed in the same manner described for bio-filters.

High-rate biological treatment processes, in combination with primary sedimentation, typically remove 85 per cent of the BOD and Suspended Solid (SS) originally present in the raw wastewater and some of the heavy metals. Activated sludge generally produces an effluent of slightly higher quality, in terms of these constituents, than bio-filters or RBCs. When coupled with a disinfection step, these processes can provide substantial but not complete removal of bacteria and viruses. However, they remove very little phosphorus, nitrogen, non-biodegradable organics, or dissolved minerals.

Up-flow Anaerobic Sludge Blanket (UASB) Process

The UASB is an anaerobic process whilst forming a blanket of granular sludge and suspended in the reaction tank. Wastewater flows upwards through the blanket and is processed by the anaerobic microorganisms. The upward flow combined with the settling action of gravity suspends the blanket with the aid of flocculants. The blanket begins to reach maturity at around three months. Small sludge granules begin to form whose surface area is covered in aggregations of bacteria. In the absence of any support matrix, the flow conditions create a selective environment in which only those microorganisms, capable of attaching to each other, survive and proliferate. Eventually the aggregates form into dense compact bio-films referred to as 'granules'. The fine granular sludge blanket acts as a filter to prevent the solids in the incoming wastes to flow through as the liquid part does. So if the hydraulic retention time (HRT) does not change, which is limited to 1–3 days (the bigger the digester, the shorter time it is, because the size costs money), the solid retention time (SRT) can be 10–30 days or more for more effective digestion, depending on the shape of the digestion chamber. This means that the digester becomes much more efficient without having to increase the size, which costs money. Standing and hanging baffles are used, with a conic separation and a small outlet at the centre; this is much more effective in keeping the anaerobic sludge blanket in the lower part of the digester. This also acts as a very good filter to retard the flow of solids in the wastes and prolong the solid retention time for more bacterial action. However, the digester would be more economic if the loading can be increased for a specific size of digester with the conic separation.

Bio-chemical activities in UASB Digesters comprise of bacterial actions which have three phases and they occur in the following sequence:

- Hydrolysis or solubilization: The first phase takes 10–15 days, and until the complex organics are solubilized, they cannot be absorbed into the cells of the bacteria where they are degraded by the endoenzymes;
- Acidogenesis or acetogenesis: The result from stage one is utilized by a second group of organisms to form organic acids;
- Methanogenesis: The methane-producing (methanogenic) anaerobic bacteria then use the product from the second stage to complete the decomposition process.

Waste Stabilization Ponds

Wastewater stabilization pond technology is one of the most important natural methods for wastewater treatment. Waste stabilization ponds are mainly shallow man-made basins comprising a single or several series of anaerobic, facultative, or maturation ponds. The primary treatment takes place in the anaerobic pond, which is mainly designed to remove suspended solids, and some of the soluble elements of organic matter (BOD). During the secondary stage in the facultative pond most of the remaining BOD is removed through the coordinated activity of algae and heterotrophic bacteria. The main function of the tertiary treatment in the maturation pond is the removal of pathogens and nutrients (especially nitrogen). Waste stabilization pond technology is the most cost-effective wastewater treatment technology for the removal of pathogenic microorganisms. The treatment is achieved through natural disinfection mechanisms. It is particularly well suited for tropical and subtropical countries because the intensity of the sunlight and temperature are key factors in the efficiency of the removal processes.

ANAEROBIC PONDS

These units are the smallest of the series. Commonly they are 2–5 m deep and receive high organic loads equivalent to100g BOD/ $meter^3$ per day. These high organic loads produce strict anaerobic conditions (no dissolved oxygen) throughout the pond. In general terms, anaerobic ponds function much like open septic tanks and work extremely well in warm climates. A properly designed anaerobic pond can achieve around 60 per cent BOD removal at 20°c. One-day hydraulic retention time is sufficient for wastewater with a BOD of up to 300 mg/l and temperatures higher than 20° c. Designers have always been preoccupied by the possible odour that these tanks might cause. However, odour problems can be minimized in well-designed ponds, if the $SO42_{-}$ concentration in wastewater is less than 500 mg/l. The removal of organic matter in anaerobic ponds follows the same mechanisms that take place in any anaerobic reactor.

FACULTATIVE PONDS

These ponds are of two types: primary facultative ponds receive raw wastewater, and secondary facultative ponds receive the settled wastewater from the first stage (usually the effluent from anaerobic ponds). Facultative ponds are designed for BOD removal on the basis of a low organic surface load to permit the development of an active algal population. This way, algae generate the oxygen needed to remove soluble BOD. Healthy algae populations give the water a dark green colour but occasionally they can turn red or pink due to the presence of purple, sulphide-oxidizing photosynthetic activity. This ecological change occurs due to a slight overload. Thus, the change of colouring in facultative ponds is a qualitative indicator of an optimally performing removal process. The concentration of algae in an optimally performing facultative pond depends on organic load and temperature, but is usually in the range 500 to 2000 µg chlorophyll per litre. The photosynthetic activity of the algae results in a diurnal variation in the concentration of dissolved oxygen and pH values. Variables such as wind velocity have an important effect on the behaviour of facultative ponds, as they generate the mixing of the pond liquid. Blumenthal et al. (2000) indicate that a good degree of mixing ensures a uniform distribution of BOD, dissolved oxygen, bacteria, and algae, and hence better wastewater stabilization. More technical details on the efficiency of the process and removal mechanisms can be found in Mara (2009).

MATURATION PONDS

These ponds receive the effluent from a facultative pond and the size and number depend on the required bacteriological quality of the final effluent. Maturation ponds are shallow (1.0–1.5 m) and show less vertical stratification, and their entire volume is well oxygenated throughout the day. Their algal population is much more diverse than that of facultative ponds. Thus, the algal diversity increases from pond to pond along the series. The main removal mechanisms especially of pathogens and faecal coliforms are ruled by algal activity in synergy with photo-oxidation. On the other hand, maturation ponds achieve only a small removal of BOD, but their contribution to nitrogen and phosphorus removal is more significant.

Aerated Lagoons

The mechanical-biological purification of wastewater takes place in one or more aerated lagoons according to the size of the plant, which are followed by a non-aerated sedimentation and polishing pond. The sewage coming from the canalization is normally led directly into the first aerated lagoon without mechanical pre-purification. So the continuous disposal of screenings, sand, and sedimentation sludge and its maintenance efforts can be omitted. Coarse stuff, sand, and heavy sludge settle in the inlet zone while dissolved contaminants are distributed in the whole first lagoon. Liable to putrefy matter should mainly be stabilized by aerobic processes to avoid odours and digested sludge coming up to the water surface. According to our experience, sludge at the inlet zone of the first aerated wastewater lagoon has to be removed at regular intervals of several years. To exhaust and take the sludge out, liquid manure-vacuum-tankers are used. Floating solids are retained by a scum board in the inlet area. They should be removed once or twice a week with a rake.

Oxidation Ponds

Oxidation Ponds are also known as stabilization ponds or lagoons. They are used for simple secondary treatment of sewage effluents. Within an oxidation pond, heterotrophic bacteria degrade organic matter in the sewage to produce cellular material and minerals. The production of these supports the growth of algae in the oxidation pond. Growth of algal populations allows further decomposition of the organic matter by producing oxygen. The production of this oxygen replenishes the oxygen used by the heterotrophic bacteria. Typically oxidation ponds need to be less than 10 feet deep in order to support the algal growth. In addition, the use of oxidation ponds is largely restricted to warmer climate regions because they are strongly influenced by seasonal temperature changes. Oxidation ponds also tend to fill, due to the settling of the bacterial and algal cells formed during the decomposition of the sewage. Overall, oxidation ponds tend to be inefficient and require large holding capacities and long retention times. The degradation is relatively slow and the effluents containing the oxidized products need to be periodically removed from the ponds.

Karnal Technology

The Karnal Technology involves growing trees on ridges 1m wide and 50 cm high and disposing of the untreated sewage in furrows. The amount of the sewage/effluents to be disposed of depends upon the age, type of plants, climatic conditions, soil texture, and quality of effluents. The total discharge of effluent is regulated so that it is consumed within 12–18 hours and there is no standing water left in the trenches. This technique utilizes the entire biomass as a living filter for supplying nutrients to soil and plants; irrigation renovates the effluent for atmospheric re-charge and ground storage. Further, as forest plants are to be used for fuel wood, timber, or pulp, there is no chance of pathogens, heavy metals, and organic compounds entering into the human food chain system, a point that is a limiting factor when vegetables or other crops are grown with sewage. Though most plants are suitable for utilizing effluents, yet, those tree species which are fast growing, can transpire high amounts of water and are able to withstand high moisture content in the root environment, are most suitable for such purposes. Eucalyptus is one such species, which has the capacity to transpire large amounts of water, and remains active throughout the year. Other species suitable for this purpose are poplar and leucaena. Out of these three species, eucalyptus seems to be the best choice as poplar remains dormant in winter and thus cannot bio-drain effluent during winter months. However, if area is available and the volume of effluent is small, a combination of poplar and eucalyptus is the best propagation. This technology for sewage water use is relatively cheap and no major capital is involved. The expenditure in adopting this technology involves the cost of making ridges, cost of plantation, and their care.

This system generates gross returns from the sale of fuel wood. The sludge accumulating in the furrows along with the decaying forest litter can be exploited as an additional source of revenue. As the sewage water itself provides nutrients and irrigation ameliorates the sodic soil by lowering the pH, relatively unfertile wastelands can be used for this purpose. This technology is economically viable as it involves only the cost of water conveyance from source to fields for irrigation and does not require highly skilled personnel. This technology seems to be the most appropriate and economically viable proposition for rural areas as it is used to raise forestry, which would aid in restoring the environment and generating biomass.

Duckweed

Duckweeds (aquatic plants) are the world's smallest and simplest flowering plants. Duckweeds are floating plants that grow on the surface of still or slow moving waters during warmer weather. Because duckweeds usually reproduce by budding, they can multiply very quickly and cover the entire surface of a pond in a short span of time. Small numbers of duckweeds will not harm a pond, but large numbers will block sunlight from entering the pond and upset the oxygen balance in the pond, placing the fish population in danger. *Lemna* spp. are the most common duckweeds. *Lemna* grow up to 4 mm wide and have a single root dangling from the leaf of the plant. Duckweeds do not have true leaves or stems; the roundish, flattened leaf-like part of the plant is called a frond. Another type, watermeal (*Wolffia* spp.), is the smallest of the duckweeds. These plants are so tiny that they look like grains of green meal floating on the water surface. They are generally less than 1 mm wide and barely visible as individuals. This type of duckweed does not have roots. Many a time control is necessary because the duckweeds reproduce rapidly and can cover a pond causing oxygen problems.

Fluidized Bed Reactor

Aerobic fluidized bed reactors (FBRs) are used as a new technology in wastewater treatment. An aerobic fluidized bed reactor with granulated activated carbon (GAC) as carrier material can be operated under different conditions, including batch-loading, semi-continuous loading, and continuous loading. The basic idea behind the FBR is to have a continuously operating, non-clogging bio-film reactor which requires: (i) no back-washing, (ii) has low head loss and (iii) high specific bio-film surface area. This is achieved by having the biomass grow on small carrier elements that move with the liquid in the reactor. The movement within the aerobic reactor is generated by aeration. These bio-film carriers are made of special grade plastic density close to that of water. The FBR employs fixed film principle and makes the treatment process more user friendly because it does not require sludge recycle that is, synonymous with conventional Activated Sludge Process. The absence of sludge recycle frees the operator from the enormous task of measurement and monitoring MLSS levels in the tank and adjusting recycle rations continuously, due to fluctuating inlet Chemical Oxygen Demand (COD) loads. The FBR produces small quantity of sludge which requires no further treatment. This technology is used in small STPs for treating city wastewater, industrial sewage treatment plant from food waste, paper waste and chemical waste etc. Due to fixed film nature, these plants accept shock loads much better than those employed for suspended growth process. The reactors are generally tall (6 m and above), thereby reducing cross-sectional area further.

Sequential Batch Reactor

In this process, the raw sewage, free from debris and grit, is taken up for biological treatment to remove organic matter, nitrogen, and phosphorus. The activated sludge bio-system is designed using the Advanced Cyclic Activated Sludge Technology which operates on extended aeration activated sludge principle for the reduction of carbonaceous BOD, nitrification, denitrification as well as phosphorus removal using energy-efficient, fine bubble diffused aeration system with automatic control of air supply based on oxygen uptake rate.

In this form, the sequences of fill, aeration, settle, and decant are consecutively and continuously operated in the same tank. No secondary clarifier system is required to concentrate the sludge in the reactor. The return sludge is recycled and the surplus is wasted from the basin itself. The complete biological operation is divided into: (i) fill-aeration (ii) settlement, and (iii) decanting. These phases in a sequence constitute a cycle. During the period of a cycle, the liquid volume inside the reactor increases from a set operating bottom water level. During the fill-aeration sequence, the mixed liquor from the aeration zone is recycled into the selector. Aeration ends at a predetermined period of the cycle to allow the biomass to flocculate and settle under quiescent conditions. After a specific setting period, the treated supernatant is decanted, using a moving weir decanter. The liquid level in the reactor is so returned to bottom water level after which the cycle is repeated. Solids are separated from the reactor during the decanting phase. The system selected is capable of achieving the following: (i) bio-degradation of organics present in the wastewater by extended aeration process; (ii) oxidation of sulphides in the wastewater; (iii) co-current nitrification and denitrification of ammonical nitrogen in the aeration zone; and (iv) removal of phosphorous

Tertiary Treatment

Tertiary wastewater treatment is employed when specific wastewater constituents which cannot be removed by secondary treatment must be removed. The treatment processes are necessary to remove nitrogen, phosphorus, additional suspended solids, refractory organics, heavy metals, and dissolved solids. Because advanced treatment usually follows high-rate secondary treatment, it is sometimes referred to as tertiary treatment. However, advanced treatment processes are sometimes combined with primary or secondary treatment (for example, chemical addition to primary clarifiers or aeration basins to remove phosphorus) or used in place of secondary treatment (for example, overland flow treatment of primary effluent).

Control of Pollution: Legal and Institutional Provisions to Control Pollution

The Water (Prevention and Control of Pollution) Act 1974 and The Environment Protection Act 1986

The government enacted the Water (Prevention and Control of Pollution) Act 1974 with the primary objective of prevention and control of water pollution and restoration of water quality. The Central and

State Pollution Control Boards were established for its implementation. The Water Act empowers the pollution control boards to lay down and maintain water standards. The actual provisions for enforcement such as penalties, imprisonment etc. are largely confined to source-specific standards for individual polluters. The Environment Protection Act, 1986 is an umbrella act providing for the protection and improvement of the environment and for matters connected therewith. It authorizes the central government to intervene. The nature of penalties allowed under this act are similar to those authorized under the Water Act.

The Environment Protection Act, 1986 covers hazardous wastes and chemicals, hazardous microorganisms, and transportation of toxic chemicals. Supported by recent legislative, administrative, and judicial initiatives, environmental regulations in India are becoming more comprehensive. The licensing regime is supplemented by a 'citizen suits' provision and besides, a statutory 'right to information' now enables an aggrieved citizen to directly prosecute a polluter after examining the government records and data. Rules have been notified for environmental auditing of all the industries which may cause water pollution or generate solid or hazardous wastes. The Ministry of Environment and Forests has adopted a 'Pollution Abatement Policy' which includes adoption of clean technology, conservation of resources, change of concentration-based standards to mass-based standards, incentives for pollution control, public participation, environmental auditing, and Ecomark on environment friendly products.

The legal and institutional provisions are provided in Water (Prevention and Control of Pollution) Act, 1974 wherein standards are developed and enforced for treatment of municipal wastewater by pollution control boards. There are provisions for tightening of standards by state pollution control boards for site-specific requirements, in view of low flow or no flow in stretches of rivers or streams and for critically polluted areas in view of high concentration of pollution loads in a specific area. The need based directions for zero discharge are prescribed for grossly polluting industrial units; however, such enforcements are non-implementable in case of municipal bodies. The concept of delinking of sewer to river is gaining momentum in river conservation plans and may bring about a visible improvement in water quality of recipient water bodies. There is, however, a need for institutional provisions to make the rivers and streams perennial by introduction of minimum/environmental/ecological flows to maintain the biodiversity and sustainable ecosystem of aquatic resources.

Conclusion and Outlook

There is a need to generate water from all available resources including wastewater by recycling, reuse, recharging, and storages. There is urgent need to plan strategies and give thrust to policies giving equal weighting to augmentation of water supplied as well as development of wastewater treatment facilities.

Municipal wastewater collection, treatment, and disposal are still not a priority by the municipality/state government as compared to water supply. In the absence of sewer lines, untreated wastewater is flowing into storm water drains and poses health hazards to the citizens inhabiting the areas near the drain. The O&M are not satisfactory due to lack of proper power supply/backup power; municipal authorities do not have the money for spares and payment of electricity bills; there is a lack of skilled manpower and most of the plants are under-loaded due to lack of proper sewer lines.

Although municipal wastewater treatment is given impetus under National River Conservation Plan of Ministry of Environment and Forest, Government of India to provide sewage treatment plant to cities discharging wastewater to rivers, in spite of all these effort and various schemes, the gap between generation and treatment is still large.

There are various issues with treatment technology in addition to management aspects. The primary requirement for wastewater treatment is adequate supply of electricity which is a deterrent in the present context in almost all the states of the country. Treatment technology selection for different sizes of urban settlements is another issue due to the constraint of land availability.

The waste stabilization ponds (oxidation ponds, maturation ponds, and duckweed ponds) are most appropriate for small towns having land availability for treatment plants and demand for treated wastewater in agriculture. In large urban settlements with land scarcity for the establishment of STPs and less demand for treated sewage for farm application, mechanical treatment systems viz. activated sludge process, trickling filter, UASB, and aerated lagoons are appropriate and produce good results. There are success stories of treatment plants producing reasonably good quality water which is being used in the industrial sector for processes as well as cooling purposes thereby reducing the industrial demand for fresh water.

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21 The Economics of Municipal Sewage Water Recycling and Reuse in India

Pritika Hingorani[†]

Defining the Wastewater Problem: Challenges and Opportunities

Together, India's largest cities generate more than 38,254 million litres of sewage[1] each day. Of this, it is estimated that less than 30 per cent of what is collected undergoes treatment before it is disposed into freshwater bodies or the sea. Worryingly, these figures exclude sewage generated in informal settlements and in smaller cities and towns where an acute lack of municipal infrastructure for water supply and sewage collection makes data hard to find.

As per Central Pollution Control Board (CPCB) rules, a city or town's municipality or water authority[2] is responsible for collecting and treating 100 per cent of the sewage generated within its jurisdiction. The level to which the sewage has to be treated depends on where it will be disposed—treatment standards are higher for disposal into freshwater bodies than the sea (See Figure 21.1). However, typically even where sewage treatment plants (STPs) exist, sewage collection networks are inadequate so only a small portion goes for treatment. The rest flows into *nallahs* and drains from where it is pumped into surface water bodies. Sometimes wastewater stagnates in pools from where it leaches into the groundwater table and contaminates underground aquifers. Often, informal industry and peri-urban agriculture add industrial and agricultural waste to the mix.

As a rule of thumb, about 80 per cent of household water is released as wastewater. As India's per capita water consumption grows rapidly, the concurrent

[†] I would sincerely like to thank Ritu Anand, Piyush Tiwari, and Sambit Basu for their research and editorial support, guidance, and invaluable inputs in preparing both this chapter and the IDFC Quarterly Research Note 'Sewage wastewater recycling for industry' on which this chapter is based.

[1] Sewage or 'black water' is actually a sub-set of household wastewater that contains urine, feaces, and other biological waste. The other portion is 'grey water' generated from activities, such as bathing and cooking. While grey water can generally be safely reused for gardening or flushing toilets, the former contains pathogenic micro-organisms that must be treated prior to reuse. However, in India both streams of wastewater are collected together and hence the term sewage is often used to describe all household wastewater.

[2] In some cities, the municipality is responsible for water supply and sewerage while in others, it is a separate water supply and sanitation board. For the purpose of this chapter the responsible agency is referred to as water authority (WA).

sewage problem poses both a significant cost and an opportunity to water authorities (WAs). On the one hand, untreated sewage is the single most important contributor to surface and groundwater pollution in the country. As a result water-borne diseases like diarrhoea, caused by consuming faecally contaminated water, are the largest cause of child mortality in India.[3] A 2010 study by the World Bank's Water and Sanitation Program calculates the per capita economic cost of inadequate sanitation (including mortality impact) at Rs 2,180 (HPEC 2011). There are additional costs that are seldom valued. For example, water pollution poses costly threats to the ecology, to aquatic life, and the fishing industry. Most importantly, pollution of freshwater bodies is inextricably linked to growing water scarcity as polluted water is more expensive and unsafe to use directly.

On the other hand, the large volume of sewage offers tremendous potential for WAs to recycle water within their cities and reduce their reliance on bulk freshwater sources. While freshwater is needed for human consumption, sewage can be treated to the minimum quality required for its subsequent use and safely reused for many non-potable industrial and agricultural uses. As this chapter explores, it is often cheaper and more reliable for WAs to meet non-potable water demand through sewage treated water (STW) than by pumping freshwater over long distances. Where cost differentials exist, they should be weighed against the WA's imperative to preserve freshwater for growing potable water demands. Since WAs are required to treat their sewage anyway, selling STW at full or partial treatment costs can also unlock a sizeable revenue stream.

At present, a majority of the WAs in the country neither have the installed capacity nor the collection networks to undertake sewage recycling. A 2010 Centre for Science and Environment report puts installed treatment capacity at only 19 per cent of total sewage generation and even this limited capacity reportedly runs at 72 per cent utilization (CSE 2010). A 2007 CPCB sample survey of existing STPs classified the performance of only 10 per cent as 'good' with 54 per cent falling into the 'poor' and 'very poor' categories. A number of reasons are cited for this, including lack of qualified staff, poor maintenance, overloading of facilities, irregular power supply, and apathy. However, the lack of funding for O&M appears to be a significant impediment. STPs are generally not self-financing and given that WAs are often in poor financial condition, STPs must depend on unreliable state government transfers instead.

Already several industries have taken the initiative to use STW. Some like Saint Gobain Glass (Sriperumbudur), Wipro, and Shree Cement (Beawar) recycle the sewage that they generate. The resultant freshwater savings are significant. For example, the M&M Auto (Nashik) plant meets up to 30 per cent of its total water consumption with STW (Iyer 2011).

There appears to be tremendous scope for WAs to do the same and provide STW to commercial, industrial, and even household users. Yet while there is undoubtedly an environmental imperative to reuse STW, from a purely economic perspective WAs would prefer to supply STW over freshwater only if the cost of doing so is cheaper. Similarly, large-scale adoption of STW by industry and other users also hinges on economic feasibility. This chapter compares the cost of producing STW and freshwater and looks at the costs currently incurred by potential STW users to understand whether and to what extent STW is a cost-effective option.

This chapter is structured as follows: it first gives a brief review of STP technology options. This is followed by a discussion on the range of costs for producing STW. The next section looks at the current costs faced by potential STW users. Cost estimates for producing freshwater follow. Finally the chapter concludes with recommendations for encouraging the use of STW.

Technology Options

Sewage water is treated in stages to progressively improve its quality. The most important water quality characteristics in the case of sewage are biological oxygen demand (BOD), chemical oxygen demand, total suspended solids (TSS), and nutrients (nitrates and phosphates).

[3] It is estimated that the cost to the country from diarrhoeal disease alone is Rs 500 crore in terms of disability adjusted life years (DALYs). DALYs are a metric developed in conjunction with the World Bank and the World Health Organization as a measure of overall disease burden, expressed as the number of years lost due to ill-health, disability, or early death.

There are numerous technologies to treat wastewater. At the more basic level are technologies, such as waste stabilization ponds (WSP) and duckweed ponds that rely primarily on biological processes [See Chapter 19 for more details]. However, for numerous reasons, including variable output quality, the inability to manage mixed industrial and domestic effluent, fixed capacity and land intensity, these technologies tend to be better suited to rural areas where energy and capital may be scarce but land is easily available. Being more suited to small-scale treatment, they have largely been replaced by more advanced technologies at the municipal level.

Among the more common and cost-effective technologies preferred by municipalities or large industries are conventional activated sludge process (ASP) and sequential batch reactor (SBR). These processes are at least partly automated and are designed to meet specific output quality parameters. Although their processes are also primarily biological they typically involve some use of chemicals, particularly at the tertiary treatment level in the case of ASP. Both technologies are suited to Indian conditions as they can effectively treat both diluted and concentrated wastewater as well as mixed household and industrial waste.

SBR is regarded as an advanced form of ASP. Since treatment takes place in a single basin it requires up to 33–50 per cent less land and has 40 per cent lower civil construction expenditure than conventional ASP plants (CSE 2010). Being fully automated, it consumes 35–45 per cent less power than conventional ASP, has low chemical requirements, and reduces manpower costs significantly. SBR has inbuilt nutrient removal although this can be added to conventional ASP.

For most non-potable uses, water must have certain minimum quality characteristics (see Figure 21.1). CPCB norms for discharge into surface water bodies fall short of these quality requirements. Sewage water treated by SBR can be directly reused. While secondary level ASP treatment typically produces output quality as shown in Figure 21.1, some tertiary treatment is usually required to bring it up to low-end industrial use standards. However, some industry experts argue that while it is cheaper to use SBR to meet reuse standards than conventional ASP, the latter is marginally cheaper in meeting CPCB norms.

The Cost of Treating Sewage Water

WAs across the country will incur slightly different costs of treating their sewage. This will depend on factors, such as technology choice, quality of their existing treatment facilities, and the potential for economies of scale. In addition to treatment costs, these agencies must also consider the cost of building or augmenting their sewage collection networks. At present only a handful of cities like Chennai, have achieved 100 per cent sewage collection. However, since the investment requirement for the network depends crucially on the size and density of the city, the cost of sewage collection is hard to generalize. Therefore, this section focuses mainly on treatment using existing cases from WAs and industry to estimate a possible range of treatment costs across the more common technologies.

SBR Treatment

The Navi Mumbai Municipal Corporation (NMMC) has been proactive in treating and attempting to reuse its sewage. It has chosen to use SBR technology for its STPs. NMMC's first plant at Nerul was built in 2008 at a capital cost of Rs 67.9 crore for 100 million litres a day (MLD) capacity. By the end of 2011, when work is completed on the last three plants, NMMC will have a total of 6 plants and a total treatment capacity of 420 MLD. To run its three operational plants, NMMC has given service contracts to private operators, but pays the electricity bills directly. The current 3-year O&M contract is for Rs 70 lakh per year, and will be bid out again possibly at a revised rate, when it expires next year.

The Nerul plant is currently operating at 45 MLD. At this level of utilization, the O&M cost inclusive of electricity is Rs 1.20/KL. However, this cost does not account for the significant capital expenditure incurred. Table 21.1 calculates the 'levelized' production cost if capital and O&M expenditure are included. A levelized cost essentially divides the net present value of the total investment in a project into an equal, annual, per unit cost. In other words, if NMMC were to sell its STW at this constant levelized cost each year for the life of the project, it would recoup its total expenditure. In calculating the levelized costs, two scenarios are envisioned. In the first, the WA undertakes recycling and does not make a profit, whereas in the second the private sector operates the plant and factors in a 16 per cent return on

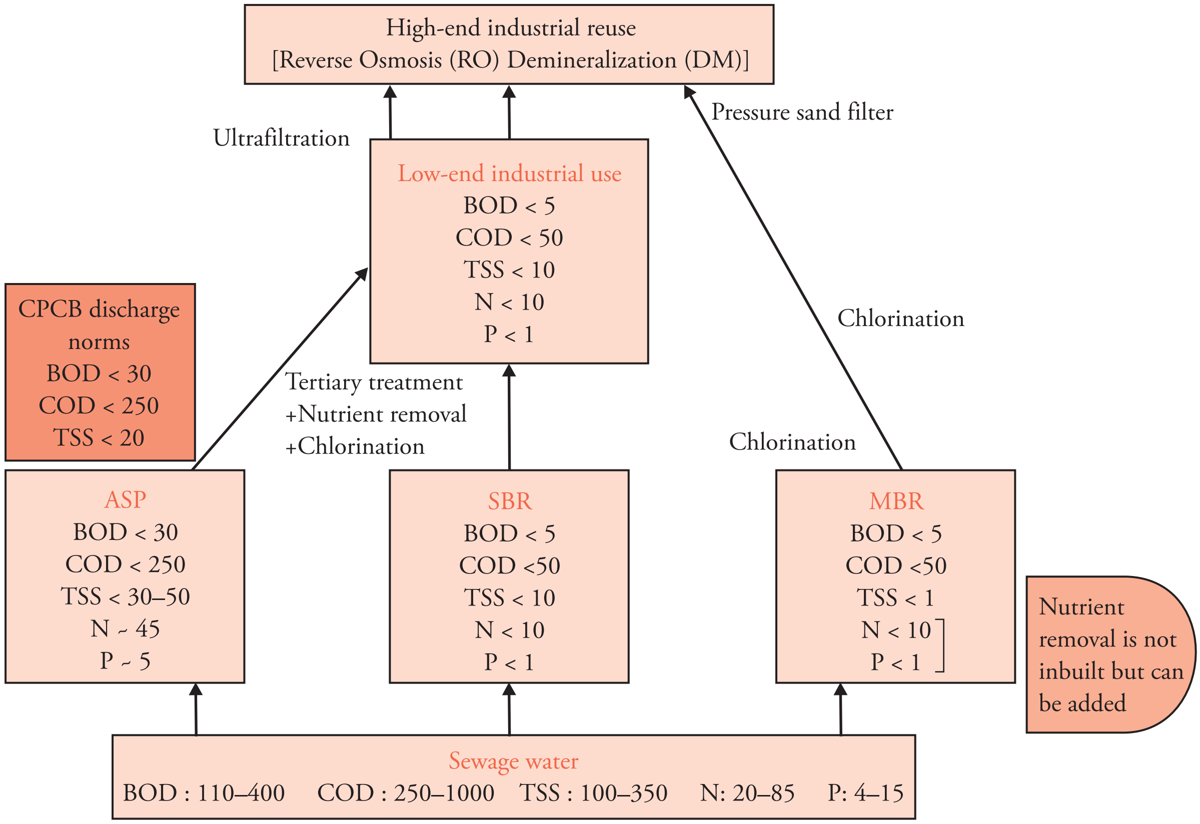

Figure 21.1 Treatment Technology and Reuse Standards

Source: Interviews with SFC Environmental Technologies Ltd. (interviewed on 27 May 2011), Central Pollution Control Board (interviewed on 29 March 2011); Author's analysis based on IDFC Appraisal.

Note: BOD and COD are indirect measures of the amount of organic and inorganic material in sewage water. TSS measures the concentration of suspended, non-filterable solids. Nutrients (N=Nitrogen, P=Phosphorous) are measured as they encourage growth of algae and other aquatic plants.

MBR or membrane bio reactor is an additional treatment technology which is currently much more expensive than SBR and ASP in India.

equity. Table 21.1 also models these scenarios assuming that the plant is running at full capacity. Doing so reveals that economies of scale significantly reduce the cost of treatment.

SBR treatment costs should be reasonably consistent across the country as it is a proprietary technology. However, the levelized costs would vary depending on the structure of debt incurred by the WA, local electricity costs, desired return on equity, and other such factors assumed in our model.

ASP Treatment

Chennai Metro Water (CMW), the water supply and sanitation authority in Chennai, is a progressive water board that has actively pursued its sewage collection and treatment targets. CMW uses secondary level ASP plants to treat its sewage slightly beyond CPCB standards for freshwater discharge. Of the 486 MLD of STW currently produced CMW sells 36 MLD to three large industries located in the north of the city. The STW is sold for Rs 10.20/KL and includes the cost of pumping the STW to the plant gates.

Between the 1970s to the early 1990s, Chennai built six conventional ASP and trickling filter plants. Between 2005 and 2006, it built four additional conventional ASP plants with funds from the Chennai City River Conservation Project (CCRCP). By 2013, three more ASP plants will be built under the Jawaharlal Nehru

Table 21.1 Estimated Range of Costs for Producing Secondary Level STW

				Levelized annual total costs	
Technology	*Source*	*Capacity (MLD)*	*Current O&M*	*Public*	*Private*
ASP	PPCL	20	4	15	17
	CMW	5–100	–3.5*		
	Other ASP	60–80	–1.3**		
SBR	Nerul	45	1.2	7	9
	Nerul	100	–1.2***	4	5
Mix (Include collection costs)# HPEC Report	Class IA		10		
	Class IB	9			
	Class IC	7			
	Class II	5			
	Class III	5			
	Class IV+	3.5			
Range			1.2–10#	4–15	5–17

Source: Interviews with SFC Environmental Technologies Ltd. (interviewed on 27 May 2011), Degrémont (interviewed on 29 March 2011), and Pragati Power Corporation Ltd. (interviewed on 28 March 2011); Delhi Electricity Regulatory Commission Tariff Order (2008–11); High Powered Expert Committee Report on Indian Urban Infrastructure and Services (2011); Tokyo Engineering Consultants (2004); author's analysis based on IDFC appraisal.

Note: *This includes about two-third of the total manpower costs of Rs 1.58/KL, to be conservative.

** The range of costs is Rs 1.07/KL to Rs 1.34/KL. Figures were adjusted to 2003 rupees using the wholesale price index.

*** We assume that current O&M costs for 100 MLD operations increase proportionately. However, it is likely that this figure will be lower due to scale economies.

HPEC estimates include the O&M cost for the sewerage network, which is Rs 3.3/KL on average.

Assumption for PPCL and Nerul: All non-fixed costs escalate at 5.5 per cent per year over 30 years. Capital expenditure for the Nerul STP is Rs 67.9 crore, for PPCL it is Rs 2.5 crore per MLD. 'Public' assumes no return on equity, whereas 'Private' does: it is 16 per cent for Nerul and a DERC-approved 14 per cent rate for PPCL. Debt: equity ratio for all is 70:30, loan is for 10 years at 12.5 per cent interest. PPCL estimates include pumping costs from the STP to PPCL power plant.

National Urban Renewal Mission (JNNURM) funding for a total treatment capacity of 740 MLD. Given the varying age of the plants, CMW reports an average O&M cost for collection and treatment across all its plants of Rs 8.90/KL. The O&M cost of treatment alone is estimated to be approximately Rs 4.08/KL.

Due to the age of some of its plants, CMW does not include capital expenditure in its treatment costs. It is interesting to note that CMW's four newest plants are completely powered by internally generated biogas for nine months of the year which reduces electricity costs significantly by about Rs 0.45/KL.

An alternative estimate of costs comes from industry. In 2004, the government-owned Pragati Power Corporation Limited (PPCL) a Delhi-based power station was denied a freshwater linkage to operate its 330 MW gas-based power plant. Instead, PPCL was given the option to operate two of the Delhi Jal Board's (DJB) 10 MLD each STPs to meet their industrial water requirement.

PPCL has outsourced the O&M to Degrémont, an international water treatment company. The contract is renegotiated every two years and Rs 1.26 crore per year for the period 2010–12. In addition, electricity costs for 2011 were Rs 1.6 crore. Like CMW, STW output quality is slightly higher than CPCB standards. STW is pumped to the PPCL power plant where it undergoes further treatment to be used in boilers and coolers. However, this additional treatment would be necessary even if freshwater were used. Current O&M for PPCL is Rs 4.0/KL. Table 21.1 also calculates levelized total costs using an estimated capital expenditure.

Since PPCL's plant uses proprietary ASP technology, its costs may be slightly different from other generic ASP plants. In particular, its capital costs per MLD are higher than generic ASP at Rs 2–2.5 crore per MLD. In 2004, Tokyo Engineering Consultants undertook a study of all the STPs built under the Ganga and Yamuna River Action Plans. The generic ASP plants surveyed were built between 1991 and 2001 and had O&M and electricity costs ranging between Rs 1.07/KL to Rs 1.34/KL. Their capital costs ranged between Rs 22 to 33 lakh per MLD. However, these costs are not directly comparable to the costs for PPCL reported below as they have been adjusted to 2003 rupees using a wholesale price index. The generic plants also have a larger capacity than PPCL at between 60–80 MLD, which brings in economies of scale especially in construction costs.

There are factors to be kept in mind when comparing SBR and ASP. For example differences in plant scale and the fact that since the ASP plants are government run they might not be operating at maximum efficiency.

Lastly, the estimates can be compared with those from the High Powered Expert Committee Report on Indian Urban Infrastructure and Services (HPEC). The report uses detailed project reports (DPRs) submitted by cities to JNNURM. They calculate an average treatment O&M cost of Rs 5.40/KL to produce secondary level STW. This is consistent with the cases presented earlier, especially as the HPEC numbers include technologies other than ASP and SBR. The HPEC estimates in Table 21.1 are for both treatment and collection O&M. On average, collection O&M alone is Rs 3.30/KL. The HPEC estimate for Class IA cities is similar to CMW's cost of collection and treatment of Rs 8.90/KL.

The HPEC Report also disaggregates per capita investment costs for network and treatment. As Table 21.2 shows, the per capita investment costs indicate significant economies of scale in both network and treatment. The unit costs are negatively correlated with the incremental project capacity for treatment plants. The largest component of investments, however, is the network and this cost escalates significantly for smaller cities and towns possibly because density reduces and the quantum of existing infrastructure falls. The per capita O&M costs for treatment range from Rs 145 to Rs 414 per capita.

Tertiary Level Treatment

Urban local bodies (ULBs) are not obligated to treat their sewage beyond the secondary level. However, some like the Bangalore Water Supply and Sewerage Board (BWSSB) have chosen to do so. At present, only four of their seven STPs do tertiary level treatment but there are plans to upgrade all the plants to that level. Their reported production cost for the 60 MLD Vrishabhavathi Valley STP is between Rs 10–12/KL. STW is presently supplied to a number of industries and it is proposed that it will be pumped for use in a local power plant.

In the absence of available tertiary treated STW, some industrial units have chosen to buy either raw sewage or secondary STW and treat it further to meet their water purity requirements. For example, Madras Fertilizers Limited (MFL) in Chennai and Rashtriya Chemicals and Fertilizers Limited (RCF) in Mumbai are purchasing STW and raw sewage, respectively from their local water authorities. Both require portions of their water at the tertiary treated, reverse osmosis (RO), and demineralized (DM) levels of purity. MFL utilizes 60 per cent of its water at the tertiary treatment level while 40 per cent is sent for RO and DM. Of the total water it receives from BMC and its STP, RCF uses 73 per cent at the RO level and 27 per cent at DM stage. Stage-wise cost of treatment and weighted average cost of treatment are given in Table 21.3. In the case of MFL, it is actually cheaper to use STW than freshwater both because of the high industrial water tariff in Chennai and because it is more expensive to demineralize freshwater than tertiary level STW. In the case of RCF, while there is a minimal price difference between RO level water which is used interchangeably with fresh water, this is weighed against having a reliable supply of

Table 21.2 Per capita Network and Treatment Costs for Sewage

(*Rs*)

City size class	*Network*	*Treatment*	*Total*
Class IA	2,092	1,268	3,360
Class IB	2,573	1,268	3,841
Class IC	2,338	1,073	3,411
Class II	3,246	2,070	5,316
Class III	3,637	2,012	5,649
Class IV +	4,636	2,012	6,648

Source: HPEC Report (JNNURM project appraisal notes used for cost estimation).

TABLE 21.3 MFL and RCF Current Total Treatment Costs

(*Rs/KL*)

	MFL		*RCF*	
	STW	*Fresh water*	*Raw sewage*	*Fresh water*
At plant gate	10	60	0.60	40
At TTP plant	28	Not Req	NA	Not Req
At RO plant	70	Not Req	45	Not Req
At DM plant	100	130	100	100
Weighted avg treatment cost	57	88	60	56

Source: Interviews with Madras Fertilizers Ltd. (interviewed on 19 May 2011), Rashtriya Chemicals and Fertilizers (interviewed on 9 May 2011), and Chennai Metro Water (interviewed on 18 2011); author's analysis based on IDFC appraisal.

water and control over quality which is highly valued by these kinds of industries. According to *The Hindu* (2009), the financial loss to RCF from disruption to their freshwater supply in 1992 was almost Rs 50 crore. In comparison, in the early 1990s when MFL set up its plant and STP technology costs were significantly higher than what they are today its capital expenditure was just Rs 30 crore. However, since the numbers given in Table 21.3 are internal estimates that may include other overheads, MFL and RCF's cost of production might not be representative of those faced by WAs or even other industries.

Like BWSSB, other water authorities might be able to produce tertiary treated STW at a substantially lower cost. For example, CMW was offered funding from the Japan International Cooperation Agency to set up a tertiary treatment and RO plant to supply water to industry provided the industries signed a guarantee to purchase certain quantities of water.

Cost of Alternatives

For customers to switch to STW it must be priced competitively with alternative water supplies for the same or better level of quality. This section describes the two main categories of potential STW users—bulk industrial or commercial users, and household consumers—and the costs of their alternatives.

Industrial and commercial users of STW have varying needs. Large industrial users, such as power plants require huge volumes of water but most of this is not needed at a high level of purity. Others, such as MFL and RCF require large volumes, but also a significant share of high quality water. However, many of these users must already further treat the freshwater they receive and may be able to absorb the costs of setting up additional treatment facilities or an STP.

Large-scale commercial users, such as malls, theatres, or office complexes need water primarily for air-conditioning and cooling and can utilize STW at low-end industrial reuse standards. However, STW needs to be chlorinated and its nutrient content removed to prevent scale formation and algae growth in their cooling systems. Transport authorities are another important bulk consumer who can use low-end STW. For example, it is reported that the Indian Railways uses 300 MLD of freshwater for washing its train carriages. Smaller industrial users who need good quality water might be more tricky if the STW provided falls short of freshwater standards as they may not have the financial capacity or scale to make additional treatment viable.

At present, most of these users buy their water from WAs at the industrial tariff, purchase tanker water, or pump groundwater themselves.

Retail or household users can use STW for gardening, flushing, or washing cars. According the Centre for Science and Environment (2010) these activities account for almost 40–50 per cent of total water use per individual. At present, most households buy freshwater at domestic water tariffs while some use groundwater or tanker water.

Industrial and Commercial Users

PUBLICLY SUPPLIED

Industrial water tariff in most large cities is typically quite high as industrial tariffs are set high to cross-subsidize drinking water. For example, Chennai's industrial water tariff is Rs 60/KL whereas the domestic water tariff is just Rs 4/KL. According to Prakash (2007) report, industrial tariffs across the larger cities are typically above Rs 45/KL. Given the range of treatment costs described earlier, it appears that WAs could afford to provide STW at below the current industrial tariff.

PRIVATELY SUPPLIED

(a) Tanker Water:

Tanker water costs vary across the country. In the larger metros, these costs range between Rs 50/KL to upwards of Rs90/KL in the dry season. Again, WAs in larger cities should be able to supply STW at competitive rates. For example, NMMC is considering supplying STW for the construction of the Navi Mumbai International Airport which would otherwise require about 500 tankers of water per day (5 MLD) at Rs 50/KL. Given Navi Mumbai's costs of production, this could constitute a considerable saving to the airport authorities while allowing NMMC to cover their treatment costs and earn revenue.

(b) Ground Water:

A challenge to the use of STW comes from industries that use groundwater. For these industries, the cost of water is practically free and dependent on the cost of pumping. Groundwater use can be both legal and illegal. For example, in New Delhi and Chennai, industries must apply to the local groundwater authority and be granted a permissible limit for extraction. However, to a large extent, groundwater extraction takes place illegally. Stricter regulation and availability of low-cost alternatives might encourage a shift away from groundwater use.

Household Users

Given that households receive freshwater at highly subsidized rates, it may not be feasible to supply STW at the levelized cost of production, or even at its O&M cost. However, as described later, the cost of augmenting bulk freshwater supply is usually higher than that of producing STW, meaning less cross-subsidy is required. Moreover, if using STW allows households to have a close to 24×7 water supply by preserving freshwater for its best use, then households might even be willing to pay a slightly higher cost for it.

Cost of Freshwater Supply

As the demand for water grows, WAs must continually augment their bulk water supply. Burgeoning urban populations and the growing imperative to supply water for more than a few hours in a day will all require large investment in water supply infrastructure.

Most large cities in the country pump their water from freshwater bodies at a distance between 50 to 200 km away. Although this water usually needs very little treatment, the infrastructure and operating costs of water supply pipelines are significant. Using estimates for pipeline and pumping costs for a pipe of 1 metre diameter Table 21.4 shows the range of levelized costs for augmenting bulk water supply. These estimates exclude the cost of water treatment plants.

Table 21.4 Levelized Pipeline Costs

(*Rs/KL*)

	*Levelized costs**		
	50 km	*200 km*	*1 km*
Variable costs	–8	–30	–0.15
Total costs	–13	–50	–0.25
Total costs (excl ROE)	–11	–44	–0.22

Source: Interviews with SFC Environmental Technologies Ltd. (interviewed on 27 May 2011); author's analysis based on IDFC appraisal.

Note: Assumptions: We assume all non-fixed costs will escalate at 5.5 per cent every year over 30 years. Total costs include capital expenditure of Rs 3 crore/km, pumping costs of Rs 1 per 10 km, pipeline of 1 metre diameter (carrying capacity of 132 MLD), debt: equity ratio of 70:30 and an return on equity (ROE) of 16 per cent.

In terms of current costs, water supply pipelines of 1 metre diameter cost Rs 3 crore per km to build and it costs Rs 1/KL over 10 km to pump. Levelized costs range between Rs 11/KL to Rs 50/KL. However if water boards receive grant funding or concessional electricity rates for pumping, then these costs might be reduced.

Most cities will already have some bulk water supply infrastructure. Water scarce Chennai has made large investments to supply the required 800 MLD of water supply. Its cost of freshwater supply using both surface and groundwater ranges from Rs 5 to Rs 10.50/KL for surface water and Rs 29/KL for groundwater. In addition, it is now desalinating water under a DBOOT contract, that they purchase at Rs 40/KL. It also has an additional desalination plant coming on line in 2012 which will supply desalinated water at Rs 21/KL.

To obtain a more comprehensive perspective of costs across the country, the *HPEC Report* estimates the O&M cost for bulk water supply as given in Table 21.5.

Table 21.5 O&M Costs of Freshwater Supply

(Rs/KL)

City size class	*O&M cost*
Class IA	13.0
Class IB	10.0
Class IC	8.0
Class II	8.0
Class III	6.0
Class IV	4.0

Source: HPEC Report (JNNURM project appraisal notes used for cost estimation).

However, it is important to keep in mind that this may not be the case in every city. Cities like Delhi that have access to perennial water supplies within close proximity might find it cheaper to supply freshwater. However, there too, the DJB reports that the growing need to preserve freshwater has made it take a more proactive stance towards producing and selling STW. The DJB is considering plans to sell STW from its STP located at Rithala to two power plants at approximately Rs 8/KL. However, the details of the arrangement are yet to be finalized.

To summarize, Table 21.6 compares the levelized costs of providing STW versus freshwater under both public and private arrangements.

Table 21.6 Comparative Cost of Producing STW and Freshwater

(Rs/KL)

	*Levelized Costs**	
	STW	*Freshwater*
Public	(–) 4–14	(–) 11–44
Private	(–) 5–17	(–) 13–50

Source: HPEC Report, Interviews with SFC Environmental Technologies Ltd, Chennai Metrowater and Pragati Power Corporation Limited; author's analysis based on IDFC appraisal.

* We assume all non-fixed costs will escalate at 5.5 per cent every year over 20 years. Total costs include capital expenditure of Rs 3 crores/km, pumping costs of Rs 1 per 10 km, pipeline of 1 meter diameter (carrying capacity of 132 MLD), debt: equity ratio of 70:30 and a Return on Equity (ROE) of 16 per cent.

Thus overall, it appears that the cost of producing STW suitable for low-end industrial use can be lower, or at least competitive with the cost of freshwater supply. While tertiary treated water, and certainly water treated by reverse osmosis is more expensive than freshwater, extensive use of STW where possible can reduce the overall investment burden for water supply.

Conclusions and Recommendations

To date, there has been much more emphasis on investing in water supply infrastructure than in sewage networks. Even JNNURM funding to date for water supply has been double that of sewage projects. Thus, while treatment costs are not a deterring factor, large upfront investment will be required to bring the current condition of sewerage infrastructure in the country up to the required level.

At present CPCB and state PCBs cannot penalize WAs that violate disposal norms. Partly as a result, only a handful of cities and towns are complying with their obligations. Given the acute lack of funding and the poor condition of many WAs, CPCB and PCBs could be given a budgetary allocation to help the relevant authorities prioritize sewage treatment through long-term loans or grants. In larger or more industrialized cities where there is potential to recover costs of producing STW, pipeline networks could be grant funded while medium or long-term loans could be given for STP construction. In particular, there should be a strong orientation towards O&M cost recovery and operational efficiency to ensure proper use of investment. This means that WAs should be required to meet all O&M costs through sale of STW. For example, CMW has full cost recovery for the STW it sells and earns Rs 12 crore annually from it. To enable this scenario, there should be strict enforcement procedures and concerted Central or state assistance in capacity building and training STP personnel.

Given the cross-cutting nature of benefits offered by STW reuse, there may be multiple agencies willing to fund such projects as the CCRCP did in Chennai. Funding from various agencies could be streamlined through JNNURM to enable maximum funding impact and transparency.

In allocating JNNURM funding, it could be mandatory that all bulk water supply projects be proportionately linked to an increase in sewage infrastructure.

Cities must draw up a phased infrastructure plan in which bulk water source augmentation is planned in conjunction with STP construction and sewage pipeline development. Incentives and funding should be tied to reaching certain STW reuse benchmarks. In the absence of sufficient industry, incentives could be linked to improvements in quality of surface water bodies used for discharge. Possible incentives could include electricity at cost, as the power cost of older plants in particular can be high or increased allocation for investment for household sewerage networks.

As part of their city development plans (CDPs), WAs could be required to broadly profile the water requirements of all bulk users in their jurisdiction and estimate the price at which STW could be supplied to them. This could be based on the cost recovery principle as well as a small premium to subsidize smaller industrial or commercial units. Given the savings to bulk users in particular they must build the connecting pipeline to the nearest STP. Already industrial users are asked to bear the cost of building connecting infrastructure for freshwater. For example, NMMC estimates that even if two large bulk consumers located across the sea in Mumbai built a Rs 200–250 crore undersea pipeline to the NMMC STP, they would recover their costs in 7 to 8 years by buying STW at Rs 8/KL rather than freshwater at the industrial tariff of Rs 40/KL. Alternately, to make this more palatable to industry, WAs could incur the cost of building the pipeline and recoup this by including the cost in their levelized tariff. However, this may require the WAs to take on loans for construction against a guaranteed purchase contract from industry.

Given the cost of sewage networks, CPCB is gradually encouraging decentralized treatment. Thus, for example, all new housing colonies above a certain size in Chennai, are required to set up their own STPs. Similarly, for large industries located further away from urban areas, WAs could mandate that they reuse their own sewage water to meet part of their own overall water requirements. In the case of power plants, captive STPs should be allowed to use the plants' own generated power rather than having to purchase it at commercial rates. WAs should not discourage industries from treating raw sewage themselves. For certain types of users, STW reuse could be mandatory. For example, this could include all public parks and gardens and transport authorities.

Tariff structures could be revised so that STW is provided free but potable water is charged higher. As the experience of ULBs across the country has shown, from a political perspective it might not be possible to raise monthly household bills. Yet it might be possible to design a tariff structure in a way that potable water is charged higher than it is at present and non-potable water is free so that the monthly bill remains the same. Doing this would send a strong price signal that incentivizes less potable water consumption. However, for household users to use STW, significant investment would be required to build a set of dual pipelines to carry both STW and freshwater to properties. While the idea of dual pipelines might seem daunting, some of this cost can be shifted to developers, as has been done with rainwater harvesting. It should also be mandatory to separate 'grey water' from 'black water' so that the former can be directly used for flushing and gardening within the building at least once before entering the WA's sewage network. To ensure this, planning norms for STW reuse should be issued for all new cities, townships, industrial, areas and special economic zones (SEZs). Building codes should mandate dual pipelines to carry STW and freshwater. Lastly, municipalities should be required to allocate land to accommodate STPs, pumping stations, and other related infrastructure.

With estimates of industrial water demand at 8 per cent of freshwater withdrawal and growing rapidly, the need to promote sustainability in freshwater use has become exceedingly important. Although the task ahead appears daunting, India with a large chunk of infrastructure remaining to be built, is actually well poised to plan its development in a way that ensures our water security in the future.

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Section V

Water Valuation and Institution

22 Water Sector Reforms

Implications on Empowerment and Equity*

Sachin Warghade and Subodh Wagle

Introduction

The achievements and failures of efforts in the development of the water sector are well-known. While on the one hand, these efforts have contributed significantly to food security as well as improvement in the quality of life in many Southern nations, there have been many and equally significant gaps and unintended negative impacts on nature and society. Over the years, the marginalized and disadvantaged sections of society have been further disempowered as they have lost control over the process of making decisions related to the development of the water sector. As a result, they have been subjected to a disproportionately high burden of costs of development in the sector, while the benefits, both direct and indirect, that have actually reached them have been insignificant. A bigger problem associated with the development of the water sector has been disempowerment of the marginalized and inequity. In this background, the efforts aimed at restructuring and reforming the water sector acquire special importance.

Sectoral reforms in the water sector began in 1990s in India as a part of pilot projects funded by international financial institutions (IFIs). These reforms have now penetrated into policy and legal frameworks of water governance at the national as well as state levels. These reforms are crucial for many reasons. First, the reforms acquire importance because of the centrality accorded to them in sector governance. Second, reforms are making fundamental changes to the values and principles underlying laws and policies. Third, these reforms are comprehensive, covering all important aspects and elements of the sector. Fourth, and most importantly, many of the reforms have brought in changes in not only policies and laws but also in the institutional structures and even ground conditions that are very difficult to reverse.

It is argued that the water sector requires huge investments for infrastructure development and upgradation, which most governments would fail to provide. The most common solution proposed to address this problem consists of market-based reforms, which include operating the system on a full cost recovery principle and commercialization or private sector participation of varying degrees (Prasad 2007). While arguing in favour of cost-based water pricing, a World Bank (2005a: 54) document states that 'although the massive distortions

* This chapter is developed based on the paper presentation in Fourth South Asia Water Research Conference organized by SaciWaters on 'Interfacing Poverty, Livelihood and Climate Change in Water Resources Development: Lessons in South Asia' held in Kathmandu, Nepal on 4 May 2009.

in the pricing of water services are justified "in the name of the poor", it is, paradoxically, the poor who are the major victims of these distortions'. The document further argues that '[t]he situation in India remains one in which public monopolies face no competition. The one over-riding lesson from the global revolution in the provision of public services is that competition matters' (the World Bank 2005a: 44). Reforms, in this context, are justified mainly on two grounds: (i) improving efficiency and economy, and (ii) enhancing equity and empowerment.

First, it is claimed that different elements of reforms will bring in improvements in performance, which implies reducing, if not eliminating different types of losses and inefficiencies. This improvement in performance will result, on the one hand, in improvements in the economic and financial health of the organization in the sector as well as of the sector as a whole. The Government of India in the World Bank's 'Water Forum' stated that '[t]he sector is characterized by serious under-performance, and this crisis will continue unless there is a fundamental reform of service arrangements' (GoI 2002a: 2). On the other hand, increased efficiency will also result in a decrease in consumer prices and an increase in the quality of services given to consumers and users.

Second, it is argued that the many elements of reforms will empower consumers against the mighty utilities—both public and private owned. The reforms will have special instruments and mechanisms to deal with grievances of water users. Further, it is also argued that reform elements, which would improve overall transparency and accountability in the functioning of the sector, will empower water users too. Reforms will bring in a level playing field to all water users, and help users who face economic, political, or social challenges. It is also argued that the improved functioning of the sector will bring in private investments and reduce the burden on government funds, which can be meaningfully utilized for supporting the interests of disadvantaged sections within or outside the water sector (the World Bank 2005a).

Hence, such reforms in the policy and legal instruments require an assessment of their potential contribution to equity and empowerment. Such an assessment can provide valuable inputs for the future direction of reforms. This chapter presents the outcomes of an assessment of key reform instruments in the water sector in India.

Framework for Assessment

The terms 'equity' and 'empowerment' need to be interpreted in a manner that is relevant to the water sector. The main issue in the equity dimension is the distribution of costs and benefits among different stakeholders. In the water sector, apart from financial costs, the main costs involved are social and environmental costs, which are the result of developing infrastructure required for generating water sources and distributing water. The main benefit from the sector is water services, including effective access. Effective access to water is seen to be dependent on the availability of water to a particular user—which, in turn, is affected by physical, economic, political, and social factors.

In assessing the equity implications of reforms, both costs and benefits, need to be investigated. While the financial costs are borne by the state and national governments, the decisions on the social and environmental costs are made through policy and legal instruments that lie outside the water sector. For example, in Maharashtra, land acquisition for water projects is carried out by the revenue department using special land acquisition laws. Similarly, decisions on environmental matters are handled by the agencies under the purview of the Ministry of Environment and Forests (MoEF), whereas issues of water quality are handled by pollution control agencies under separate laws.

Empowerment here implies increased influence on the governance of the sector, especially on the functions of decision-making and regulation. Influence on governance is a function of participation, accountability, and transparency. The ability to get decision-makers, implementing agencies, and regulators to be accountable is a key measure of the influence of that water users and citizens have on the governance of the sector. Similarly, true and meaningful participation in all functions and all stages of governance is necessary to ensure that the needs, aspirations, and demands of the stakeholders are reflected in the outputs and outcomes of governance processes. Transparency—defined as 'timely and unrestricted access to information'—is a precondition to effective extraction of accountability and meaningful participation.

It is also argued that the location of decision-making is important for exercising influence on governance. The geographic distance as well as procedural remoteness are considered as adversely affecting the ability of water users and citizens in influencing governance. Decision-making at the local level is preferred from the point of view of water users.

The term 'reform' is used in a limited sense—to designate measures aimed at 'structural reforms' or 'sectoral restructuring', especially those measures that are aimed at changing the governance-related role given to the state. Apart from these, other reforms too have been introduced in the water sector, like those aimed at increasing the participation of farmers in the management of irrigation. However, these participation-related reforms are more focused at the project or sub-project level. Though they affect the role of the state, they are focused on shifting the role in management of irrigation systems away from the state and in favour of water users (discussed in Chapter 9). As against this, 'structural reform' instruments are primarily aimed at changing the distribution of governance roles in the sector, away from the state and in favour of non-state actors.

In choosing 'structural reform' instruments for this assessment, the criteria used are the comprehensiveness or depth of the reform instruments, which have implications for the core of sector governance. The following three sets of reform instruments are identified for assessment: (i) National Water Policy, 2002, (ii) State water policies, and (iii) Legislations for establishing independent regulatory authorities.

Water is a state subject. But there are certain issues that are supposed to be governed or guided by national interests. The National Water Policy (NWP) represents the overall policy direction for the water sector that shall be followed at the national as well as the state levels. While the first NWP was formulated in 1987, the new revised NWP was launched in 2002. NWP 2002 is seen as the turning point in the governance of the water sector in India.

For the purpose of the current assessment we have selected state water policies (SWPs) of six states in India, Madhya Pradesh (GoMP 2003), Uttar Pradesh (GoUP 1999), Rajasthan (GoR 1999), Maharashtra (GoM 2003), Karnataka (GoK 2002), and Andhra Pradesh (GoAP 2008), where water sector reform projects are being intensively implemented. The third category of the reform instruments chosen for the assessment includes different legislations for establishing independent regulatory authorities (IRAs). IRAs for the water sector have been established by enacting special laws in the three states of Maharashtra, Arunachal Pradesh, and Uttar Pradesh. The other states are also planning to establish IRAs in the water sector. Laws pertaining to participatory irrigation management (PIM) are not the primary focus of this chapter, though they have been touched upon in the current assessment.

The scope of this assessment of these reform instruments is restricted to the following key substantive issues:

- Centralization (especially 'nationalization') of water sector governance: What are the latest trends and their possible impacts on 'empowerment'?
- Emergence of IRAs in the water sector: What could be their impact on 'empowerment'?
- Emergence of the 'water entitlement system': The laws establishing IRAs delegate setting entitlements as one of the primary functions of the IRAs. What could be the impact of the new emerging entitlement regimes on 'equity', especially in water distribution? What is its relation with 'water markets' and the possible impact of these relationships on 'equity'?
- Emergence of the new 'water tariff system': What could be the possible impact of the new tariff system on 'affordability' and hence 'access' to water services?

Key Findings

Centralization of Governance of the Water Sector

The distribution of decision-making powers between the local, state, and national actors affects the level of empowerment that can be achieved. With this view, many social movements as well as innovative field experiments in the water sector have demanded delegation of power to local level functionaries and communities regarding crucial decisions related to the distribution of water, decisions about new water projects, and funds allocation. Such efforts seem to have led to a widespread acceptance of the need to decentralize the governance and management of sectoral functions. Emergence of legislations related to participatory irrigation management could be seen as the outcome of the demand for decentralization, though there have been much criticism of these instruments on the same count (Koppen et al. 2002). The following findings pertain to the issue of centralization of governance.

National Water Policy: Foundation for 'Nationalization' of Water Resources

As per Entry 33 of List II of the Indian Constitution, the development and management of water is a 'State Subject'. Hence, the water sector has remained predominantly under the control of the states and has been governed by state level ministries and authorities. This allows citizens of the state to participate, lobby, and influence the state government machinery in achieving water access and equity. As against this conventional understanding, recent reform instruments seem to indicate that these reforms bring to the fore national level concerns over and above the state or local level concerns. Some examples are:

- National Water Policy (NWP), 2002, in Sections 1.1 and 1.4, defines water as precious *national* asset or resource (emphasis added) (GoI 2002b).
- NWP further states that planning, development, and management of water resources need to be governed by the *national* perspectives (emphasis added) (refer to Section 1.1 of the Act) (GoI 2002b).
- About inter-basin transfer of water, NWP states that water should be made available to water short areas by transfer from other areas based on the national perspective (refer to Section 3.5 of the Act) (GoI 2002b).
- About the inter-state water disputes, NWP says that water sharing/distribution among states should be guided by the national perspective (refer to Section 21.1 of the Act) (GoI 2002b).

Each of these policy provisions reiterates that the water sector should be guided and governed by the national perspective. In doing so, NWP clearly lays down the foundation for increasing national level intervention in the governance of the water sector.

Attempt to Develop Constitutional Basis for Nationalization of Water Resources

The Ministry of Water Resources of Government of India published in December 2006, a report titled *Report of the Working Group on Water Resources for the Eleventh Five Year Plan (2007–12)* (GoI 2006). The *Report* recommendeds developing a Constitutional basis for bringing central control on key decisions in the water sector. The *Report* also suggested that water and water resources' projects must be considered as national assets and there must be a platform, such as the (national) water regulatory authority to timely and effectively settle all inter-state issues in a national perspective. The national level regulatory authority is seen as a mechanism for making decisions on a state's matters at the national level. Such recommendations to centralize key decisions in the water sector at the national level are evident from policy directions. This kind of nationalization is seen to be necessary if national projects like inter-linking of rivers are to be successfully completed.

State Level Centralization of Water Governance

Similar trends on centralization of governance are also visible at the state level. The new laws for establishing water regulatory authorities provide for concentration of key decisions in the hands of state level actors such as state government departments and state regulators, without much space for intervention by citizens or water users. For example, both the Maharashtra Water Resources Regulatory Authority (MWRRA) and Uttar Pradesh Water Management and Regulatory Commission (UPWMRC) Acts provide for developing integrated state water plans (GoM 2005; GoUP, 2008). These plans are to be prepared by the respective state governments. The particular laws do not provide any space for public participation in the preparation of such plans. Hence, eventually the planning process may remain outside the domain of the public and it may merely turn into a centralized top-down bureaucratic exercise.

Another important example is the case of legal provisions for determining and distributing 'water entitlements'. As per the regulatory laws, the state level regulator will determine entitlements based on the rules framed by the state government. Here again it can be seen that the laws do not make any provision for consultations with, and participation of, stakeholders in taking such a crucial decision on water distribution (GoM 2005; GoUP 2008).

This clearly shows that while on one side attempts are made to decentralize the governance of the water sector, on the other side there is centralization of key decisions in the water sector at the level of the state government.

The Impact of Centralization and Nationalization on Empowerment

The discussion so far suggests that there are strong tendencies to centralize the governance of the water sector at the national level as well as at the state level. Once such enormous powers related to crucial sectoral decisions get concentrated in the hands of the top bureaucracy, top regulators, or dominant vested interests, then empowerment will merely remain in the form of delegating the implementation functions at the local level. A major negative impact of 'centralization' and 'nationalization' of water sector governance will be on empowerment of the citizens and other stakeholders.

It must be noted that there might be genuine concerns that prompted calls for giving due importance to the national perspective. These would include concerns over the increasing instances and increasing severity of inter-state disputes or concern over repeated failure of the state level machinery and other instances, which would justify intervention, mediation, coordination, or control by the national government or other national level agencies. But it also needs to be noted that such attempts of giving an increasing role and control of the sector governance in the hands of national level agencies, without adequate thought to the dencentralization framework, would certainly lead to an adverse impact on the empowerment of state and local level actors.

Establishing IRAs: Impact on Empowerment

Three states have established IRAs in the water sector. Other states are considering setting up of IRAs. The findings related to this development are now discussed.

Genesis of IRAs: Not Grounded in Public Debate and Demand

National Water Policy discusses regulation as a policy measure mainly in relation to groundwater and flood management (GoI 2002b). This policy does not make any mention of the need for a regulatory authority in the water sector. SWPs of various states also do not give any policy direction for setting up IRAs in the water sector. The only exception in this case is the policy of the state of Uttar Pradesh (UP) (GoUP 1999).

This suggests that the initiative towards setting up of IRAs in the water sector at the state level is not grounded in policy debates at the state or national level, which are supposed to reflect in the respective water policies. Similarly, the need for IRAs does not seem to emerge from an informed public debate or demands from stakeholders. The initiative to set up IRAs seems to be largely due to an externally driven stimulus, which became active mainly after the articulation of the NWP and SWPs.

The major external stimulus in this regard is provided by the water sector improvement/restructuring projects undertaken in various states, which were funded by the World Bank. These projects were initiated in Madhya Pradesh (MP) in 2004, Maharashtra in 2005, and Rajasthan and Uttar Pradesh in 2001. It can be seen that state policies in MP, Rajasthan, and Maharashtra were declared before undertaking these World Bank-funded projects. Further, the project appraisal documents of these World Bank-funded projects include establishing regulatory authorities as one of the conditions of the loan agreement (World Bank 2005b). This suggests that the move towards the formation of state level IRAs in the water sector has been an externally driven phenomenon. The main rationale provided by the World Bank for bringing in IRAs is to bring rationality in the decisions on key economic and financial matters, such as tariff and entitlements, which is shown as the necessary precondition for increasing private participation in the sector. This reform has no connection with the state or national level policy debates, but is created by an external stimulus with the intention that has nothing to do with empowerment. It is equally interesting to undertake a state-specific assessment of the process of establishing IRAs. The findings of such an assessment are:

- Maharashtra became the first state in India to pass a law for establishing IRA in the water sector. In 2005, the state passed the Maharashtra Water Resources Regulatory Authority (MWRRA) Act. It is interesting to note that the bill in this respect was passed in the state legislative assembly on the last day of the session through voice vote, without much discussion on the revised draft. The World Bank loan for sector improvement was sanctioned by the Bank's board immediately after the Act was passed.

- Arunachal Pradesh was the second state to pass such a law. The state literally copied the entire Act passed by Maharashtra. An assessment shows that many provisions in the Act are totally irrelevant to the specific context of the water situation in Arunachal Pradesh. For example, the legislation provides for removal of irrigation backlog in backward regions. The issue of irrigation backlog is relevant to Maharashtra and not Arunachal Pradesh. Here again there was no attempt to ensure empowerment through public participation and consensus on crucial decisions, such as the setting up an IRA.
- Uttar Pradesh passed a legislation for establishing an IRA in the water sector following the conditions stipulated in the contract for the World Bank supported water sector reform project. Neither civil society organizations nor any other key stakeholders in the state were consulted in the process of forming the law for this purpose (PRAYAS 2009a).

Thus, the sources or roots of these laws have nothing to do with empowerment; and even the processes of passing these laws are, without exception, are marked by complete disrespect to the basic tenets of public participation or transparency. In summary, it could be said that the assessment of the genesis of the laws for establishing IRAs indicates that there is hardly any consideration of empowerment or equity in either the genesis or passage of these laws.

Water Sector IRAs: Disempowering Tendencies

Major concerns regarding the setting up of IRAs in the water sector are about their 'accountability' to citizens and common water users. Their status—as quasi-judicial bodies—defined by the respective laws make them immune to political pressures or political activities. In effect, unlike the elected representatives who are held accountable by the public through the mechanism of elections, there is no formal mechanism to hold the IRAs accountable to the public.

IRAs are expected to be governed by the law that created them as well as by the rules and regulations for conduct of their business (which the IRAs are expected to articulate). To ensure that the IRAs adhere to the laws and regulations, the process adopted by them to arrive at decisions, has to be transparent, participatory, and accountable to their stakeholders, including common water users.

An assessment of IRAs was carried out by comparing provisions of the Act for establishing state regulatory authorities in the water and electricity sectors (GoM 2003, 2005). After comparing the Electricity Act, 2003 and MWRRA Act, 2005, it was found that the Electricity Act contains much better provisions for transparency, public participation, and accountability of state regulatory commissions. In contrast the MWRRA Act is very weak in all these aspects. Some of the findings of the comparative analysis of the two acts are (PRAYAS 2007):

- Section 3 (4) of the Electricity Act (E-Act) provides for public participation in preparing the national electricity plan. In contrast to this, the MWRRA Act does not provide for participation in preparing the integrated state water plan.
- Section 181 (3) of the E-Act makes it mandatory on the regulatory commission to make regulations subject to the condition of previous publication. The condition of prior publication keeps open the opportunity for public awareness and participation in forming the regulations before they are finalized. There is no such condition of previous publication in the MWRRA Act for provisions related to the powers of the regulator to make regulations.
- Section 86 (3) of the E-Act makes it mandatory on the regulatory commission to ensure transparency while exercising its powers and discharging its functions. This provides blanket acceptance and unrestrained scope for transparency. Unfortunately, the MWRRA Act does not provide any concrete measure for transparency.
- The MWRRA act requires participation of water users only while setting tariff. It does not require participation of water uses while making decisions on important matters, such as determining water entitlements or project assessment.

These examples show that the MWRRA Act, which is often been proposed as a model regulatory act for replication by other states, is, in fact, not supportive of the cause of empowerment of citizens and other stakeholders in the water sector.

There is another major hindrance in common water users influencing the functioning of IRAs. The IRAs are expected to ensure economy and efficiency in water use. As a result, the focus of their deliberations is on technical, economic, and financial aspects of issues on which decisions are to be taken. In order to influence these deliberations, the participants in the deliberations require a high level of technical, economic, and financial expertise. Moreover, all proceedings of IRAs are supposed to be carried out in a quasi-judicial format and thus participants are also required to have adequate legal knowledge and skills for effectively participating and influencing the proceedings. Most civil society organizations, common water users, or their organizations do not possess knowledge, expertise, or skills in these areas; neither do they have financial resources to hire expensive professional services. This is not the case with dominant actors like the state and corporate houses, who often have both expertise and resources. In such situations, the proceedings and deliberations before IRAs may be controlled and captured by these dominant actors, often at the cost of the interests of other stakeholders. In other words, the nature of the proceedings and deliberations before IRAs tend to effectively disempower common water users.

The experience of proceedings by MWRRA vindicates this analysis. The authority, which was conducting the process for determining water tariff for farmers, initially chose to restrict itself to a website as the only means of communication for reaching out to farmers. It did not take into consideration the fact that these farmers were spread in remote rural areas, most of them did not even get electricity beyond 6 to 7 hours a day, and certainly did not have connectivity to the internet. Similarly, it also required all participants in the public consultation to submit written petitions, when most farmers lack skills and resources to articulate their grievances on paper. In fact, it initially asked all participants to make legal affidavits. The authority was forced to set aside this requirement due to strong protest by farmers (PRAYAS 2009b).

Water Entitlements: Regime of Inequitable Water Distribution

An assessment of the new legislations enacted in Maharashtra, Arunachal Pradesh, and Uttar Pradesh for establishing IRAs in the water sector shows that the creation, management, and regulation of the water entitlement system (WES) is at the heart of the regulatory framework of IRAs in the water sector. As part of WES, various water users and groups of users shall be allotted certain shares of water as their 'water entitlement'. UPWMRC and the MWRRA are empowered, through their respective legislations, to determine and regulate water entitlements to different user groups (GoM 2005; GoUP 2008).[1] The MWRRA Act states that entitlements are deemed to be usufructuary rights, (refer to Section 11 (i) (i) of the Act). Water entitlements are certainly not ownership rights but they are 'rights to use' (in short 'use rights'), which are also called 'usufructuary rights'. Thus, entitlements are legally recognized, registered, near-perpetual, and regulated rights over use of water.

Such a system of water entitlements will drastically change the way water resources are shared among various users. The system will usher a completely new mechanism for determining, recognizing, and allocating rights over the use of water among contending stakeholders.

Narrow Interpretation of 'Equity': Creating Water Lords

Both the UPWMRC and MWRRA acts specifically mention in their preambles that the regulator shall ensure judicious, equitable, and sustainable management

[1] While the paper was under printing there was an amendment to the MWRRA Act which was passed in 2011. As per this amendment the powers of determining inter-sectoral allocations have been transferred from MWRRA to the Cabinet. The criteria for 'equitable' entitlement that existed in the earlier law now stands abandoned as per the amendment. The key feature of the amendment is the provision that legalizes all the past decisions of water allocation that led to water diversion from irrigation to non-irrigation use. These decisions were made by a ministerial group by bypassing the powers of MWRRA.

and allocation of water resources. Thus, the legislations accept equity as the key principle that shall guide the allocation of water resources. Based on this acceptance, it is expected that there will be equitable distribution of entitlements, thus making the poor and other disadvantaged sections including the landless, entitled to their due share of water resources.

A thorough assessment of the UPWMRC Act shows that except for its preamble, the term equity is not mentioned in any of the legal provisions in the Act. In fact, there has been no attempt to legally define the criteria for equitable allocation of water resources. The absence of a practically implementable definition of equity will not help the regulator to implement the principle of equitable distribution in practice. Thus, in practice, the provision for equitable distribution will not yield any results.

The term equity is mentioned in the MWRRA Act four times in its main provisions, apart from being mentioned in the preamble (GoM 2005). The main provisions related to these in the MWRRA Act are:

- 'for equitable distribution of water in command areas of the project, every land-holder in the command area shall be given a quota'.
- 'the quota shall be fixed on basis of the land in command area, (refer to Section 12 (6) (a) & (b) of the MWRRA Act).

These provisions clearly indicate that water will be made available to only those people who have land in the command area and it will be in proportion to the landholding. Hence, this definition of equity includes only landowners in the command area of an irrigation project. The definition totally ignores the rights of landless communities, including land tillers, agriculture labourers, and women cultivators. By making this law, the state has actually given legal sanctity to such a narrow definition of equity. The reform instrument fails to evolve an inclusive interpretation of the principle of equity.

The combination of two factors: (i) establishing the entitlement regime (legally recognized and perpetual use rights over water), and (ii) interpretation of 'equity' in terms of the land owned will allow big landlords to gain immense control over water resources that would not only have the government's support but also have legal sanctity. The WES with a narrowly defined principle of equity may thus lead to the emergence of water lords. This will ultimately reinforce the financial and political clout that the dominant group holds today and would lead to further erosion of space for disempowered sections to assert their rights. The problem gets further accentuated when we explore the linkages between WES and the creation of water markets.

Priority of Water Allocation: No Clear Mandate for Equitable Water Distribution

The IRAs have to follow the policy guidelines given in state water policies while determining water entitlements for agriculture or industry (GoM 2005). The national water policy as well as most of the state water policies in their list of priority use of water, give higher priority to water requirements in agriculture water than to industrial water requirements. The only exception to this is Maharashtra, which has allocated higher priority to industrial water use as compared to agriculture water use (GoM 2003). This prioritization of industrial users over agricultural users in a state facing semi-arid conditions and water scarcity is seen by many as a clear case of inequity in water allocation as far as the water demands of farmers are concerned.

The higher priority to agriculture water use in comparison to industrial use provided in NWP as well as most other SWPs is, however, not unequivocal. These reform instruments include a provision allowing for modifying the priority based on specific needs of certain regions and purposes. Thus, the policies are in a way non-committal in giving higher priority to agriculture use in water allocation. Almost half of the SWPs that were assessed included such a provision allowing modification of priority. Such discretion could be used in future to change the original priority list, resulting in inequitable distribution of water resources among contending users, disfavouring the small and disadvantaged stakeholders.

NWP, which acts as a guideline to all states, included the following categories in defining priority for water allocation: drinking, irrigation, hydropower, ecology, agro-industry, non-agriculture industry, and navigation. Similarly, SWPs in some states (there are some exceptions) also have very short lists, neglecting water needs of diverse livelihood practices of rural people in this vast and diverse country. These livelihood practices which need water include aquaculture, afforestation, and livestock, which are important rural, agro-based livelihood practices. Exclusion of these categories of water uses would lead to disadvantages to some sections of the rural population.

Entitlement as Precursor to Water Markets: Impacts on Equity

According to Section 11(i) of the MWRRA Act, the regulator is accorded the powers to fix criteria for trading of water entitlements. Further, the law states that, 'entitlements … are deemed to be usufructuary rights which can be transferred, bartered, bought or sold … within a market system' (refer to Section 11(i) (i) of the Act) (GoM 2005). Thus, emergence of formal water markets is not just hypothetically linked with entitlements; it has already penetrated the regulatory framework and received legal sanctions in one of the states in India. The assumption underlying the creation of water markets is that market forces will ensure allocation of water to the most high-value application or most economic use of water. This has already been implemented in countries like Australia and Chile (GoAu 2005) (Saleth and Dinar 1999).

One of the most comprehensive studies done on the distributive impacts of water markets in Chile concludes that farmers' share of water rights decreased significantly after formal water markets backed by the system of property use rights (entitlements) were introduced (Romano and Leporati 2002). This led to deterioration in the standard of living. The study further concludes that the share of the agricultural sector in water rights as a whole decreased while that of non-agricultural sectors increased. Such impacts would be detrimental to the agro-economy and the overall rural economy in India. This will further deprive the vulnerable sections of their rights to water resources.

Water Tariff Systems and Inequity

An assessment of the legislations for establishing IRAs also indicates that establishing a tariff system and regulation of tariff is one of the key functions of IRAs. The UPWMRC Act as well as the MWRRA Act entrust the responsibility of determining and regulating water tariff to the respective regulatory authorities. Water tariff has been a politically controversial and emotive issue. This is primarily due to its direct impact on the affordability that, in turn, affects access to water for common citizens, especially, for vulnerable sections of society.

Paradigm Shift in Tariff System: From 'Affordability' to 'Cost Recovery'

It should be noted that in many parts of India water charges are based on the (explicit or implicit) criteria of affordability for water users. As a result, in many places water is being provided free or at highly subsidized rates to certain areas or to certain sections of society. And for the same reasons expenditure for water services was subsidized using the revenue generated from general taxes. Thus, historically water services were predominantly considered social services and water was considered a social good.

The new tariff regime that will be implemented as part of water sector reforms attempts to reverse this principle and replace it with the principle of water as economic good. There is an emerging consensus that water services should either be run like a business, or become a business (Kessler 2005). A business-like operation would require full cost recovery from the water tariff charged to individual consumers. In effect, this requires charging of water services based on market principles.

An assessment of state water policies shows that almost all the states in India have accepted the principle of cost recovery for determining water tariff. But, there was no formal mechanism to establish the tariff regime based on this principle. So this has been secured by making relevant provisions in the new regulatory laws, such as the UPWMRC Act and MWRRA Act, which effectively provide legal sanction to the paradigm shift in the perspective towards economic water services and tariff. Both the laws empower water regulatory authorities to establish tariff systems based on the principle of cost recovery, and to determine and regulate water tariffs. Such a shift from affordability to cost recovery will have a strong bearing on the cost burden of water services on the poor and marginalized sections of society. An application of the cost recovery principle will naturally increase water tariffs.

Assessment of Levels of Cost Recovery

In the Water Week Panel on Political and Technical Issues in Cost Recovery organized by the World Bank

(February 2005), six different levels of cost recovery were proposed and recommendations were made for moving to higher and higher levels of cost recovery. The lowest cost recovery level pertains to the level where even operations and maintenance (O&M) costs are not recovered while the highest level pertains to not only recovery of O&M costs but also recovery of capital investments and profits (Revels 2005).

The movement from one level of cost recovery to a higher level, as proposed by the World Bank panel, is actually being implemented through the new water regulatory laws in India. The water tariff levels that exist in a majority of the Indian states fall in the first level of cost recovery, that is, tariff levels at which even O&M costs are not recovered. This explains the need that was felt for moving to the next level as accepted in MWRRA Act. As per Section 11(d) of this Act, water tariff should be able to recover O&M costs.

The UPWMRC Act makes a provision for going to a still higher level of cost recovery than that achieved by the MWRRA Act (which was passed three years before the UPWMRC Act). The UPWMRC Act provides for recovery of cost of not only O&M, but also the cost of depreciation, and subsidies. In effect, the UPWMRC Act gives legal sanction for a higher level of recovery of costs. The provision for cost of recovery of depreciation from water tariff in the UPWMRC Act makes way for allowing recovery of that part of the capital which gets reduced due to aging and use. In accounting terms, depreciation is often equated with the cost of repayment of a loan. Hence, part of the tariff can be used to repay the loan (principal amount) on capital assets. The depreciation amount collected as part of the tariff can also be used for renewal, rehabilitation, or replacement of capital assets. Thus, the UP Act makes a landmark decision for recovering a significant part of the capital cost on a continuous basis from water tariff. Provision of recovery of capital costs in this manner paves the way for a higher level of commercialization of water services, which would result in increasing the cost of services. Recovery of capital costs also creates a conducive environment for privatization in the water sector.

This assessment shows that both the regulatory laws have still not made a provision for recovery of investments or profits from water tariffs. Once this level of cost recovery is reached, the water sector will be able to attract private investors.

Unlike the MWRRA Act, the UPWMRC Act makes a provision for recovery of subsidy from water tariffs. The MWRRA Act makes provisions for cross-subsidy, which comes from the revenue from water tariff, as well as from government subsidy. But the UPWMRC Act mandates the authority to fix tariff such that the revenue from the tariff should also recover subsidy. Thus, the UPWMRC Act attempts to close the option of government subsidy by putting the entire cost burden of subsidy on revenue from water tariff. Such an attempt will lead to tremendous pressure on service providers to reduce the subsidy component of the costs to enhance the already limited revenue collected from water tariffs.

Pricing Out the Poor and Rural

The tariff regime being envisaged in the policies and legislations will lead to an increase in water tariff. The increase in water tariff will mostly be targeted at the agriculture and rural economy, since these are the categories that are subsidized either by industries or by the government.

This inference could be justified by looking at the water tariff increase proposed in the first approach paper prepared for MWRRA by a consultant for determining tariff regulations (PRAYAS 2009b). The proposal envisages 39 per cent increase in the tariff for agriculture water use and an only 5 per cent increase in water tariff for industrial water use. The proposal also seeks to put in place cost recovery as the primary principle for determining tariff and totally neglects the principle of affordability.[2]

[2] While this paper was under printing, the final criteria for tariff determination were fixed by MWRRA. These include various social criteria related to affordability. These criteria were accepted by MWRRA only after strong demands made during the intense public consultations conducted by MWRRA due to pressure from civil society groups. Hence, this was achieved after a high social cost incurred by civil society groups in analysis, awareness generation, and public participation in regulatory process. The social criteria based on affordability should be made part of the law to avoid reliance on such a high social investment. Such social investment is not always possible due to lack of resources and capacities among the marginalized groups.

Thus, the new tariff regime in the water sector is attempting to bring in practice major commercial principles of regulation like cost recovery and reduction in cross-subsidy. Such a move to commercialize the water sector will have detrimental impacts on the poor and the agro-based rural economy of the nation. This will put the price of water services beyond the paying capacity of the poor and marginalized sections of society.

Conclusion

The findings of an assessment of selected reform instruments pertaining to the four issues can be summarized as:

- Reform instruments like NWP have attempted to centralize and nationalize the water sector. This may lead to disempowerment of local and state level actors by denying them an opportunity to participate and influence key sector level decisions in the water sector.
- The emergence of IRAs in the water sector raises the question of accountability of these new decision-making bodies to the public. Lack of adequate mechanisms for transparency, public participation, and accountability in the proceedings of IRAs further leads to the lack of influence of citizens and water users on the governance of the water sector. This will open avenues for dominant and vested interest groups to control the sector by indulging in a regulatory capture.
- Legal reform instruments usher in new mechanisms for determining, allocating, and regulating water entitlements. WES has the potential to strengthen the water rights of local communities and marginalized sections of society. But, the current legal instruments use a very narrow meaning of equity that links water entitlements to the quantum of land owned. Hence, in reality they strengthen and reinforce the already inequitable system of land ownership. Also there is no strong commitment of giving priority to the water requirements of agriculture water as against industrial water requirements. Further, the linkages of water entitlements to development of formal water markets poses a serious threat of diversion of water to urban-industrial elites by compromising on the water needs of rural, agro-based poor communities.
- Water tariff systems based on commercial principles like cost recovery and cutting subsidies are also mandatory aspects of the new legal reform instruments. Such commercialization of the water sector will further put water services beyond the reach of common water users, especially of the poor and vulnerable sections of society.

Overall, the analysis indicates that the reform instruments do not provide adequate measures for enhancement of equity and empowerment. In fact, many of them are working against equity and empowerment. This calls for urgent and proactive measures to ensure that public interest, especially the interests of the vulnerable sections of society, are not compromised in the process of reforms in the water sector. Some the important measures that should be undertaken are:

- Participatory deliberations with wider participation of farmers' organizations, organizations of agriculture labourers, environmental organizations, and other marginalized sections should be held to review policies and legal instruments used for water sector reforms. Such a review should lead to necessary changes that will result in pro-equity and pro-empowerment frameworks and mechanisms.
- There is an urgent need to evolve a normative framework for water governance based on the principles of equity and empowerment. This normative framework should be legally enforceable so that all future reform instruments, including IRA laws, follow the principles and norms laid down in the framework.
- There is a need for rethinking of the IRA models being implemented in the water sector, especially because of its peculiar multi-dimensional nature. Water is a life and livelihood sustaining resource. Unlike commercial sectors which rely on economic principles alone, water regulation should be approached with proper integration of the social, environmental, economic, and political dimensions of water resource. The focus should be on developing a regulatory system comprising of decentralized nested institutions rather than total reliance on an apex level authority.

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23 Pricing the 'Fluid Mosaic'

Integrated 'Inclusive Valuation' of Water from the Scarcity Value Perspective

Nilanjan Ghosh and Sarika Rachuri†

Introduction

The spatio-temporal differences in water endowments make the problem of water allocation a difficult task. In determining allocation, policymakers employ various approaches to allocate water, some more efficient than others. This marks a crucial entry point for economics—a discipline whose canonical definition is 'allocation of scarce resources among competing ends' (Robbins 1932) and which tries to explain and analyse the scarcity problem and proposes efficient ways of allocation of the resource. Growing water scarcity has thus propelled interest in finding out means to reduce conflicts that centre on this scarce and essential resource.

Institutional economic theory has therefore emerged as a discipline that has proposed ways of establishing a proper water management regime (for example, Brown 1997; Holden and Thobani 1996; and Richards and Singh 2001). Institutionalists have discussed the economics of property rights and also legal matters that have been instrumental in the formulation of international statutes on water resources (Barrett 1994; Berck and Lipow 1994; and Richards and Singh 2001). However, despite claims of comprehensibility, the institutional framework has at best provided theoretical explanations. Many a times, the laws defining property rights have been too rigid and have failed to provide meaningful solutions; sometimes the laws have been too flexible enabling strong stakeholders to interpret them for their own convenience (Chauhan 1981; Tarasofsky 1993). At the same time, while institutionalists have been pointing out to the diminution of transaction costs, they have failed to provide any tangible, neutral, and quantified instrument for water resource development. The result is that the water policy has been guided by judicial decisions—of the apex court or judicial bodies—that are governed by such amorphous laws. Under the circumstances, it is imperative to find an evaluation instrument that will be a potent, unprejudiced means for resolving water management problems.

It is in this context that valuation of water has emerged as an important objective instrument for taking critical decisions on the 'fluid mosaic'.

The most important function of valuation for an environmental resource like water is perhaps the

† The authors acknowledge the extensive editorial support and help of Satyajit Chattopadhyay, and comments from an anonymous referee.

correction of market failures, which is crucial for a sustainable management of water. Water pricing, whether through government mandate or by market forces, is a significant way of improving water allocation and encouraging conservation (Tsur et al. 2004), and can be an important instrument in the mediation of water conflicts. Despite this realization, there have been very few attempts at establishing an objective economic analysis of policies using valuation.

Valuation of Economic Services of Water Resources

Water valuation studies can be classified under two broad categories:

- Water as an input in production
- Water as a good in a consumer's utility bundle

Water as an Input in Production

Water often acts as an input in agricultural and industrial production. In this sense, its value is being derived from the contribution that it makes in the total production. Studies that have taken this view, value the role of water in the economy by looking at water as a factor of production.

Studies on the Valuation of Agricultural Water

In a majority of the cases, agricultural water has been valued using a production function approach. This involves assuming a production function where water is an input in the production. Theoretical details of the economic principles on which such pricing, and hence, the demand and supply curves for water are based, have been provided by Tsur et al. (2004: 64–85). Similar to economic valuations in various contexts over time and space, assigning a monetary value to water derived from the value of improved agricultural output resulting from improved availability of the water resource, involves the 'with' versus 'without' comparison (Gittinger 1982). Bouhia (2001) estimates the value of water from a constrained maximization exercise for the waters of Morocco. His analysis discusses the sectoral shadow values of water by considering the three sectors, industrial, urban, and agricultural. Ghosh and Bandyopadhyay (2003) propounded a set of rules for optimal payment by the beneficiaries to the affected for obtaining benefits from a marginal increase in water usage. In another paper, Ghosh (2009) shows how increasing agricultural scarcity values of water in India and the US affect inter-state hydro-political relations.

Pricing of Water as an Input in the Industrial Sector

The value of water in the industrial sector emerges from its role as an intermediate good that plays an active part in production, thereby reducing the unit cost of production. Despite the ubiquity of water use among manufacturing firms, studies on the structure of industrial water demand are few. A majority of the water use studies for industry have been performed by estimating water demand models where ratios of total expenditure on water to total quantity of the purchased were used as proxies for prices. The initial studies of water use in the industry were conducted by estimating single-equation water-demand models (Turnoskvsky 1969; Rees 1969; and DeRooy 1974). Grebenstein and Field (1979) and Babin et al. (1982) extended these analyses to incorporate trans-log cost functions where water was included and treated like any other input as labour, capital, and material, and the average cost of water was used to determine the price. Most of these studies used average cost of water as an indicator of price. In most jurisdictions globally, self-supplied firms typically acquire their raw water intake at little or no external cost (Renzetti 1992; Renzetti and Dupont 2003). In these cases, analysts typically have access to information on the quantity of water withdrawn, and perhaps the characteristics of these firms. A number of methods have been employed for inferring the value of industrial water use in these circumstances. One straightforward method involves calculating the ratio of the value of output to the quantity of intake water (Giuliano and Spaziani 1985; Mody 1997). This approach is problematic as it fails to consider the contributions to production of non-water inputs and for differences in revenue across firms that arise due to factors that are not related to water use, such as the structure of output markets.

In Chapter 24, there is an interesting analysis by Sridhar and Mathur in the context of urban water pricing, by way of which they argue that marginal cost and not the average cost, should be the basis for pricing water supply. This is opposed to the thought process existing in most of the studies mentioned in this section. Though Sridhar and Mathur's analysis is conducted for urban waters, (something that has not been touched upon in this chapter), the principle of marginal cost pricing is equally valid for industrial and agricultural waters. As is explained later in this chapter, an extension of such an approach to decision-making over the water resource emerges from the scarcity valuation of the resource.

Valuation with Water as a Good in a Consumer's Utility Bundle

Valuation of water as a good in a consumer's utility bundle has followed three approaches, which can be classified under two broad heads: the stated preference approach and the revealed preference approach. The stated preference approach has only one method, which is called the contingent valuation method (CVM). The CVM involves the creation of a hypothetical market and in asking respondents about their willingness to pay for a qualitative or quantitative change in their ambient environment (Mitchell and Carson 1989; Whittington et al. 1990, 1993). Under revealed preference approaches, there are two methods the travel cost method and the hedonic pricing method. The travel cost method involves estimating the value of an environmental resource, through the amount spent by a consumer in visiting that resource. On the other hand, hedonic pricing estimates the value of a resource through the differentials in the property prices resulting from variations in ambient environments through locational changes (Kolstad 1999). Application of such methods in water valuation is rare for irrigational waters, but is quite common for urban waters and for determining various non-use values of water. However, due to hypothetical observations on the markets, valuation methods like CVM have been criticized. Other methods like travel cost may only capture certain recreational aspects of the resource, which may not fully reflect the cost of the resource.

The contingent valuation method can be used to estimate consumers' willingness-to-pay (WTP) for just about any environmental good or service imaginable, including cleaner water. There are many instances, like such studies being carried out for WTP of households for improved sanitation examples, for improvements in drinking water quality, for evaluating safe water supplies for urban households, and for effects of improved water supply and sanitation on various diseases like ascariasis, diarrhoea, and so on.

Ecosystem Services Provided by Water

Ecosystem services provided by water involve aquatic ecosystems, such as rivers, wetlands, estuaries, and near-coast marine ecosystems that provide a great variety of benefits to the people. The benefits provided by water range from water as a commodity, meeting the needs of drinking water, fish, and fibre to an input in waste treatment and recreational opportunities. Rivers and other aquatic ecosystems need water and other inputs like debris and sediment to stay healthy (Dyson et al. 2003; Tharme 1996).

Existing strands of literature reveal that quantitative knowledge of changes in ecosystem functions is scarce. Without knowledge getting ubiquitous over time and without user-friendly procedures to quantify ecological services, the development of integrated water resource management (IWRM) as a discipline will remain inhibited. One important aspect on which such quantified models have been based is the self-purification potential of river systems. Since the nutrient import in aquatic ecosystems has increased considerably during the last few decades, the self-purification potential of river systems has become more and more important to guarantee ecosystem integrity (Mitsch and Gosselink 2000). Therefore, it is not surprising that studies dealing with ecosystem services often evaluate the self-purification potential of river systems (Bystrom 1998; Gren et al. 1997).

Economic Valuation of Ecosystem Services of Water

Once the ecosystem damages get valued monetarily, the intensity of the services provided by nature becomes more transparent (Hawkins 2003). One of the most comprehensive reviews of literature on the economic valuation of ecosystem services of water has been done by Dalton and Cobourn (2003). The existing body of literature on such matters needs to be seen under three heads: the theory behind ecosystem service valuation, application of ecosystem service valuation, and multi-functional attributes of agriculture and ecosystem valuation. The theory governing the valuation of ecosystem services is, by far, the largest section of the review because a bulk of the discussion on ecosystem valuation has been either theoretical or analytical. However, attempts to empirically value ecosystem services have been limited. Studies on ecosystem service valuation in, for example, the measurement of the multi-functional attributes of agriculture provide a contrasting view of how to expand the value of agricultural production into food and other functional values.

The Theory of Ecosystem Services Valuation

Among the various theoretical models that have been constructed, Farber et al. (2002), while discussing economic valuation versus ecological valuation, feel that while economics refers to values in various terms like use, exchange, labour, utility, and scarcity, ecology relies on the energy theory of value. They deal with critical zones or threshold conditions for ecosystems. This leads to the idea that there is an insurance premium that society will have to pay to avoid a natural catastrophe.

Limburg et al. (1997) suggest that as an ecosystem rapidly bifurcates or changes qualitatively (rather than quantitatively) thereby rendering it the property of non-marginality, ecological methods of valuation are more appropriate than economic valuation. This suggests a combined system based on both forms of valuation, depending on where the system is on its marginality.

Hannon (2001) attempts to model ecological and economic systems into an 'input–output' framework. He assumes that the system is static, linear, and requires a system equilibrium assumption. However, he does not deal with the computation of biological costs. The three core competencies of his paper are delineation of metabolism as net input of the ecosystem, use of economic techniques to evaluate metabolic costs, and addition of lost capital to the net output definition to determine system efficiency.

There is no doubt that theoretical models have their own novelties, but what constrains their real-life application is the understanding of complex ecological processes, which is further impacted adversely by data availability.

Application of Ecosystem Service Valuation

Research on the application of ecosystem service valuation has been limited. The few studies that have conducted valuation of ecosystem services have been criticized on various methodological grounds. Klauer (2000), based on an analogy between ecological and economic systems, uses a mathematical economic price theory and applies it to ecosystems to derive values based on gross ecosystem outputs. The study states that estimated ecosystem service values are not comparable to economic prices. Flessa (2004) estimates that the ecosystem service value of the Colorado water is $208 per acre-foot ($0.17 per cubic metre), which is an unpaid cost to society. This unpaid cost emerges as a hidden subsidy currently paid through the loss of nature's services to society.

Costanza et al. (1997) compiled more than 100 studies that estimate the ecosystem services of various biomes. They obtained values of these services by using one of three methods: the sum of consumer and producer surplus, producer surplus, and product of price and quantity. They multiplied these values by the surface area of each respective ecosystem to generate an estimate of the total value of all ecosystem services. They estimate that the total value of the ecosystem is in the range of $16–$54 trillion. Pearce (1998), in a critique of Costanza et al.'s (1997) paper, says that they have violated all principles of economic valuation. The results are inconsistent with WTP as the estimates exceed world income. Pearce (1998) argues that their study focuses only on benefits of protecting the environment and not on costs. Further, Costanza et al. (1997) do not conduct a marginal analysis, and 'find the value of everything' but WTP is for relatively small changes, not the extensive changes that the authors assume. This paper has also been criticized for its methodology, especially with the assumption that there are no irreversible environmental thresholds, and there is no interaction between services (Dalton and Cobourn 2003).

Scarcity Value of Water

The 'scarcity value' of an environmental resource has remained a neglected concept, with implicit and infrequent mention in literature. Values arise due to shortages of the resource and act as a monetized scarcity signal (Batabyal et al. 2003). The value of scarcity can be found in the concept of Ricardian rent (see Ricardo 1817). In this concept rent arises because inferior quality of land is being brought under production that results in diminishing productivity of the marginal land.

While the concept of scarcity implicitly remained in analyses done by economists and never came to the forefront, it was finally formalized by Hotelling (1931) who showed the mechanism by which a market price serves as a signal of scarcity. Barnett and Morse (1963) extended this work by demonstrating the way in which the increasing price associated with increased scarcity actually mitigates the scarcity problem. However, in all these works, the focus is primarily on the scarcity of exhaustible resources, for which well-functioning markets exist. Environmental resources are non-market goods, and hence the market system has no say in their price determination. Thus, there is no readily available price or non-price signal that can serve as an indicator of scarcity. Costanza and Folke (1997) and Goulder and Kennedy (1997) point out that important ecological phenomena that affect the scarcity of ecosystem services are often not incorporated into prices. Batabyal et al. (2003) point out that although ecologists are aware of the complex dynamics of the environmental system, they rarely consider behavioural forces that influence individual decision-making. By focusing on the scarcity of the provision of ecosystem services, both ecologists and economists will be able to find a common ground that can be the basis for meaningful future research towards the formulation of environmental policy.

Saleth (2001), while discussing the problems of water pricing, refers to the difference between the scarcity value and the total market value (as given by cost) of water. The total cost signals the scarcity value and the opportunity cost of water and guides allocation decisions within and across water sub-sectors. Hence, he advocates that the financial function requires water rates to cover the cost of supplying water to users. As in practice, the supply cost is obtained by adding operations and maintenance (O&M) costs and capital costs of constructing the system. However, full cost recovery also requires water rates to reflect the long-term marginal cost (the cost of supplying an additional unit of water, including the social cost of externalities). Thus, Saleth (2001) implicitly refers to the scarcity value of ecosystem services provided by water along with the scarcity value of economic services. While discussing water pricing policies, Saleth (2001) highlights the role of scarcity value:

> The economic and allocative role of water pricing requires water rates to capture the scarcity value (or the marginal productivity/utility) and to equalize the opportunity costs (the value of water in its next best use) of the resource across uses. As water moves from least productive to most productive uses, places, and time points for efficient allocation, there will be a convergence of the scarcity value, opportunity cost, and long-term marginal cost of the resource. Unfortunately, such a convergence is rarely seen in practice. … Water rates are still subsidized even in countries with a relatively mature water economy such as Australia, Israel, and the United States. This is rooted in the political economy of water, as powerful state and user interests often oppose charging the full cost of water. As a result, the gap is vast between the observed water rates and the ideal economic prices of water, as reflected by its scarcity value and opportunity cost.

The notion of the scarcity value of water emerges more explicitly in a CIE (2004) document. It clearly states that for water to acquire a scarcity value, the supply of water must be a limiting constraint to economic activity. In such circumstances, a marginal reduction in access to water will reduce profitability, wealth, or other measures of economic welfare of the entitlement holder.

Scarcity values have often been referred to as resource rent or scarcity rent. These terms are used for returns or imputed values of natural resources that remain after all user costs have been accounted for. For renewable resources, such as water, the scarcity rent equates to above-normal returns to using water in production (CIE 2004). Normal returns are defined as the earnings needed to cover long-term costs, including labour and other variable operating costs (including water charges); overheads, including depreciation and the cost of capital; a 'normal' rate of return on capital, which is the minimum rate of return required to hold capital in the activity (sometimes referred to as normal profit) and; a margin to cover risk (CIE 2004). Above-normal returns are defined as returns in excess of all the costs listed above. They are the surplus above returns that are necessary to retain the use of inputs in production. Scarcity rent to the use of water in a particular activity is only available where there is a surplus after all other costs, including water service charges, are accounted for. The entitlement to take and use water will have value as an asset if these surpluses are expected to be positive, either in their current use or when traded to another (CIE 2004).

In the two previous sections of this chapter we discussed the valuation of economic and ecosystem services of water. It should readily be realized that like the total value of water, the scarcity value of services can arise from both economic services of the resources, as well as ecosystem services of the resources. Due to scarcity of water, losses occur in both economic and ecological services. Scarcity value can capture the loss of value in each of these services.

Scarcity Value and Agricultural Water Cess in India: Case of Cauvery Water Conflicts

The Cauvery river basin is one of the most disputed inter-state river basins in India due to the long-standing water allocation conflicts between the south Indian states of Karnataka and Tamil Nadu. Ghosh and Bandyopadhyay (2009) estimated the scarcity value of water in the Cauvery basin over years and across seasons for paddy (the crop with the maximum acreage in the basin), based on a theoretical framework, where the scarcity value of water was defined as a difference between its marginal product and marginal cost. Estimates of water use for producing rice in the basin were also generated. Water cess paid by farmers for irrigating rice for the respective years too was tabulated. After deflating the total water cess with the minimum support price for rice for respective years, the marginal cost of irrigation was arrived at. This is irrigational cost per unit that the farmers are paying through quantities sacrificed per unit of water. The marginal cost of water, as shown in Figure 23.1, is diminishing for farmers in Karnataka. This is the real cost of irrigation borne by a farmer (Ghosh 2009).

With diminishing marginal real cost of water over time, the scarcity value increases. The negative component of the scarcity value of water (marginal cost) starts losing significance and implies that over the time water is being treated as a free good with little incentive to manage and save it for Cauvery basin farmers in Karnataka. Whereas, according to the theoretical framework of Ghosh and Bandyopadhyay (2009), the scarcity value of water should have been diminishing with increasing water use, the scarcity value of water for summer rice somehow reveals a non-diminishing characteristic (Table 23.1).

For Tamil Nadu, a more or less similar pattern can be noted—a diminishing marginal cost or real value

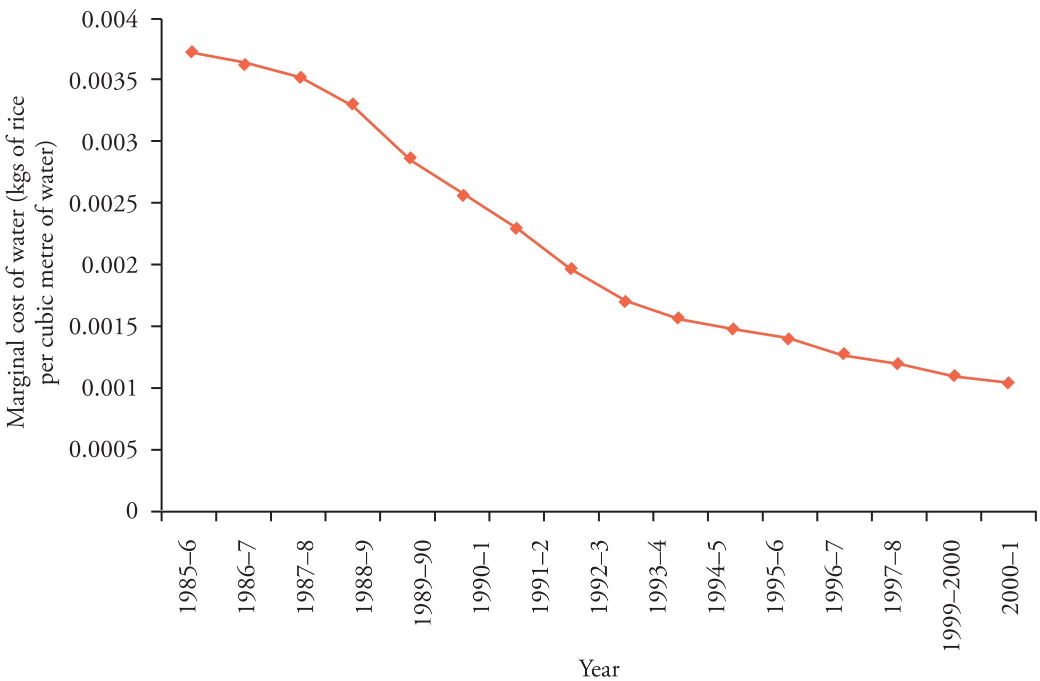

Figure 23.1 Average Annual Marginal Cost of Water for Growing Rice in Karnataka

Source: Ghosh (2009).

Table 23.1 Scarcity Value of Water and Average Water Use for Rice in the Cauvery Basin Districts in Karnataka, 1980–1 to 2000–1

Year	*Kharif rice*		*Rabi rice*		*Summer rice*	
	Average scarcity value (kg per cubic metre)	*Average water use (million cubic metres)*	*Average scarcity value (kg per cubic metre)*	*Average water use (million cubic metres)*	*Average scarcity value (kg per cubic metre)*	*Average water use (million cubic metres)*
1980–1 to 1985–6	0.2242	4,581.2171	0.2068	11.1708	0.1664	584.3104
1986–7 to 1990–1	0.1993	4,463.1020	0.2095	107.3835	0.1767	808.8115
1991–2 to 1995–6	0.1755	4,909.5410	0.1553	118.8880	0.1820	1151.9935
1995–6 to 2000–1	0.1994	5,431.4619	0.1477	123.4188	0.1723	1240.6844

Source: Ghosh (2009); Ghosh and Bandyopadhyay (2009).

of water (Figure 23.2), and non-diminishing scarcity value with increasing water use (Table 23.2) (Ghosh 2009).

There are three paddy seasons in Tamil Nadu, as given in various volumes of 'Season and Crop Report' of the Department of Economics and Statistics, Government of Tamil Nadu. The seasons are known as *sambal thaladi/pishnam* (August to November), *navarai/kodai* (December to March), and *kar/kuruvai/sornavari* (April to July). For cropping, the kuruvai coincides with the

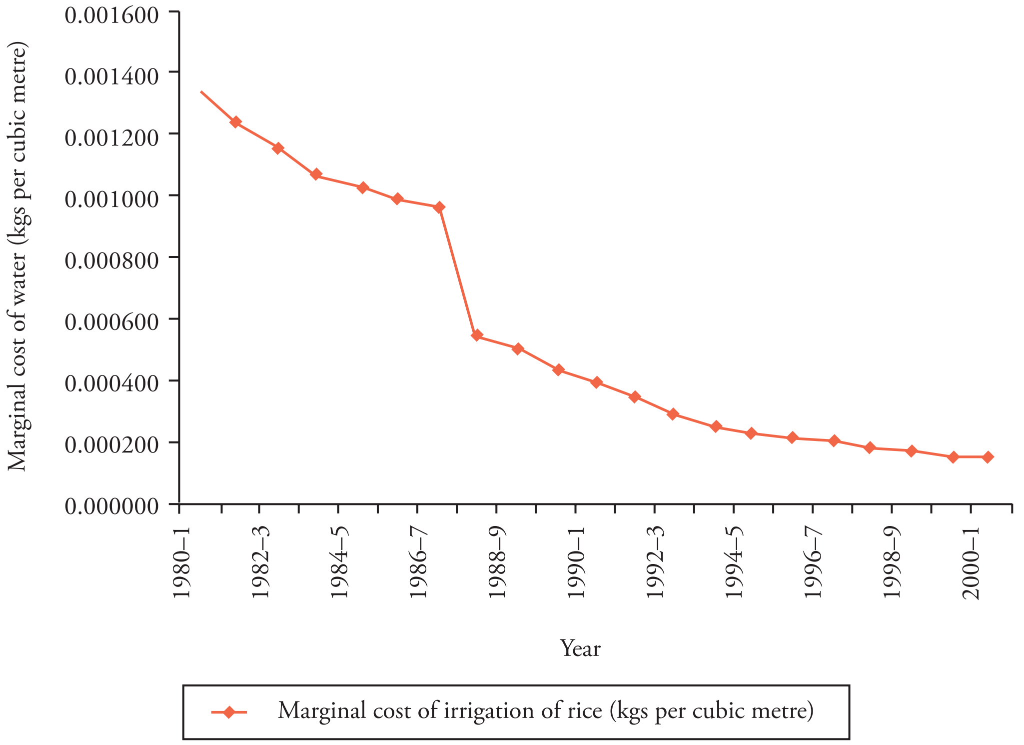

Figure 23.2 Movement of Marginal Cost of Water for Rice in the Cauvery Basin in Tamil Nadu, 1980–1 to 2000–1

Source: Ghosh and Bandyopadhyay (2009).

TABLE 23.2 Scarcity Value of Water and Water Use for Rice in the Select Cauvery Basin Districts in Tamil Nadu, 1987–8 to 2000–1

Phase	*Year*	*Samba/Thaladi/Pishnam*		*Navarai/ Kodai*		*Kar/ Kuruvai/ Sornavari*	
		Scarcity value (kg per cubic metre)	*Average annual water use (bn. cubic metres)*	*Scarcity value (kg per cubic metre)*	*Average annual water use (bn. cubic metres)*	*Scarcity value (kg per cubic metre)*	*Average annual water use (bn. cubic metres)*
Late 1980s	1987–8 to 1989–90	0.20889	11.49742	0.20746	0.57621	0.28021	0.65124
Early 1990s	1990–1 to 1993–4	0.17163	11.25177	0.18930	0.96355	0.21309	1.57011
Mid 1990s	1994–5 to 1996–7	0.14870	11.75764	0.19992	0.57099	0.21451	1.82149
Late 1990s to new millennium	1997–8 to 2000–1	0.17633	15.05974	0.22003	0.75109	0.22735	2.20993

Source: Ghosh (2009); Ghosh and Bandyopadhyay (2009).

south-west monsoon season, samba coincides with the north-east monsoon season, while navarai coincides with the hot summer months. The scarcity values of water for paddy and the associated water use are given in Table 23.2.

It has been observed that Cauvery water disputes have erupted primarily in June, the month when the kuruvai paddy in Tamil Nadu needs irrigation. However, this coincides with the period of the newly started cultivation of summer paddy in Karnataka, the cropping season of which continues till July.

There are two major sources from which water can be obtained for agricultural production in the Cauvery basin region—on-field rainfall and irrigation water supplied from water diverted from the Cauvery. Incidentally, Ghosh and Bandyopadhyay (2009) find that a non-diminishing scarcity value, associated with a significant increase in area under summer paddy in Karnataka, and kuruvai paddy in Tamil Nadu in the 1990s, as compared to the 1980s was an important contributor to the intensification of disputes between Karnataka and Tamil Nadu.

In the late 1990s, starting from 1997–8, the June rainfall in Tamil Nadu reduced significantly. It is clear that a non-diminishing scarcity value associated with an extensive increase in the area under paddy and also the diminishing real cost of irrigation, created a high demand for irrigation water. Hence, the pressure was on the flows in the Cauvery. For a large part of the 1990s, the flow to the Mettur dam in Tamil Nadu was low. This was because upstream, Karnataka's water use had increased, though there had been no significant decline in the scarcity value of water for paddy production. A non-diminishing scarcity value of water with increasing water use is perilous for the hydro-political situation in the river basin.

The interesting thing brought out by this case is that in an attempt to deal with the physical scarcity of water, both the states opted for supply augmentation plans through engineering constructions, which finally resulted in a conflictual situation. The attempt therefore should not be confined to supply side interventions to reduce scarcity but should entail demand management of water to reduce its scarcity value. This is discussed in the next section, where we argue why the scarcity value of water can be treated as a notion embedded in the new emerging paradigm of IWRM.

'Scarcity Value' of Water: A Concept Embedded in IWRM

The term 'scarcity' confines the analysis to the quantitative physical availability of water, without giving much consideration to its quality. Scarcity mitigation exercises were conducted through supply augmentation plans (Bandyopadhyay and Perveen 2004; Gleick 2000; and Ghosh 2008a, 2008b). The importance of supply augmentation is slowly but steadily getting reduced, and demand management has started taking its place. Notionally, as well as in practice, demand management (either through virtual water imports or through other measures), does not mitigate scarcity, but allows for 'adaptation' to scarce conditions. It allows for 'playing on the will of nature', rather than 'playing against the will of nature'. For example, as argued by Ghosh and Bandyopadhyay (2009), regions under chronic water scarcity would be under further stress if they produce high water consuming crops like rice. By raising less water consuming crops in these regions, scarcity is not mitigated, but the scarcity value of the concerned high water consuming crops is lowered, as the unmet or excess demand for water for the same goes down.

Israel happens to be the ideal case, where one finds attempts to reduce the economic scarcity value of water, rather than scarcity mitigation. If one looks at scarcity in the region in terms of low physical availability of the resource, one would be horrified to note the state of affairs. Yet, scarcity value mitigation through appropriate strategies has totally changed the profile of Israel, thereby calming down hydro-political tensions with Jordan and Palestine. Agricultural (virtual water) imports have played a crucial role in this context.

It needs to be understood that the scarcity value is a holistic measure of not only the state of the resource, but of every type of intervention that can occur on the resource, which rarely gets captured by the notion of scarcity. In this section what we present is that a shift from the old paradigm to the new paradigm should be understood as a shift from addressing scarcity to understanding the scarcity value. The notion of scarcity value is adequately embedded in the principles of the new emerging paradigm of IWRM, as is stated now.

- *All water systems are viewed as integrally linked with the hydrological cycle and contribute to the ecological system*
  The scarcity value framework developed for explaining economic needs reflects on the rationale of water diversion and the pursuance of supply augmentation plans based on the old paradigm. Ecological concerns have not come to the fore in literature in India to a great extent, though in other contexts they have been well documented (for example, Flessa 2004; Glenn et al. 2001; and Postel and Morrison 1998). Water diversions, so far, have happened in an attempt to reduce agricultural scarcity values. Such diversions also lead to an 'unmet demand' for water from the ecosystem, which needs to be understood from the theory of the scarcity value of ecosystem services.
  It has been shown by Ghosh and Bandyopadhyay (2009) with the scarcity value theory, appropriate demand-management is the key to addressing the new problems of water resource management. This fact needs to be appreciated properly, with properly designed studies on the scarcity value of ecosystem services. In the new paradigm based on a holistic understanding of water systems, the economic gains or losses, tangible or otherwise, should be recognized and considered over the whole of the related ecosystem, like a river basin.
- *Greater supplies of water is not a pre-requisite*
  The scarcity value framework has explicitly and implicitly indicated that supply development beyond a threshold can lead to disputes in river basins (Fisher 1995; Ghosh and Bandyopadhyay 2009). Hence, in order to obtain economic benefits, there is the associated social cost of conflicts, which lead to unsustainable resource use and hostile and untenable hydro-political conditions in many river basins of the world. Hence, it needs to be understood that economic development is no more linked to supply augmentation, but by ways of reduction of the scarcity value of water through appropriate demand management. That proper demand management can lead to effective development is exemplified by Israel.
- *Comprehensive assessment of water development projects keeping the integrity of the full hydrological cycle*
  With the understanding of the scarcity value of ecosystem services, along with the scarcity value of economic services, a comprehensive assessment of water development projects is possible. Human intervention in the hydrological process for extracting economic services has negative ecological consequences, which is in contravention with the principles of 'sustainable development'. The attempt to diminish scarcity of water for economic services imposes an inherent cost in the form of an enhanced scarcity value of ecosystem services. Hence, the need for understanding the optimal trade-off between the two scarcity values is important, and can serve as an important criterion in a comprehensive assessment of water development projects.

As argued by Ghosh (2009), in the case of the Cauvery the hostile hydro-politics in the basin for agricultural water use has overridden ecological concerns. Even after full utilization of Cauvery waters, there were further attempts of supply augmentation. A similar situation has been reported by Bandyopadhyay (2002) in the context of Himalayan waters. These gaps can be corrected by a holistic understanding of the river basins through the scarcity value of economic vis-à-vis ecosystem services.

- *Prioritization of water needs*
  As stated earlier, the scarcity value needs to be understood at two levels: at the level of the ecosystem and at the level of human economic needs. As Ghosh and Bandhpoadhyay (2003) argue in the context of the Cauvery basin, the scarcity value of economic services of water (in the form of agricultural services) became insensitive to water use. This implied a situation of utmost 'non-satiation' in terms of water consumption. This implied that under no circumstances, could the 'unmet demand' component be met, however larger supplies were made. Hence, providing water for economic needs becomes a waste and that too at the cost of ecological health and at the cost of other sectors. Such concerns need to be understood properly, and right priorities should be defined in this context.
- *The new economics of water*
  Scarcity value is an accrual to the emerging framework of the new economics of water. It offers a new basis of pricing of water use, provides a means to understanding and evaluating the emergence of institutional mechanisms for water resource management, provides institutions with an objective instrument for better management practices, and offers the foundation for a new ecological economic valuation of ecosystem services provided by water systems. It reflects upon the fact that disputes can be explained by economics, and economics can also suggest effective policy tools for the same.
- *An interdisciplinary knowledge base*
  Scarcity value, despite being based on economics, is embedded in an interdisciplinary knowledge base. Trans-disciplinary interactions, as argued by Falkenmark et al. (2004), become extremely important in this context. To arrive at the right type of scarcity value for various uses of water, there remains the need of understanding of sciences and social sciences at various levels. In the regime of the old paradigm, disciplines were not intersecting with each other in a way to understand potential contributions of other areas of competence, not even from closely neighbouring disciplines (Falkenmark et al. 2004).

  However, under the changed scenarios of demand, the new paradigm demands a real understanding of the nature of water resources, their complex links and inter-relations with other systems, and how societies manage them. Such complex interactions can no longer remain the domain of compartmentalized sector and single-disciplinary approaches. The notion of scarcity value adequately reflects upon this. While deriving the scarcity value of agricultural services of water in the context of Cauvery and Colorado, Ghosh and Bandyopadhyay (2009) use elements of economics, agronomy, and hydrology, to explain the social phenomenon of dispute.

  Understanding the scarcity value for water resources in a holistic manner (that is, combining economic as well as ecosystem services) precisely requires interaction of social sciences, geophysical sciences, agricultural sciences, economic sciences, and ecology and the environment. Simultaneously, it would go on to buttress the existing framework of the water law, with the provision of objective tools. Hence, the scarcity value of water resources should be taken up as a concept embedded in the new emerging 'water science'.

Concluding Remarks: A Broadened Framework of Water Management with Inclusive Valuation

Incidents of water violence are becoming rampant across river basins. A vast literature has developed to explain how increasingly scarce water resources lead to trans-boundary water conflicts among co-riparian states. Most of this literature proposes that 'scarcity induces conflicts', (for example, Homer-Dixon 1991, 1994), but the paradigm change in water valuation reflects that the temporal coincidence of demand between the co-riparians increases scarcity value and conflicts, rather than absolute physical scarcity being the cause of the conflict (Ghosh and Bandyopadhyay 2009). Though institutions and hydrology play an important role, yet under diminishing water availability the role of demand management is strategic.

Thus, it is not the mere physical scarcity of water that leads to conflicts, but it is how competing stakeholders perceive the value of water. This value, at the margin, has been delineated as the scarcity value. In other words, the scarcity value of water has been defined as the value that would be generated if the ceiling on water availability is relaxed by a unit. For operational research, this emerges as the lagrangian multiplier in a constrained maximization exercise of the profit function, with a constraint existing on water availability.

Demand management solutions are important due to the existence of complex linkages and inter-relations of water with other systems. Regions under chronic water scarcity, like the Cauvery basin, would be under further stress if they produce high water-consuming crops like rice. The region should grow low water consuming crops that would increase water availability. By raising less water consuming crops in the region, scarcity is not mitigated, but the scarcity value of the concerned high water consuming crops is lowered because the unmet or excess demand for water for producing water consuming crops goes down.

In the context of the emerging ecological point of view of looking at water management, a fundamental rethink on the economics of water has been going on. Economic values are being identified with ecosystems (Bandyopadhyay and Ghosh 2009); something that was not possible during the early years of reductionist's economics and engineering which merely looked at economic contributions of water. Though such valuations are done with big approximations, they are proving to be useful in internalizing factors that were totally externalized in the traditional assessment of river projects. Even theoretical papers, at times, become useful in providing a baseline for a broader assessment at the local level (for example, Ghosh and Shylajan 2005).

Bouhia (2001) extends the economic valuation framework for the understanding of the effects and assessment of water projects. This framework has further been extended by the valuation of river systems. A very comprehensive valuation method has evolved from water allocation systems (WAS) developed at MIT on water management and conflict resolution in west Asia. Fisher's (2005) volume on the MIT project not only incorporates social and private economic problems, but also environmental concerns. Such models therefore need to be developed for a comprehensive evaluation of river basins, such as the Ganges–Brahmaputra–Meghna basin.

It is critically important to choose the right valuation mechanism or pricing for water. Here, an inclusive valuation framework that would encompass the various problems of ecology, economy, and society is needed. In the inclusive framework, the valuation of not only socio-ecological systems (SES) as defined by Ostrom (2005), but also a broader ecological system that is contingent upon the intricate dynamics of the SES is discussed.

In the inclusive framework, the ecosystem and its services are accounted for and included in the national account statistics of the economy. The important part of this framework is not only to incorporate the monetary values of natural ecosystems, but also to incorporate values in the input–output (I–O) matrix of the macro-economy, and delineate its values as intermediate or final goods and services as applicable in the I–O matrix. Several such SES can be defined in the Ganges sub-basin where welfare change through changes in environmental inputs can be traced, and where externalities play an important role. One example can be the loss to fishermen due to reduced catch of fish and crustacean species in the lower Ganges because of upstream diversion, pollution, and eventual damage to mangrove forests. Compensation to the fishermen for the loss of economic opportunity is not enough. The value of the ecological damage also needs to be accounted for. On the other hand, the services provided by the highland community to the plains, by preserving water output and quality, also deserve to be compensated, based on the nature of the SES, as also ecological services. Hence, the inclusive valuation framework moots an integrated approach to include social values, economic contributions, as well as ecosystem services provided by the hydrological cycle.

This chapter thus emphasized on the need and significance of water valuation. While weaving the entire body of literature on water conflicts and water valuation, it fills the gap by introducing a broadened framework on inclusive water valuation. The different dimensions of water that emerge from its dual characteristics of being an input in production and as a feature in a consumer's utility bundle, call for an integrated approach. The inclusive water valuation framework provides a paradigm shift in water valuation studies.

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24 Pricing Urban Water

A Marginal Cost Approach

Kala Seetharam Sridhar and Om Prakash Mathur[†]

Introduction

The objective of this chapter is to estimate the marginal costs of providing water in Indian cities. As discussed later in the chapter, marginal cost and not the average cost, should be the basis for pricing water supply. A city usually develops its least expensive water sources first, but as demand grows it normally becomes increasingly expensive to produce an additional unit of water. In such an instance, using the average leads to an underestimation of the cost of additional water (see Williamson 1988).

Ideally the basis for pricing water supply should be the long run marginal cost (LRMC). However, due to the lumpy nature of capital expenditure and difficulty in full cost recovery of capital expenses in water supply, it is difficult to use LRMC-based water pricing. The alternative is to use short run marginal cost (SRMC) based water pricing, where the basis for pricing is operation and maintenance (O&M) costs. The literature suggests that SRMC has been used for pricing various modes of transport (see Link 2003 for pricing of roads and Idström and Tervonen 2004 for rail infrastructure).

This chapter applies the principles of SRMC to six water utilities (or municipal service providers) in India and evaluates their tariffs against the price obtained from SRMC estimates. The next section discusses the data on water supply and service levels in the six cities of study. Following this, we summarize the results from the estimation of marginal costs, the output elasticity of costs which has implications for returns to scale. Then, the marginal costs of supplying water and water tariffs are compared in the cities of study, with a view to understanding the policy implications of the work.

Description of Data on Water Supply Expenditure and Service Levels

The discussion in this section and the marginal cost estimates in the following section are based on data from six Indian cities—Bengaluru, Chandigarh, Jaipur, Surat, Lucknow, and Pune.[1] Table 24.1 presents the data on expenditure and the level of service of water supply for the six cities for the period 1991–2003.

[†] The authors would like to thank Surender Kumar for help with econometric estimation in the paper. The authors thank the United Nations University–World Institute for Development Economics Research (UNU–WIDER) for the time to work on this, where part of this paper was completed when the principal author was visiting UNU–WIDER during April–May 2011. Any errors remain that of the authors.

[1] For a description of why the choice of these Indian cities makes sense, see Sridhar and Mathur (2009).

Table 24.1 Capital and Operation & Maintenance (O&M) Expenditure on and Availability of Water Supply, All Cities (No. of cities: 6)

	Capital expenditure				*O&M*		
	Per capita expenditure (at constant 1993–4 prices) (Rs)			*Water supply per capita per day* (litres)*	*Per capita expenditure (at constant 1993–4 prices) (Rs)*		
Year	*Average*	*Max.*	*Min.*	*Average*	*Average*	*Max.*	*Min.*
1991	50.22	107.02	0.47	206.13	96.73	216.40	1.83
1992	26.28	73.11	0.43	195.59	99.72	249.29	1.61
1993	21.77	43.85	0.40	239.98	97.59	277.71	1.47
1994	49.76	112.77	0.39	243.06	119.69	381.78	1.30
1995	44.69	84.93	0.41	257.54	116.34	325.93	1.24
1996	65.70	173.43	0.27	250.46	149.01	395.40	1.43
1997	48.48	102.65	0.23	246.11	155.55	320.28	1.47
1998	81.10	161.23	0.25	248.09	166.11	350.74	1.54
1999	110.71	321.41	0.19	248.13	197.56	351.36	1.44
2000	130.42	397.47	0.23	246.36	215.35	425.24	1.48
2001	102.34	447.24	0.19	244.56	193.30	407.42	1.41
2002	104.53	432.31	0.23	254.96	203.31	473.52	1.35
2003	55.57	120.80	0.29	248.48	151.24	395.02	1.33
Average	68.58			240.73	150.89		

Source: Sridhar and Mathur (2009).
Note: *The water supply amounts stated are net of leakages.

The volume of water supply per capita per day in the six cities varies between 196 and 260 litres during the time period of the study. The maximum capital expenditure is Rs 447.24 per capita in 2001–2 while per capita O&M expenditure is Rs 473.52 (2002–3). The minimum per capita capital expenditure incurred is Rs 0.19 (1999) while the minimum per capita O&M expenditure is Rs 1.24 (1995).

Since our sample consists of cities which differ on several criteria, we classify them into various categories to examine if there are common outcomes for cities in similar situations. We consider Chandigarh and Surat as our benchmark cities to demonstrate how much spending can be expected from such cities to offer a certain level of services. Over the years, we find that our benchmark cities have supplied more water per capita than others and that the expenditure on water supply has also been higher for benchmark cities.

Next, we classifiedthe six cities on the basis of whether water is supplied by a municipal corporation or non-municipal bodies such as a parastatal (for instance, the Bangalore Water Supply and Sewerage Board, BWSSB in Bengaluru) and other state level bodies. We find that, on average, both per capita capital and O&M expenditures are lower in cities with non-municipal service providers than they are in cities with municipality service providers (see Tables 24.2). This could either be a reflection of the fact that non-municipal bodies are more efficient in the delivery of their services or that they spend too little per capita. There appears to be greater support for the latter since the average per capita per day volume of water supply is also higher in the municipality service provider cities than in the non-municipal counterparts. However, water supply is more volatile in the municipality provider cities than that in the non-municipal service provider cities.

Table 24.2 Capital and O&M Expenditures on and Availability of Water Supply, Non-Municipal and Municipal Provider Cities

Year	*Capital expenditure*				*O&M expenditure*	
	Non-municipal provider cities (no. of cities: 3)		*Municipal provider cities (no. of cities: 3)*		*Non-municipal provider cities (no. of cities: 3)*	*Municipal provider cities (no. of cities: 3)*
	Average per capita expenditure (at constant 1993–4 prices) (Rs)	*Average water supply per capita per day (litres)*	*Average per capita expenditure (at constant 1993–4 prices) (Rs)*	*Average water supply per capita per day (litres)*	*Average per capita expenditure (at constant 1993–4 prices) (Rs)*	*Average per capita expenditure (at constant 1993–4 prices) (Rs)*
1991	62.84	149.69	12.38	262.56	70.77	135.68
1992	29.42	149.00	16.87	242.18	85.88	120.50
1993	19.99	168.00	27.13	311.97	95.45	100.82
1994	40.72	184.39	76.85	301.72	129.46	105.05
1995	31.53	184.15	64.44	330.92	111.01	124.34
1996	39.25	181.62	92.15	319.30	134.27	163.75
1997	31.05	180.03	74.62	312.19	108.99	202.12
1998	54.27	189.15	107.94	307.02	110.64	221.57
1999	69.98	183.56	151.45	312.71	118.64	276.47
2000	141.72	181.46	119.12	311.25	144.54	286.15
2001	156.22	177.80	48.45	311.33	130.19	256.40
2002	164.39	182.83	44.68	303.05	160.47	246.15
2003	18.49	183.53	80.29	291.79	5.42	248.46
Average	66.14	176.55	87.01	301.38	108.13	191.34

Source: Sridhar and Mathur (2009).
Note: *For 1991–4, the capital expenditures are just for Surat, hence the standard deviation is 0. Pune did not supply data on capital expenditures for those years and Chandigarh became a municipal corporation only in 1994.

We distinguish the impact of Octroi-levying cities from those that do not levy this tax. Octroi, while being a distortionary tax, has been a major source of revenue for cities. Hence, it is expected that cities that have access to this revenue should be spending more than those that do not. It may, however, be mentioned here that most cities in India have abolished Octroi and abolition of this tax is a major reform agenda driven by the central government. In our sample of cities, Surat and Pune continued to have the Octroi (during the time period chosen for the study) whereas Bengaluru, Lucknow, Jaipur, and Chandigarh did not.

Aggregating the O&M and capital expenditure across all the years, we find that the Octroi levying cities (that is, Surat and Pune) indeed spent higher amounts per capita on water supply than their non-Octroi counterparts (see Tables 24.3 and 24.4).[2] The per capita per day supply of water in the Octroi cities was also, on

[2] As of June 2011, Octroi continues to be levied by Pune. For Octroi rates for 2010–11 see http://www.punecorporation.org/pmcwebn/index.aspx, last accessed on 9 June 2011. The continued existence of Octroi has also been confirmed by talking to an official.

Table 24.3 Capital and O&M Expenditures on and Availability of Water Supply, Cities with and without Octroi

Year	*Cities with Octroi (no. of cities: 2) Average capital per capita expenditure (at constant 1993–4 prices) (Rs)*	*Cities without Octroi (no. of cities: 4) Average capital per capita expenditure (at constant 1993–4 prices) (Rs)*
1995	64.44	31.53
1996	121.41	37.84
1997	102.65	34.94
1998	137.97	52.67
1999	195.39	68.37
2000	158.43	116.41
2001	57.52	124.74
2002	36.81	138.39
2003	60.04	52.59
Average	103.85	62.34

Source: Sridhar and Mathur (2009).

Table 24.4 O&M Expenditures on Water Supply, Cities with and without Octroi

Year	*Cities with Octroi (no. of cities: 2)*		*Cities without Octroi (no. of cities: 4)*	
	Average O&M per capita expenditure (at constant 1993–4 prices) (Rs)	*Average water supply per capita per day (litres)*	*Average O&M per capita expenditure (at constant 1993–4 prices) (Rs)*	*Average water supply per capita per day (litres)*
1991	135.68	205.75	70.77	206.31
1992	120.50	183.62	85.88	201.57
1993	100.82	296.37	95.45	211.79
1994	105.05	283.87	129.46	222.65
1995	124.34	275.98	111.01	248.31
1996	148.13	268.45	149.45	241.47
1997	151.65	260.48	157.51	238.93
1998	156.99	262.06	170.67	241.10
1999	245.95	279.51	173.36	232.44
2000	237.20	285.84	204.42	226.62
2001	180.89	281.44	199.50	226.12
2002	179.31	274.67	215.31	241.82
2003	175.18	265.87	135.29	236.90
Average	158.59	263.38	146.01	228.92

Source: Sridhar and Mathur (2009).

average, higher than that in the non-Octroi cities, a finding that again reinforces the relationship between spending and level of service in the case of water supply. While spending may or may not translate into higher levels of service, it is possible that where cities are efficient (for instance, those that ensure minimal leakages) in their provision of the service, higher spending does result in higher volume of the service.

Further, we made a distinction between cities whose populations grew rapidly in the 1990s and those that grew more slowly during this period (Table 24.5).[3] Surprisingly, the slow-growth cities spent more (capital as well as O&M) per capita on water and were able to supply higher volume of water per capita. We noted that Bengaluru, which is the highest spender on water in absolute terms, was a slow-growing city during the 1990s. So it is possible that the findings in Table 24.5, of the slow-growing cities spending more per capita than the fast-growing ones, are influenced by the figures for Bengaluru. Bengaluru's growth in the 1990s

Table 24.5 Capital and O&M Expenditures on and Availability of Water Supply, Cities by Population Growth

Year	*Capital expenditure*				*O&M expenditure*	
	Fast-growing cities (no. of cities: 3)		*Slow-growing cities (no. of cities: 3)*		*Fast-growing cities (no. of cities: 3)*	*Slow-growing cities (no. of cities: 3)*
	Average per capita expenditure (at constant 1993–4 prices) (Rs)	*Average water supply per capita per day (litres)*	*Average per capita expenditure (at constant 1993–4 prices) (Rs)*	*Average water supply per capita per day (litres)*	*Average per capita expenditure (at constant 1993–4 prices) (Rs)*	*Average per capita expenditure (at constant 1993–4 prices) (Rs)*
1991	6.43	199.80	94.02	212.45	91.07	208.00
1992	8.65	187.59	43.91	203.58	80.87	214.02
1993	13.76	242.15	29.78	237.82	67.70	209.70
1994	38.62	234.40	60.89	251.71	70.47	268.12
1995	43.10	230.84	47.08	284.23	83.31	264.94
1996	81.03	226.18	50.36	274.75	99.23	278.75
1997	51.44	221.56	46.51	270.66	101.59	291.11
1998	92.07	220.89	70.14	275.28	105.17	308.18
1999	130.32	229.73	91.10	266.53	164.44	326.81
2000	105.70	234.12	155.14	258.59	158.63	363.69
2001	38.41	229.29	166.26	259.83	121.06	339.39
2002	24.62	226.12	184.45	298.22	119.99	363.78
2003	40.12	220.30	78.74	290.76	117.23	306.38
Average	51.87	223.31	86.03	260.34	106.21	287.91

Source: Sridhar and Mathur (2009).

[3] We used the average growth rate of population during 1991–2001 for the six cities to distinguish between fast-growth and slow-growth cities. Based on this, cities that grew relatively rapidly during the 1990s were Surat, Jaipur, and Pune while Bengaluru, Chandigarh, and Lucknow were classified as being the slow-growth cities.

of course does not include the eight urban areas, which were merged into the Bruhat Bengaluru Mahanagara Palike (BBMP) only in 2006.

Results from Estimation of Marginal Costs

As McNeill and Tate (1991), Link (2003), and Idström and Tervonen (2004) point out, the marginal cost is equal to the marginal operating cost, which includes variable costs. Turvey (1976), however, points out that the capital costs required to meet incremental demand for water tend to be lumpy, and cannot be determined statistically. Others (for example, Warford 1997) also generally accept that for capital expenditures, a statistically determined function would be rarely appropriate. Hence we estimate the SRMC, based on O&M expenditures.

The first step is to develop a cost (expenditure) function based on the city's/utility's budgets for O&M expenditures. The cost function shows the relationship between the water supplied and the costs incurred.[4] Other factors such as topography, input prices, and expenditure responsibilities of the local government also determine the expenditure/cost levels (for a complete discussion of the methodological challenges involved in separating costs from expenditures, see Sridhar and Mathur 2009).

To estimate the cost function, a random effects panel data model is estimated. 'Random effects' is the most suitable procedure here as it accounts for unobserved heterogeneity.[5] Table 24.6 summarizes the random effects estimates of the marginal cost of supplying one extra kilolitre (kl) of water. The results indicate that marginal cost estimate for Bengaluru's is about Rs 2.43 per kl of water provision (followed by Chandigarh at Rs 1.83 per kl). The estimates also show that ownership (city versus parastatal or utility) has the biggest effect on the cost of providing water supply—the non-municipal bodies incur a marginal cost of Rs 141 per kl of water supply when compared with that incurred by municipal bodies.[6]

Based on the estimates in Table 24.6, Table 24.7 presents the output elasticity of cost. An inference for increasing or decreasing returns to scale can be made on the basis of these estimates. In cities where municipal bodies offer water supply (Chandigarh, Surat, and Pune), the output elasticity is >1 (with decreasing returns to scale), whereas in the case of all cities where non-municipal bodies offer water supply (Jaipur, Lucknow, and Bengaluru), the output elasticity is <1 (relatively inelastic) with the result that they experience increasing returns to scale, quite in line with what one would expect with utilities or parastatal bodies.

Based on the estimates in Table 24.6 (for all cities), we arrive at the predicted expenditures, predicted costs (based on various factors included in the estimation) and compare these with actual average expenditures incurred by these cities on water supply (see Table 24.7).

[4] What determine this volume of water supply (or of any other service considered here) is of course subject to debate—migration, increasing population, or simply demand. We do not have data to determine the demand schedule for water for which micro, household-level data on water tariffs paid and quantity of water consumed would be required. Education is a normative characteristic, which could affect the preference for water. But it may not necessarily affect the actual expenditure/cost incurred, at least not in the context of India. If education affects the demand for water, then it must be the case that the highest water spending municipalities should also be the ones with educated population since that indicates water demand. We did attempt to get data on the proportion of population with bachelors and masters' degrees in the six cities of our study over the entire time period. This was available only for a few years, which substantially reduced the size of our already small sample.

In alternative specifications, we were exploring the possibility of using average household income in the city as an exogenous determinant of the level of expenditure on water supply, which is a different variant of the education characteristic. But that may not be necessary or desirable. That would involve mixing positive and normative issues. Further, income data at the city level in India are rarely collected; for a single year we could use data published by the National Council of Applied Economic Research (NCAER). But such data are not available in a time-series fashion, required for the study. So, effectively, we were unable to adequately control for local preferences for public services in determining expenditures.

[5] We performed a Hausman test on the suitability of a fixed versus random effects; and found that random effects is most suited for estimating this model.

[6] Since the dependent variable is the log of the deflated O&M expenditure on water supply, we converted the coefficient estimates into numbers for interpretation by taking the exponent of the logs.

Table 24.6 Random Effects Estimation of Expenditure on (Net) Water Supply, Dependent Variable: Log of O&M Expenditure, All Cities (deflated in 1993–4 prices)

Variable	*Coeff.*	*Z*
Log of net water supply (net of leakages)	0.89	3.57
Leakages	0.01	2.16
Log of city's land area	0.40	2.07
Ownership[municipal body (0) versus a parastatal (1)]	4.95	1.84
Log of duration of watersupply (in hours)	0.05	0.20
Net watersupply dummy for Chandigarh	0.60	1.90
Net watersupply dummy for Jaipur	–0.27	–17.90
Net watersupply dummy for Surat	0.56	1.81
Net watersupply dummy for Pune	0.53	1.72
Net watersupply dummy for Lucknow	–0.25	–11.10
Constant	–4.87	–3.35

Source: Public Health Engineering Department, Government of Rajasthan.
Note: Number of observations is 53.

Table 24.7 Output Elasticity of Cost and Returns to Scale

City	*Output elasticity of cost*	*Economies of scale*	*Increasing or decreasing returns to scale*
Chandigarh	1.49	0.67	DRS
Jaipur	0.62	1.63	IRS
Surat	1.45	0.69	DRS
Pune	1.42	0.70	DRS
Lucknow	0.64	1.56	IRS
Bengaluru	0.89	1.13	IRS

Source: Government of Rajasthan.
Notes: DRS–Decreasing returns to scale; IRS: Increasing returns to scale.

Table 24.8 shows that all cities, notably Jaipur and Lucknow, spend very little on water supply (with their actual expenditure as a proportion of expenditure predicted on the basis of various factors, being less than 2 per cent), when compared with what we predict on the basis of various characteristics. Bengaluru's expenditures on water supply are in line with our projections from the model.

Comparison of Marginal Costs and Water Tariffs

Part of the rationale for estimating marginal costs is that many cities might find it economically efficient to price their services appropriately (as reflected in the tariffs) and offer a better level of public services rather than close their doors to in-migration. Table 24.9 summarizes the water tariffs for the six cities (as of 2006).

The rationale for setting water tariffs by cities is based on some notion of affordability. Such a notion is delinked from the O&M and capital expenditures (which they perceive to be the same as costs, although they are not the same. (See Sridhar and Mathur 2009 for an explanation of differences between expenditures and costs incurred by the cities). Cities such as Jaipur have always kept the price of water low and affordable for major sections of the population. Political considerations have played a major role, and typically no cost or expenditure considerations are taken into account while determining tariffs.

In Lucknow, the water tax is set at 12.5 per cent of the annual rental value of the property, so it is primarily related to the consumption (of water) which is assumed to depend on the size and other characteristics of property. No considerations of coverage of capital or O&M expenditures or costs are taken into account by the Lucknow *Jal Sansthan*. Similarly, in Pune, the water

Table 24.8 Predicted and Actual Expenditures

City	*Predicted expenditure*	*Actual expenditure*	*Actual/ Predicted (per cent)*
Chandigarh	515,146,668	333,694,057	64.78
Jaipur	447,074,592	2,840,345	0.64
Surat	650,225,825	241,288,782	37.11
Pune	1,143,062,189	581,299,405	50.85
Lucknow	776,737,233	12,715,307	1.64
Bengaluru	1,159,286,604	1,262,246,076	108.88

Source: Sridhar and Mathur (2009).

tax is set at a certain proportion of property taxes which are based on the annual rental value of property.[7] This is based on the assumption that the consumption of water is related to carpet area of the household. Thus, while the cities relate water tariff to consumption of the good, most are unable to recover their actual costs or expenditures of supplying water, due to concerns of affordability or political considerations.

On the other hand, in Bengaluru, the increase in water tariffs is based on proportionate increases in the electricity expenditures which account for nearly half of the total expenditures, thus confirming the role that topography plays in increasing expenditures though affordability concerns also play a role. Surat switched to a system of metered connections in March 2008. In this system, consideration is paid to both expenditures and the level of consumption of water. Water tariffs are based on the O&M expenditures of supplying water, the carpet area of the household for which the connection is given. The cost (expenditure) of salaries of the employees and water treatment are covered by the water tariff. Currently Surat is able to recover about 70 per cent of the O&M cost (expenditure) through the tariffs. By 2011, as required by the Jawaharlal Nehru National Urban Renewal Mission, the city will be covering 100 per cent of O&M expenditures through its water tariffs. However, the city is not covering depreciation charges in its water tariff. Chandigarh Municipal Corporation has attempted to cover nearly 80 per cent of its O&M costs through the tariff.[8]

TABLE 24.9 Current Water Tariff Structure for Metered Water Connections

City	*Rate of Water Tariffs (rate per kl)** *Duration*	*Domestic*	*Non-domestic*
Chandigarh	From 31 March 2002 till now	1–15 kl @ Rs 1.75 per kl 15–30 kl @ Rs 3.50 per kl 30–60 kl @ Rs 5.00 per kl above 60 kl @ Rs 6.00 per kl Weighted average: Rs 5.01 per kl	Institutional: Rs 9 For government andsemi-government offices: Rs 12. For industrial, semi-industrial, commercial establishments: Rs 11
Surat		All unmetered monthly Rs 240) (not consumption-based)	13.0**
Pune	January 2000 to 31March 2005 from January 2005 till now	Rs .3.00 per kl Rs 3.00 per kl	Rs 16.00 Rs 21.00
Bengaluru	Current	Rs 19.44 per kl	Rs 6 to Rs 60.00
Jaipur	From 1 June 1998 till now	Upto 15 kl @ Rs 1.56 per kl 15–40 kl @ Rs 3.00 per kl Above 40 kl @ Rs 00. Weighted average: Rs 3.39 per kl	Limit / Non-domestic / Industrial Up to 15 kl / Rs 68 / Rs 11.00 15–40 kl / Rs 8.25 / Rs 13.75 Above 40 kl / Rs 11.00 / Rs 16.50
Lucknow	Current	Rs 2.45 per kl	Non-domestic: Rs 12.25 Commercial: Rs 7.35 Government: Rs 90

Sources: Individual cities, service providers, and authors' computations.
Notes: *These tariffs are current as of 2006, when this work was originally completed.
**For non-domestic uses, depending on the purpose, various tariff rates apply, the highest being applicable for industrial uses (Rs 24 per kl), and the minimum (of Rs 4 per kl) for use in educational institutions. What is reported here is the average of the non-domestic rate for various purposes. The full schedule of rates for non-domestic uses is summarized in Table 24.9.

[7] For instance, for annual rental value ranging from Rs 0–3000, the water tax is Rs 1000 a year (see Sridhar and Bandopadhyay 2007).

[8] For instance, on average, about Rs 65 crores is incurred annually on O&M costs, out of which nearly Rs 50 crores is recovered through the tariff.

The SRMC estimates obtained here represent only the O&M expenditures. Due to this, they appear to be lower than the international evidence regarding marginal costs of providing water. A World Bank (1994) study finds that in Lima, the LRMC[9] of providing water supply was $0.45 per cubic metre (that is, per kl) whereas the actual tariff was only around $0.28 per cubic metre.

In the case of Chandigarh and Jaipur, we computed weighted average tariffs based on the quantities and rates for various categories. This weighted average tariff turns out to be Rs 5.05 in Chandigarh and Rs 3.39 per kl in Jaipur. Based on the estimates in Table 24.6, Chandigarh, Surat, and Pune incur positive marginal costs in supplying water to their residents. Lucknow and Jaipur spend very little on water supply and for this reason an additional kl of water does not impose much burden for these cities, as Table 24.6 confirms.

The results indicate that there is a potential for increasing tariffs as the current tariffs are lower than the SRMC. For better management of urban water services, efficient pricing would have to be complemented with reduction of leakages, thefts, and unaccounted for water, in the distribution system.

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[9]For purposes of computing LRMC, data on expenditures by projects, disaggregated by civil works, and plant and equipment, is required. However, we did not get such information from the cities. If we had had access to the disaggregated data, we could have attempted computation of LRMC, using the approach suggested by Turvey (1976). This hinges upon the use of discount rates and arriving at different capital recovery factors for plant and equipment vis-à-vis civil works.

25 Dams and Environmental Governance in North-east India*

Neeraj Vagholikar

Introduction

The North-east[1] has been identified as India's 'future powerhouse'[2] and at least 168 large hydroelectric projects with a total installed capacity of 63,328 MW (Central Electricity Authority 2001) are proposed for the region.

States such as Arunachal Pradesh and Sikkim are at the forefront in the initiative to sign multiple memoranda of understanding/agreement (MoU/MoA) with power developers. Till October 2010, the Government of Arunachal Pradesh had allotted 132 projects to companies in the private and public sectors for a total installed capacity of 40,140.5 MW. The large dams' juggernaut clearly promises to be the biggest 'development' intervention in this ecologically and geologically fragile, seismically active, and culturally sensitive region in the coming days. Currently 10 large projects are already operational in the region, 11 are under construction, and a substantially larger number are in the process of getting various clearances. The government and the proponents of large dams in the region paint a win-win picture: exploiting the country's largest perennial water system to produce plentiful power for the nation; economic benefits for northeastern state governments through export of power to other parts of the country, and comparatively little direct displacement of local communities as compared to elsewhere in the country.

Despite this seemingly optimistic picture, ground realities within the region have led to dams becoming a major issue of conflict in the region in recent years. The upstream, downstream, and cumulative ecological and social impact of dams in the Brahmaputra and Barak river systems has been a major issue of debate and concern, including being the subject of intense debates in state legislative assemblies and in the Parliament. This chapter highlights some of the key issues which have emerged in the ongoing debate in the region which need to be urgently addressed while evaluating the viability of a hydropower programme as envisaged in the current form. These issues are across

* This chapter is an adapted version of a briefing paper by Vagholikar, Niraj and P.J. Das (2010), 'Damming Northeast India', Kalpavriksh, Aaranyak, and Action Aid India. It primarily relies on the section of this paper which was authored by this contributor. The existing piece also refers to existing writing/publications by Kalpavriksh members on the issue in the last ten years which may not necessarily be specifically referenced. These include the special issue of the 'Ecologist Asia' magazine on Northeast dams brought out in January 2003 (guest edited by Kalpavriksh members Manju Menon, Kanchi Kohli, and Neeraj Vagholikar); the 'Dossier on Large Dams for Hydropower in Northeast India' by Manju Menon and Kanchi Kohli, published by South Asia Network on Dams, Rivers & People (SANDRP) and Kalpavriksh in 2005 and; extensive writing in the popular media by Neeraj Vagholikar.

[1] North-east includes eight states—Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, and Tripura.

[2] The tag of being the country's 'future powerhouse' has been proactively used for the region since the Northeast Business Summit in Mumbai in July 2002.

diverse categories of subjects (for example, governance, socio-cultural aspects, and environmental issues) with overlaps.

The overarching framework within which the issues highlighted in this chapter are examined is 'environmental governance'. This is because in the current governance framework in the country it is primarily within the environmental decision-making processes of the Central Government through its Ministry of Environment and Forests (MoEF) that environmental and social impacts are supposed to be addressed in a substantive manner.[3] Large hydroelectric projects need to pass through mandatory 'environmental clearance' procedures, administered by the MoEF, to evaluate their viability on environmental and social grounds. Such a process also involves mandatory public consultations before projects are appraised for grant or rejection of clearance. Based on their specific locations projects could also require other clearances, such as a 'forest clearance' from MoEF and approval from the Standing Committee of the National Board for Wildlife (NBWL) where locations inside or within a 10 km radius of wildlife protected areas (PAs) are involved.

Environmental Impact Assessment (EIA): A Critique

Northeast India, consisting of the eight states of Assam, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Tripura, and Sikkim, is known for its biological and cultural diversity and the unique Brahmaputra and Barak river systems. The region is rich in biodiversity and is home to important populations of wildlife species, such as the rhino, elephant, tiger, wild water buffalo, pigmy hog, and the Gangetic river dolphin. Three out of 34 global biodiversity hotspots cover parts of India: Himalaya, Indo-Burma, and Western Ghats, and Sri Lanka (www.biodiversityhotspots.org). Two out of these three, Himalaya and Indo-Burma, cover extensive portions of the Northeast. In just 8 per cent of the country's geographical area the region also house 21 per cent of the important bird areas identified as per international criteria by the Bombay Natural History Society and Birdlife International.

The Brahmaputra is one of the world's largest rivers, with a drainage basin of 580,000 sq km, 33 per cent of which is in India (Goswami and Das 2003). Originating in the great glacier mass of Chema-Yung-Dung in the Kailas range of southern Tibet at an elevation of 5,300 metres, it traverses 1,625 km through Chinese territory and 918 km in India, before a final stretch of 337 km through Bangladesh, emptying into the Bay of Bengal through a joint channel with the Ganga. A unique river, it drains such diverse environments as the cold dry plateau of Tibet, the rain-drenched Himalayan slopes, the landlocked alluvial plains of Assam, and the vast deltaic lowlands of Bangladesh. An extremely dominant monsoon interacting with a unique physiographic setting, a fragile geological base, and an active seismo-tectonic instability together with anthropogenic factors have moulded the Brahmaputra into one of the world's most intriguing and gigantic river systems. The river carries the second largest sediment yield in the world, while it ranks fourth in terms of water discharge. The river system is intricately linked with the floodplain ecology of wetlands (*beels*) and grasslands in the Brahmaputra valley. For example, these linkages are evident in world-renowned eco-systems, such as the Kaziranga National Park in Assam. Due to the colliding Eurasian (Chinese) and Indian tectonic plates, the Brahmaputra valley and its adjoining hill ranges are seismically very unstable and the region has seen some major earthquakes.

The other major river basin in Northeast India is the Barak. This river has its source in Manipur and the upper Barak catchment area extends over almost the entire north, northwestern, western, and southwestern portion of the state. The middle course of the river lies in the plains of Cachar in southern Assam, while the lower, deltaic course is in Bangladesh. Both the Brahmaputra and the Barak river systems are also a lifeline for livelihoods, such as fishing and agriculture by local communities in their respective floodplains.

The region is home to a rich diversity of indigenous communities, with a substantial portion of the population dependent on natural resource-based livelihoods. This diversity of communities comes with unique socio-cultural, agro-ecological, and landholding systems (such as different forms of community control over forests in various parts of the region). Considering the unique features of the region and the scale of intervention planned, it is critical that the social and environ-

[3] Issues related to land acquisition have not been specifically addressed in detail in this chapter.

mental impacts are carefully assessed before deciding on the feasibility of large dams. A key feature of the current environmental clearance process is the Environmental Impact Assessment report, which is a critical document aiding decision-making. It is important to emphasize that this is the only study under current Central Government clearance mechanisms to have a mandatory component on socio-cultural impact assessment.

A common feature in all documents evaluating the development of hydropower projects in the North-east is the delays being caused by environment and forest clearances and how to address these. While there would certainly be certain aspects of the process which need to be streamlined, what is forgotten is the shoddy quality of EIA reports based on which virtually all projects continue to get clearances. Let us, for example, look at certain bio-diversity aspects of the EIA reports. Dr Anwaruddin Choudhury, renowned wildlife expert from Northeast India, has examined EIA reports of at least five large hydroelectric projects: the 600 MW Kameng, 2,000 MW Lower Subansiri, 1,000 MW Middle Siang, 1,500 MW Tipaimukh, and 3,000 MW Dibang and finds them all exceptionally poor on wildlife aspects. A common feature of his introductory comments on these reports is: 'contains innumerable (instances of) incorrect data, unverified and superfluous statements, and above all reveals the casual approach', referring to the power companies and EIA consultants. Dr Choudhury also says: 'It is shocking that mega hydel projects in the north-east are being granted clearances based on such reports. How can we decide the fate of some of the country's most important wildlife habitats based on sub-standard impact assessment studies?'[4]

Here are a few examples from these reports: the EIA for the 1,000 MW Siyom project lists 5 bird species in an area which has over 300 and even in this short list has one which is non-existent; the EIA for the 600 MW Kameng project reclassifies carnivores, such as the red panda, pangolins, and porcupines as herbivores and; the EIA for the 2,000 MW Lower Subansiri lists 55 species of fish in a river which has at least 156 and reports an area called the 'Arctic' in the Eastern Himalayas. All three projects have got a green signal based on these EIA reports. While bio-diversity was used as an indicator in these examples, the reports have been found to be poor in many social and environmental aspects as highlighted in subsequent sections of this chapter. In some cases the MoEF asked for additional detailed studies when EIAs were found to be poor, but often they have been post-clearance studies! There is little logic in first clearing the way for destruction of wildlife habitats and then doing a detailed assessment as a formality after project work and environmental destruction is well under way.

The main problem in current environmental decision-making processes is that virtually every project is treated as a fait accompli both by the expert committees appraising these projects and the regulatory authorities concerned. This subverts the possibility of a proper environmental decision-making process. Dr Dulal Goswami, environment scientist and renowned expert on the Brahmaputra river basin says: 'The geophysical nature of the Brahmaputra river basin is fragile and dynamic. The scientific knowledge base on the river system is currently very poor, for example on aspects such as sedimentation and hydrology which are linked to the economic life of the project. This needs to be strengthened urgently, more so in light of emerging threats from climate change. Without the availability of comprehensive information, how can we determine the long-term viability of projects in this region? The wisdom of such public policy has to be questioned. Economic viability apart, the mega-projects planned come with tremendous ecological and social costs which are unacceptable.'[5]

While a comprehensive analysis of the overall EIA framework[6] is beyond the scope of this chapter, some

[4] *Source*: Interview conducted by author with Dr Anwaruddin Choudhury on 12 January 2009. Review of unpublished comments of Dr Anwaruddin Choudhury on the EIA reports of the following hydropower projects: 600 MW Kameng (2002), 2,000 MW Lower Subansiri (2002), 1,000 MW Middle Siang (2003), 1,500 MW Tipaimukh (2007), and 3,000 MW Dibang (2007).

[5] *Source*: Interview conducted by author with Dr Dulal Goswami on 15 July 2010.

[6] For a more comprehensive analysis of environmental governance issues as a whole see the December 2006 report of the Planning Commission Task Force on *Governance, Transparency, Participation and Environment Impact Assessment in the Environment and Forest Sector for the XI Five Year Plan*. Although several institutional changes in the environmental governance framework have taken place or are underway since then, the overall issues in environmental governance broadly remain the same.

principles which need to be in place for comprehensive, credible environmental governance on Northeast dams are: commissioning of EIAs to be done by an independent body/regulator and not the project developer as is the current practice; need for public consultation in the Northeast at the 'scoping' stage when terms of reference (ToR) for EIA studies are determined; EIAs to be carried involving both local experts and communities (not only by outside consultants); final EIA reports to be open for peer review and public scrutiny for at least two months before a project is appraised for environmental clearance; no clearances should be granted based on poor, sub-standard EIAs, fresh studies should be insisted upon before a decision is taken; involvement of local communities in monitoring commissioned projects; post-facto impact assessment of already commissioned projects to assess actual impacts and gain insights for future planning and; clearly defined legal norms to weed out 'conflict-of-interest' in relevant expert appraisal committees deciding on environmental clearances and greater involvement of people from social sciences in such decision-making.

It needs to be mentioned here that a former chairperson of the expert appraisal committee (EAC) on river valley and hydroelectric projects, which evaluates projects for environmental clearance, resigned after public pressure on the MoEF in 2009. He was a director on several power companies and also presided over the environmental clearances of projects which were promoted by companies on whose board he served (for example, the 1750 MW Lower Demwe in Arunachal Pradesh co-promoted by PTC India Ltd.). But the main issue here is not about a particular individual or company concerned, but about MoEF's faulty policies for constitution of EACs; currently also the subject of a public interest litigation in the Delhi High Court.[7] While MoEF claims that some of the problems in the current framework will be addressed by the setting up of the proposed National Environmental Appraisal and Monitoring Authority (NEAMA), critics have argued that unless the Government of India agrees to give social and environmental issues the same importance as techno-economic issues keeping in mind the long-term ecological security of the country, new authorities will not address the issue. For example, despite the perception in some sections of media and industry that MoEF is blocking environmental clearances, Right to Information (RTI) data clearly show that a very high percentage of all projects which apply for environmental clearances are granted these. For instance, the rate of environmental clearances in the period 1August 2009 to 31 July 2010 was over 90 per cent (ercindia.org).

Underestimating Social Impacts

One of the major arguments put forward to argue for large hydroelectric projects in the North-east, is that there is relatively 'small displacement' by submergence as compared to that in other parts of the country and therefore these projects are benign. But a careful perusal of the ground situation indicates that displacement, particularly of livelihoods and rights, is grossly underestimated. Azing Pertin of the Siang Peoples Forum in Arunachal Pradesh says: 'Since our state is hilly, there is very little land where permanent cultivation is possible. Virtually all our available arable lands will be submerged by the 2700 MW Lower Siang project in the affected area in the Siang Valley. The magnitude of impact has to be understood keeping this context in mind. It is misleading to argue that the land being lost is a small percentage of the total area of the district or state and wrongly assume that the project is benign.'[8]

The impact of dams on resources under common use (for example, pasture land), vital to the livelihoods of local communities, is also a major missing link in the impact assessment of projects.[9] In addition to submergence, land use restrictions for local communities will apply in the catchment area of the reservoir as per mandatory norms to reduce siltation and to increase the life of the reservoir. Further, compensatory mechanisms required as per forest laws to offset the loss of forests due to a project, also lead to protection of other areas, affecting

[7] *Kalpavriksh & Others* v. *Union of India*, Writ Petition (Civil) No. 2667 of 2011 in High Court of Delhi.

[8] Interview conducted by author with Azing Pertin on 26 August 2010

[9] Personal communication with Dr Gita Bharali, North Eastern Social Science Research Centre (NESRC), who has studied the impact of the Pagladiya and Karbi-Langpi projects in Assam. For detailed information and statistics on displacement due to development projects and activities in North-east India, please contact Dr Bharali at gitabharali09@gmail.com.

community access to land and resources. For example, a considerable part of the forests in Arunachal Pradesh are classified as 'Unclassified State Forests (USFs)' which are de facto under community control. Bringing such areas under 'Compensatory Afforestation' will necessarily involve declaring them as Protected or Reserved Forests, with greater state control . The impact on the rights of local communities in such cases also needs to be examined in terms of the Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006.[10] Clearly the impact on local communities is well beyond just the submergence area. However, in the existing planning and decision-making process social and environmental impacts over the larger landscape due to various aspects described earlier, are not assessed. This is therefore not reflected in the decision-making on the overall viability of the project.

States, such as Arunachal Pradesh are home to small populations of culturally sensitive indigenous communities. Therefore, direct and indirect displacement is high if looked at in the perspective of the local population (as opposed to the population of the country). Dr Mite Lingi, Chairman of the Idu Indigenous Peoples Forum, says: 'The "small displacement" argument to sell these projects as being benign needs to be confronted. The entire population of the Idu Mishmi tribe is around 9500 and at least 17 large hydel projects have been planned in our home, the Dibang Valley in Arunachal. As per this faulty argument, little social impact will be indicated even if our entire population were supposedly displaced!'[11] The land in the state has also been customarily delineated between different indigenous communities and clans. Therefore, contrary to popular belief, there isn't plenty of land for resettling people in the state, just because the population density is less.

Further, concerns being expressed in states like Arunachal Pradesh and Sikkim are not restricted to the issue of displacement. The over-900-day *satyagraha* in Sikkim by affected indigenous communities from 2007–9 focused on the impacts of hydel projects on Dzongu, the holy land and reserve of the Lepcha tribe. The protests have also received the support of the Buddhist monk community in Sikkim, as a sacred landscape stands to be desecrated. Sociologist Vibha Arora says: 'Such protests are not merely on grounds of displacement but that the region's cultural and ethnic traditions are rooted in the river Teesta and its environs.' A major concern in the North-east is the influx of large labour populations from outside the region in areas inhabited by vulnerable indigenous communities. Dr Lingi adds, 'We have been given constitutional and legal protection, particularly with respect to our land rights and restricted entry of outsiders. These projects are going to require both skilled and unskilled labour which Arunachal Pradesh cannot provide. 17 large projects in the Dibang Valley will bring in outside labour, upwards of 150,000 people, for long periods, as these are long gestation projects. We are concerned about the demographic changes and other socio-cultural impacts associated with this, as the Idu Mishmis are only 9500 in number. The development policies are in glaring contradiction to the constitutional and legal protection we have been given.'[12]

While some states, such as Arunachal Pradesh have attempted to address some of the issues through state-specific resettlement and rehabilitation (R&R) laws,[13] these primarily restrict themselves to increasing compensations for individual and community land (including forest land) to be directly acquired for the project. But prior to addressing R&R, a robust social impact assessment would need to factor in the socio-cultural realities of the region as pointed out earlier, including identification of project-affected persons (PAPs) whose land may not be directly acquired but are clearly affected by the project.

We All Live Downstream

An issue of heated current debate in the North-east is the downstream impact of dams, often a lacuna in the broader popular discourse on the impact of dams in

[10] For more information on this law and its implications for infrastructure projects in forest areas see the report *Manthan* of the joint MoEF-MoTA committee looking at the implementation of the law, available at: envfor.nic.in & fracommittee.icfre.org.

[11] Interview conducted by author with Dr Mite Lingi on 8 July 2009.

[12] Interview conducted by author with Dr Vibha Aurora on 5 September 2007. Interview conducted by author with Dr Mite Lingi on 8 July 2009.

[13] Arunachal Pradesh enacted its R&R law in 2008.

the country, which is primarily influenced by upstream submergence and displacement. When large dams block the flow of a river, they also trap sediments and nutrients vital for fertilizing downstream plains. They alter the natural flow regimes which drive the ecological processes in downstream areas. Quite literally they disrupt the connections between the upstream and the downstream, between a river and its floodplain.

A major catalyst in triggering the larger debate on downstream impacts of dams in Assam, has been repeated incidents of dam-induced floods across the state from upstream projects (for example, the 405 MW Ranganadi in Arunachal Pradesh) in recent years. Concerns about downstream impacts raised in the North-east include loss of fisheries; changes in *beel* (wetland) ecology in the floodplains; impacts on agriculture on the *chapories* (riverine islands and tracts); impacts on various other livelihoods due to blockage of rivers by dams (for example, driftwood collection, sand, and gravel mining); increased flood vulnerability due to massive boulder extraction from riverbeds for dam construction and sudden water releases from reservoirs in the monsoons and dam safety and associated risks in this geologically fragile and seismically active region. The Brahmaputra valley, a thickly populated narrow strip of land with hills surrounding it, has awoken to the fact that it is going to be increasingly vulnerable to risks from existing and proposed large dams upstream. This realization has been significant for a civilization whose cultural identity—customs, food habits, music, and religious beliefs—is inextricably linked to its river systems.[14]

One of the key issues which have come up is the drastic daily variation in river flows which will take place after these dams are commissioned, particularly in winter. For example, the average winter (lean season) flow in the Subansiri river in its natural state is approximately 400 cubic metres per second[15] (cumecs). Both the ecology of the downstream areas and people's use of the riverine tracts in winter is adapted to this 'lean' but relatively uniform flow of water on any particular day (even though there is a gradual variation through the season). *Chapories*, for example, which are exposed and drier in winter are used for both agriculture and cattle grazing purposes by local communities, and simultaneously by wildlife. After the commissioning of the 2,000 MW Lower Subansiri project, flows in the Subansiri river in winter will fluctuate drastically on a daily basis from 6 cumecs for around 20 hours (when water is being stored behind the dam) to 2,560 cumecs for around 4 hours when the water is released for power generation at the time of peak power demand in the evening hours. Thus, the river will be starved for 20 hours and then flooded for 4 hours with flows fluctuating between 2 and 600 per cent of normal flows on a daily basis.

The flow during peak load water releases in the Subansiri river in winter will be equivalent to average monsoon flow and will cause a 'winter flood', drowning on a daily basis drier riverine tracts used both by people and wildlife throughout winter. The downstream livelihoods and activities likely to be impacted by this unnatural flow fluctuation in the eastern Himalayan rivers include fishing, flood-recession agriculture (for example, mustard), river transportation, and livestock rearing in grasslands for dairy-based livelihoods. But downstream communities are yet to be officially acknowledged as project-affected persons due to upstream dams. Flow fluctuations in rivers, such as Lohit, Dibang, Siang, and Subansiri will seriously impact breeding grounds of critically endangered grassland birds, such as the Bengal Florican, foraging areas of the endangered wild water buffalo, habitat of the endangered Ganges river dolphin, and important national parks, such as Dibru-Saikhowa and Kaziranga. For example, the combined operation of the 1,750 MW Demwe Lower (Lohit), 3,000 MW Dibang, and 2,700 MW Lower Siang, all terminal dams on their respective rivers, will cause an unnatural, drastic fluctuation of over 4 metres (13 feet) in water levels on a daily basis in winter in the Dibru-Saikhowa National Park located in downstream Assam.[16]

[14] Note on 'Socio-economic Impacts of Big Dams in Downstream Areas of Assam' presented by Dr Chandan Kumar Sharma during the public consultation on dams in Northeast India held in Guwahati on 10 September 2010.

[15] One cubic metre = 1,000 litres. Therefore, a flow of one cumec (cubic metre per second) is equal to 1,000 litres/second.

[16] Downstream impact assessment for the 2,700 MW Lower Siang project carried out by the Water and Power Consultancy Services (WAPCOS). This interim report is available at: apspcb.org.in.

But until very recently, the ToRs for EIA studies granted by MoEF ignored an assessment of downstream impacts. This is, for example, evident from ToRs issued for at least 50 large hydroelectric projects in Arunachal Pradesh from September 2006 to August 2010. In most cases the 'baseline data' is restricted to only 10 km downstream of the project and the actual 'impact prediction' has been asked to be restricted to an even shorter distance downstream—only between the dam and the powerhouse! There is only one aspect which is mandatory to be studied beyond 10 km downstream in all cases; this is the 'dam-break analysis' which predicts the effects of flooding downstream in case the dam actually breaks. But, as indicated earlier, dam-break is not the only downstream risk a dam poses. Unfortunately, most detailed downstream studies are only prescribed as post-clearance studies as was done in the environmental clearance granted to the 15,00 MW Tipaimukh Multipurpose project in October 2008 and in the 1,750 MW Demwe Lower project on the Lohit river in February 2010. This clearly indicates that the projects are being treated as a fait accompli and the clearance processes as a formality. It was only recently that MoEF for the first time prescribed partial downstream impact studies for a few projects before grant of clearance (for example, the 3,000 MW Dibang Multipurpose project and the 2,700 Lower Siang). But the ToRs in these cases are very weak and will not give a comprehensive picture of the downstream impacts of these projects, a recipe for future conflicts. Moreover, the mandatory public hearings are being held only in the upstream state, even for projects which clearly acknowledge impact on flow patterns in downstream Assam.

It is absolutely important that comprehensive downstream impact assessment be made mandatory in all the ToRs for EIA studies for hydropower projects in the region (downstream distances for studies should be determined on a case-to-case basis according to the local context after widespread consultations); environmental risk-assessment as part of EIA studies should also be comprehensive, going beyond the current practice of restricting it to only a dam-break analysis; mandatory public consultations should be held in downstream affected-states and; based on this impact assessment and consultation processes, project-affected persons (PAPs) in the downstream should be identified too.

Run-of-the-river (RoR) Hydro

Irrespective of the impact of individual projects, an image has been projected in the policy domain that all RoR hydropower projects are 'environmentally and socially benign' and therefore win-win projects.

The Bureau of Indian Standards Code IS: 4410 defines a RoR power station as: 'A power station utilizing the run of the river flows for generation of power with sufficient pondage for supplying water for meeting diurnal (daily) or weekly fluctuations of demand. In such stations, the normal course of the river is not materially altered.'

IS: 4410 defines a storage dam as: 'This dam impounds water in periods of surplus supply for use in periods of deficient supply. These periods may be seasonal, annual or longer'.

Most of the so called 'run-of-the-river' hydroelectric projects being developed in the Himalayan region involve large dams which divert river waters through long tunnels, before the water is dropped back into the river at a downstream location after passing through a powerhouse. These projects are promoted as being 'environmentally benign' as they involve smaller submergences and lesser regulation of water as compared to conventional storage dams. This perception conveniently ignores the impact of several features intrinsic to this design. For example, long stretches of the river will be bypassed between the dam and powerhouse, with up to 85–90 per cent of the river flow in the winter (lean season) diverted through the tunnels. In the 510 MW Teesta V project in Sikkim the head race tunnel taking the water from the dam to the powerhouse is 18.5 km long and bypasses a 23 km length of the river. Not only will this destroy riverine ecology, but a cascade of projects will mean most of the river would essentially end up flowing through tunnels.

These projects also involve extensive tunneling in a geologically fragile landscape, the environmental and social impacts of which are grossly underestimated. Impacts observed include cracks in houses above long tunnel alignments, drying up of water resources, and major landslides. The list of PAPs is clearly much longer than what is calculated at the planning stage which only looks at those whose land is to be directly acquired for various project components. The tunneling also generates a huge quantity of muck and rock debris, the disposal of which is a huge challenge. The indiscriminate dumping of such massive quantities of excavated muck in steep Himalayan valleys with little available flat land has been another cause of serious impacts and environmental violations in projects. This is a fact corroborated by the Comptroller and Auditor General (CAG) of India in a 2009 report on Sikkim (http://www.cag.gov.in/html/cag_reports/sikkim/rep_2009/civil_chap1.pdf).

Another type of RoR project being built is that which has a 'dam-toe' powerhouse located immediately downstream of the dam. Examples of such a project are the 2,700 MW Lower Siang, the 1,750 MW Demwe Lower (Lohit), and the 2,000 MW Lower Subansiri located in the Arunachal foothills just before these rivers enter the plains. However, the impact of these mega RoR projects is certainly not small. The reservoir of the 2,000 MW Lower Subansiri project will submerge a 47 km length of the Subansiri river while the 2,700 MW Lower Siang project will submerge a 77.5 km length of the Siang river (total 100 km length of various rivers to be submerged in this project). These projects will also cause drastic daily fluctuation in river flows downstream (see section 'We all live downstream') due to power generation patterns, particularly in winter. Dam proponents argue that these projects are benign since the total flow in the river downstream over any 10-day period in the year will be the same as in the pre-dam condition. But they fail to acknowledge that the massively altered daily flow patterns will have serious social and environmental impacts in the Brahmaputra floodplains.

A misleading campaign is being run by certain sections which claims that RoR projects being built in states, such as Arunachal Pradesh do not even include construction of dams! It needs to be clarified here that the bulk of the projects involve not just dams but large dams[17] as defined by India's Central Water Commission, the International Commission on Large Dams (ICOLD), and the World Commission on Dams. Irrespective of the nature of the project, dams fragment rivers, breaking the organic linkages between the upstream and downstream, between the river and its floodplain. While it is welcome that the EAC and MoEF have finally started discussing release of 'environmental flows' (eFlows)[18] in recent times while evaluating projects, it will be misleading to again regard this as a panacea to make every project 'benign'. Eflows could be a crucial environmental management measure in projects which are otherwise socially and environmentally acceptable, but it is a contested concept which needs more widespread debate in the local context.

It is therefore clearly misleading to universally label RoR projects as 'socially and environmentally benign' ones. Whether RoR or storage type, both the individual and cumulative impacts of hydropower projects in any river basin need to be comprehensively scrutinized and understood while granting permissions.

Cumulative Impacts of Dams, Carrying Capacity of River Basins

With multiple hydropower projects coming up in each basin, the issue of cumulative impacts of multiple dams and carrying capacity of river basins has become a crucial issue, whether it is the cumulative impacts of multiple RoR projects on the Teesta river in the uplands of Sikkim or the cumulative downstream impacts of over 100 dams proposed in Arunachal Pradesh on the Brahmaputra floodplains. Currently, environmental laws do not make it mandatory to have an advance cumulative impact assessment of projects in a river basin, but there are some interesting court orders. For example, the National Environmental Appellate Authority (NEAA),[19] a special environmental court in an April 2007 order observed that it feels the need for 'advance cumulative study of series of different dams coming on any river so as to assess the optimum

[17] ICOLD defines large dams as: 'those having a height of 15 meters from the foundation or, if the height is between 5 to 15 meters, having a reservoir capacity of more than 3 million cubic meters'. For further details see, http://www.icold-cigb.net/

[18] According to IUCN, Environmental Flows (eFlows) refer to water provided within a river, wetland, or coastal zone to maintain ecosystems and the benefits they provide to people. But there is no one accepted definition and the term is highly contested, meaning different things to different stakeholders (like 'sustainable development') (iucn.org). Several methodologies exist to determine eFlows. While evolution of such methodologies is important, it is crucial that eFlows cannot be restricted to a technical issue alone. Local negotiated solutions are required in each case.

[19] With the setting of the National Green Tribunal in October 2010, the NEAA has now been dissolved.

capacity of the water resource giving due consideration to the requirement of the Human beings Cattle, Ecology/Environment etc.' However, this order has been repeatedly violated by MoEF. Even though river basin-level studies have been prescribed for some river basins, such as the Teesta in Sikkim in the past and more recently for the Bichom, Lohit, Siang, and Subansiri in Arunachal Pradesh, these studies have been specifically delinked from clearances to be granted to individual projects and have not been done in 'advance'. Therefore, project clearances can continue business as usual in each river basin without the completion of cumulative studies, making it a cosmetic exercise. While MoEF's EAC in its September 2010 meeting finally expressed an opinion that a cumulative downstream impact assessment does indeed require to be carried out in Assam to study the impacts of multiple projects in the Brahmaputra river basin, it is silent on the need to halt environmental clearances of individual projects until such a study is completed.

The focus of a river basin level study can vary substantially according to how it is defined. While a 'cumulative impact assessment' will keep hydropower projects as the key focus, a broader 'carrying capacity study' or 'river basin planning' approach will look at the river basin as a whole with different competing land use/water use priorities and development options, of which hydropower projects is one.

It is important that river basin studies (including a cumulative impact assessment of multiple hydropower projects proposed in each basin) are carried out in advance; individual clearances cannot be delinked from such studies as is the current practice. The focus and ToRs of such studies should be determined after consultations in the concerned river basin. Such studies should be carried out independently (not by developers) and peer review and public consultations based on such studies should be carried out in each river basin. A primary objective of such an exercise should be to allow rivers to flow free so as not to disrupt natural ecology and riverine production systems (e.g. fisheries) on which local communities depend. Such rivers (or sections of rivers), identified and prioritised with the consent of local communities, should be 'no-go' areas for hydropower projects[20] i.e. areas where hydropower projects cannot be built.

Looking Ahead

While this chapter primarily focused on social and environmental issues viewed through the lens of environmental governance, there are clearly larger issues related to the political economy of development in general, and large infrastructure projects in particular, which need to be addressed to make a headway vis-à-vis emerging conflicts on hydropower projects in the Northeast.

For example, in May 2008 the then Union Minister of State for Power, Jairam Ramesh, raised concern about the 'MoU virus' which was affecting states like Arunachal Pradesh and Sikkim. He was referring to the very rapid pace at which agreements (MoUs/MoAs) were being signed by these state governments with hydropower companies, particularly in the private sector. Huge upfront premiums taken from developers, before mandatory public hearings had been conducted and environmental clearances obtained, rendered the environmental governance process meaningless. While there is clear opposition in Arunachal Pradesh to specific hydropower projects in certain river valleys, an important debate in the state is also on the manner in which a large number of projects are going to be simultaneously taken up and their cumulative impacts.

Therefore, from a policy perspective 'how can we rapidly harness the hydropower potential of the Northeast?' may be the wrong question to ask. Instead it might be more appropriate to ask: At what scale and in what manner can hydropower be produced in the region as a part of a larger development ethos which respects the ecological, social, and political context of the region? Both the central and state governments will need to go beyond existing technocratic institutions in the water and power sector to find the answer to this question and the people who actually inhabit these river valleys will need to be at the steering wheel of

[20] After a major public campaign GoI abandoned three hydropower projects on the Ganga and declared a 135 km stretch of it as ecologically sensitive under the Environment (Protection) Act, 1986. In Sikkim, an area of the Teesta river basin which was declared a 'no-go' area by MoEF in October 2008 after a detailed carrying capacity study of the river basin was re-opened for hydropower investigations in 2010.

the process to find the answer. For example, an issue which has come up for discussion in popular debate is the possibility of staggering or pacing the construction of projects, which are otherwise found to be socially and environmentally acceptable, in a river basin. This will also enable learning lessons from the experience of ongoing projects for future planning of hydropower in each river basin.

From a long-term perspective, technocratic institutions in the water and power sector (for example, the Central Water Commission and the Central Electricity Authority) need an urgent revamp to reflect diverse expertise beyond engineering and technocratic wisdom. In the current hierarchy of decision-making, environmental and social aspects of water (and the accompanying environmental governance framework) are both subservient and downstream of techno-economic issues. But reforms of technocratic water and power institutions are likely to be a long and arduous process. In the short-term there is no alternative to addressing these issues but through a strengthened institutional framework for environmental and social governance. Such an environmental governance framework will need to have a level-playing field with technocratic institutions which decide on techno-economic feasibility of projects, which would also mean a more upstream involvement in the planning of river basins.. While one suggestion by the government is having a multi-disciplinary Northeast Water Resources Authority (NEWRA), the idea needs debate in the region. Critics fear that it will be another technocratic institution merely pushing mega water infrastructure projects, rather than ensuring socially and ecologically sensitive planning of river basins.

Last but not the least, a more proactive engagement and scrutiny of financial institutions supporting water and hydropower infrastructure in the region on social and environmental issues is also much needed. The political economy of hydropower development in the region may not allow all the social and environmental issues to be fully addressed in the current environmental governance framework, hence relying on these 'clearances' as certificates of the viability of these projects may pose serious risks to investments in the long term, as is evident from major protests in the region against projects which have already got a green signal.[21] An underlying issue through all of this is that we will need to abandon a virtual dogma in current decision-making that each and every project is a fait accompli. Creating genuine space for addressing social and environmental issues, including the option of saying no to certain projects based on thorough scrutiny and public consultation, will be beneficial for all concerned in the long term.

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[21] A new issue which will be debated by financial institutions and other stakeholders in the coming days is the recently formalized Hydropower Sustainability Assessment Protocol (HSAP). The HSAP was created between 2007 and 2010 by the Hydropower Sustainability Assessment Forum (HSAF), an initiative of the International Hydropower Association (IHA), an industry group that was formed in 1995. The formalized HSAP and the details of the HSAF process are available at www.hydrosustainability.org. Many believe the HSAP will undermine the recommendations of the World Commission of Dams (WCD), the first independent review of the performance of dams completed in 2000. *Source*: www.internationalrivers.org.

26 Evaluation of National Water Mission using Global Water Partnership Toolbox

Suman Apparusu

Introduction

The supply, distribution, and consumption of water vary across regions in India. Further, the governance of water is controlled by geographic contours, climate and hydrological variations, societal attitudes, local, national, and regional policy, political frameworks, and infrastructure investments. Increasing population, growing affluence, rapid urbanization, incidence of climate variability, extreme weather events, and the development aspirations of nations have put pressure on this precious resource. Addressing these multiple dimensions requires integrated management of water.

Such an integrated management needs to strike a balance between economy, equity, and environment, which are the objectives of the Integrated Water Resource Management (IWRM) approach that has now been accepted internationally as the way forward in ensuring sustainability of this resource. Global Water Partnership (GWP) defines IWRM as a 'process that promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems'.

India has instituted the National Water Mission (NWM). The NWM—one of the key missions of the National Action Plan on Climate Change—aims at the 'conservation of water, minimizing wastage and ensuring its more equitable distribution both across and within states through integrated water resources development and management'. This is coordinated by the Ministry of Water Resources and receives funding requirement of Rs 28,651 crores (USD 6.14 billion), divided between the centre and states. This chapter evaluates the NWM using the GWP Toolbox.

The GWP Toolbox (see Box 26.1) suggests that water resource management takes place in a framework of an 'enabling environment' conducive to policy making, strategizing, and legislation, an 'institutional framework' to implement them, and 'management instruments' to monitor the implementation progress. It has been developed as an open source product through collective thinking from leading water practitioners—UNEP–DHI Centre, World Health Organization (WHO), The Ground Water Management Advisory Team (Ground Water–MATE), International Capacity Building Network (CapNet), EU Water, and Associated Programme on Flood Management (APFM). A set of 55 different tools are presented in the GWP Toolbox. These are organized in a hierarchical fashion with each tool embedded in the wider context of IWRM. A straight application of the Toolbox seemed impossible without extending it to build a strength assessment layer so that the provisions of the NWM could be assessed on how well (qualitatively) they stacked up against the Toolbox framework and its instruments. Hence a separate methodology has been developed and applied in this chapter. (Box 26.1) outlines the approach.

The National Water Mission: Key Goals[1]

- *Comprehensive water database in public domain and assessment of impact of climate change on water resources*: Collect comprehensive data on water resources, develop water resources information system by 2011, make information available in the public domain, assess the impacts of climate change on the country's water resources by 2012. Scientific data collection includes additional hydro meteorological data, wetland inventory, reassessment of basin-wise water situations, and finally, using this data to predict the impacts.
- *Promote citizen and state action for water conservation, augmentation, and preservation*: Includes expeditious implementation of irrigation projects, minor irrigation schemes, groundwater development, mapping flood-affected areas, capacity-building, and awareness.
- *Focused attention on over-exploited areas*: Intensive rainwater harvesting and groundwater recharge programmes, pursuing enactment of groundwater regulation and management bill.
- *Increasing water use efficiency by 20 per cent*: Increasing efficiency both on the demand side and supply side, particularly in the agriculture and commercial sectors. Guidelines for incentivizing recycled water, water neutral and water-positive technologies, improving efficiency of urban water supply systems, benchmark studies for urban water use, water efficiency indices for urban areas, manuals for mandatory water audits in drinking water, irrigation and urban systems, promoting water-efficient techniques including sprinkler and drip irrigation systems.

Box 26.1
The GWP Toolbox and the NWM: Strength Alignment Approach

The GWP Toolbox has 55 different tools, organized in a three-tiered hierarchical structure with each tool embedded in the wider perspective of IWRM. It is presented as a free and open database with a library of case studies and references that can be used by diverse water practitioners at various levels; local, national, regional, or global. The characteristics of each of the tools in the Toolbox are described so as to allow the user to select a suitable mix and sequence to address the water management challenges specific to a country, context, and situation. Tier 1 of the GWP Toolbox represents: (A) The enabling environment, (B) Institutional Roles, and (C) Management Instruments. Tier 2 provides a break-up of the relevant tools under each of the A, B, C headers. And Tier 3 goes further down in giving a granular form to each of the tools. As an illustration, the enabling environment A is further split into A1, A2, and A3 representing Policies (A1), Legislative Framework (A2), and Financing and Investment Structures (A3), respectively. Further, A1 is broken down into National Water Resource Policy (A1.01), Policies with relation to Water resources (A1.02), and Climate Change Adaptation Policies (A1.03). (Complete details of the structure and Toolbox break-up can be accessed at www.gwptoolbox.org.)

The 3-tiers of the GWP Toolbox were further broken down into finer criteria elements and alongside each of these criteria elements, best practice highlights list was drawn up. The process was repeated for all the 55 tools in the toolbox. As an example A2.01 that is, Water Rights was further sub-divided into elements such as: customary uses, transfer rights, transitional mechanisms, rights/transfers registry, and water characterization as a social, economic, political, and governance good. And the best practices were noted from the toolbox case experiences, as water resource information systems, water users-uses-entitlement matrix, pre-conditions for water right transfers, transparency in water allocations, and water valuation methods. Next, the NWM chapter-wise details were matched up with the constructed matrix and coded to indicate how well the NWM aligned with the GWP Toolbox and its fine-grained constituents. The codes, 1 (weak), 2 (moderate), 3 (strong), and 4 (very strong match up/alignment) indicate this strength of the alignment or match up. The process was repeated for each of the 55 Toolbox instruments and the results collated. Tables 26.1, 26.2, and 26.3 in this chapter represent the results of the match up described above and the summary of opportunity maps derived from this exercise.

[1] Policy Brief—'Climate Challenge India', April 2010 available at http://www.indiaclimateportal.org/component/option.com_policybrief/view,policybriefdetail/id,8.

- *Promote basin-level integrated water resources management*: Basin-level management strategies, review of the National Water Policy (NWP) in order to ensure IWRM, appropriate entitlement and appropriate pricing; review of state water policy.

Mission goals including collecting and reviewing data for an integrated information system have been in the pipeline ever since the NWP was revised in 2002. Water being a state subject under the Indian Constitution, the NWP and the policies under the Water Mission will have to address policy and project implementation at the state level.

The mission hopes to revisit the NWP in consultation with states, in order to ensure that basin-level management strategies are applied in dealing with variability in rainfall and river flows as a consequence of climate change.

The Global Water Partnership Toolbox–National Water Mission: Strength Alignment Mapping

Given the NWM goals, its significant thrust on the application of IWRM principles at the basin level, strong requirement for mission realization through programme implementation at the state level together with the strength alignment assessment, gives areas for priority attention in the NWM and also presents distinct opportunities for improvements. The benefits of drawing up such an alignment matrix clearly lie in incorporating both objective (GWP Toolbox instrument break-up, coding, and numeric assignment to the codes) and subjective assessments (NWM chapter-wise details) into an overall scoring pattern and arriving at the percentage strength alignment at each level. Analysing the results, one can discern that the water rights strengthening public sector water utilities, water markets, and tradable permits, and vulnerability assessments present significant opportunities for improvement in the present NWM scheme of things. The assessment of NWM using GWP Toolbox presents three sets of opportunity maps represented by three codes. The codes represent how well the NWM matches up with the GWP Toolbox framework and its constituent element best practices. Code 1 is assigned with weak, Code 2 is assigned with moderate, and Code 3 with strong alignment, characterizations.

As shown in Table 26.1, four elements of the toolkit emerge as important gaps in the NWM. While water rights and water markets with tradable permits go hand in hand and the mission document has noteworthy mention of water rights, world-wide trends seem to indicate that the water marketplace is in an evolution stage. However, water rights and markets in India are in their nascent stage of development. The vulnerability assessment (Table 26.1) depends on the climate vulnerability index methodological development and adoption which, in turn, is driven by the ultimate goals of development, business interests, or investment attraction. This implies that there would be a strong need for deliberation and agreement on its development prior to incorporation of index inputs into policy

Table 26.1 Code 1–Opportunity Map

Code	*Level*	*Toolkit element*	*Opportunities for improvement*
1	A2.01	Water rights	Customary uses, entitlements, transfer rights, rights registry, transition mechanisms
1	B1.07	Strengthening public sector water	Operational efficiencies, tarrif reforms, customer orientation, sub contracting principles, autonomy, multiple use service delivery, willingness to pay and market segmentation studies/surveys
1	C7.03	Water markets and tradeable permits	Transferable water rights, water markets, tradable permits, trading rules and regulation, physical means to transfer water between buyers and sellers
1	C9.05	Vulnerability assessment	Climate vulnerability indices and index application level (national, regional, state, local)

Source: Author's own.

making. Following the above arguments and combining them with the opportunities for improvement highlighted in Table 26.1, it can be discerned that the largest and most impactful set of opportunities, therefore, remains in the realm of strengthening the public sector water utilities. These opportunities range from bringing in utility operational efficiencies to conducting willingness to pay surveys, supported by water market segmentation studies. While these are not easy and readily implementable options given the level of customer dissatisfaction in terms of billing and water access, and levels of water resource availability; with strong customer orientation and sustained capacity building efforts in re-orienting the water utilities, some improvements might become visible.

Scanning the entire set of opportunities for improvement with code 2 (Table 26.2), one notices that the technical and capacity building weaknesses in IWRM exist in the NWM. The assessment indicates that technical expertise development and well-designed capacity building programmes need strong attention.

The set of opportunities under the code scheme 3 (Table 26.3), despite strong emphasis of intent in the NWM, seem the toughest to implement. Two

Table 26.2 Code 2–Opportunity Map

Code	*Level*	*Toolkit element*	*Opportunities for improvement*
2	A2.03	Reform of existing legislation	Acceptability, administrative feasibility, compliance with international conventions, participative in nature
2	A3.03	Loans and equity	Equity models, mobilization, forex risks, water financing instruments availability
2	B1.02	Transboundry organizations	Common data sets, consultation and conflict resolution processes, shared responsibilities and power balance
2	B1.06	Service providers and IWRM	Service providers typology, service delivery performance standards, demand management, systematic use of pricing & service delivery
2	B1.09	Community based organizations	Data/tools/applications, life cycle costing approaches to service delivery
2	B1.10	Local authorities	Engagement, advocacy, capacity building
2	B1.11	Building partnerships	Local bodies as regulators and service providers, citizen engagement for voluntary water quality programmes, staff and local authorities reconstitution
2	B2.01	Participatory capacity	Public participation models (water users associations, consultative groups, community, lobby groups, associations), dispute resolution, participation models funding and institutional support
2	B2.02	Capacity of water professionals	Information and communication technologies tools, exchange workshops, group facilitation, train the trainers, water curriculum, vocational and professional courses
2	B2.02	Regulatory capacity	Legitimacy, institutional, human and technical re-orientation
2	C1.04	Developing IWRM indicators	Ordered approach to indicators development, nodal agency for monitoring and evaluation, data collection, baselines and thresholds for monitoring and evaluation
2	C1.06	Water footprint and virtual water concept	Water footprint and virtual water tools integration into policy-making, measuring water use efficiency, identifying water intensive products trading
2	C3.03	Efficiency of supply	Supply efficiencies, utility level reforms—universal metering, leakage and pressure reduction, conveyance and distribution improvements, supply infrastructure refurbishment criteria and Cost–Benefit Analysis (CBA)

(*Contd*)

Table 26.2 (*Contd.*)

Code	*Level*	*Toolkit element*	*Opportunities for improvement*
2	C4.01	Education curricula	Shared visioning, curriculum changes
2	C4.02	Communication with stakeholders	Water campaigns
2	C4.03	Raising public awareness	Product water footprint labeling, nodal information dissemination agency
2	C5.01	Conflict management	Conflict resolution intervention tools
2	C5.02	Shared vision planning	Benefit sharing valuation, scenarios and simulations, optimization models
2	C5.03	Consensus building	Structured processes and documentation, legitimacy, interest based party negotiations
2	C6.03	Regulations for water services	Mode of regulation, regulation administration capacity, institutional independence, contract or operation licensing
2	C9.03	Social assessment	Social impact assessments, assessment tools

Source: Author's own.

reasons can be attributed to this observation. First, the acknowledgement in the NWM of the existence of multiple apex water bodies and the constitution and coordination challenges that exist among them. Second, the data, methods, and systems required to evolve implementable policies rooted in IWRM principles as seen in the set of opportunities presented in the Table 26.3. Strong leadership, clarity of role of private sector involvement, funding commitment, capacity building, inclusive and transparent stakeholder consultations supported by reliable evidence, technical expertise, and DSS could go some way in realizing the full potential of the opportunities presented.

Table 26.3 Code 3–Opportunity Map

Code	*Level*	*Toolkit element*	*Opportunities for improvement*
3	A1.01	National water resource policy	Integrated land and water usage links
3	A1.02	Policies with relation to water resources	Non water policy impacts, apex bodies coordination, water resource management and decision support systems (DSS)
3	A1.03	Climate change adaptation policies	Impact assessment, national adaptation framework, adaptation interventions (hard and soft)
3	A2.02	Legislation for water quality	Simple, Measurable, Achievable, Realistic, Time-bound (SMART) indicators, enforcement expertise, institutional capacity
3	A3.01	Investment policies	Pre-conditions management, private sector role clarity, tariff policies
3	B1.01	Reforming institutions	Stakeholder engagement, transparency & accountability, best governance practices compendium, information symmetry considerations
3	B1.05	Regulatory bodies and enforcement agencies	Capacity building for regulation & enforcement, financial stability of the regulatory bodies
3	B1.08	Role of the private sector	Models of engagement—financing and service delivery

(*Contd*)

Table 26.3 (*Contd.*)

Code	*Level*	*Toolkit element*	*Opportunities for improvement*
3	C1.02	Water resources assessment	Assessment models for demand, risk, social, climate vulnerability
3	C2.04	Coastal zone management plans	Coordination processes among river and coastal zone planners and institutions
3	C6.01	Regulations for water quality	Water quality data, specific/universal standards
3	C7.01	Pricing of water and water services	Cost reflectivity, environment protection, service delivery
3	C7.02	Pollution and environmental charges	Polluter pays principles, measurement and monitoring systems
3	C7.04	Subsidies and incentives	Cross sectoral impacts of subsidies on water use
3	C9.01	Risk assessment and management	Water hazards, risk typology, risk management options and institutions, peoples perceptions capture, risk finance
3	C9.04	Economic assessment	Taxes/subsidies considerations in economic assessments

Source: Author's own.

Conclusion

This chapter presents a discussion on opportunities for improvement in NWM based on its evaluation using the GWP Toolbox. Important areas that require further strengthening in the NWM are capacity building of public sector water utilities, need for wider stakeholder participation, better co-ordination mechanism across national apex water bodies, mechanism for addressing climate risk, and need for adaptation solutions coupled with strong leadership for executing the national mission. The advantage of applying the GWP Toolbox to NWM is that it allows multiple dimensions of IWRM to be evaluated comprehensively.

Section VI

Infrastructure Review

27 The Infrastructure Sector in India 2010–11

Manisha Gulati

Introduction

Progress in the infrastructure sector during 2010–11 has been lacklustre, both in terms of physical progress as well as in terms of policy and regulatory developments. While 2009–10 saw policy and regulatory changes, attempts at improving the pace of award and execution of infrastructure projects, revival of investor interest, and more definitive future plans, 2010–11 saw a slackening in the pace of reforms as well as development activity in almost all the sectors.

The telecom sector was mired in controversies associated with licences and the process followed for the 2G spectrum which were allotted in 2007–08. The roads sector saw irregularities and enquiries about the National Highways Authority of India (NHAI), and slower than expected project award activity. The Government of India (GoI) revised its target of building roads downwards from 20 km a day to 12–13 km a day. The ports sector did not see significant capacity addition and the finances of the power distribution utilities worsened, with utilities starting to resort to higher load shedding to avoid the burden of extra power purchase costs (Power Finance Corporation Limited 2011) and to prevent their financial position from worsening further. What stands out in almost all the sectors is the poor level of monitoring and accountability for completing programmes and projects (Planning Commission 2010a).

Consequently, the targets for physical infrastructure development were not met though rural infrastructure was an exception (see Table 27.1). Nevertheless, the acute shortage of infrastructure continues. As has been the case in the past five years, peak deficit of power continued to be over 10 per cent (Central Electricity Authority 2011). The network capacity and infrastructure of Indian Railways (IR) saw a negligible increase. The Railways is behind schedule in achieving the targets set for the Eleventh Five Year Plan (FYP) (2007–12) with respect to new lines, doubling projects, acquiring

Table 27.1 Progress in Development of Rural Infrastructure during Five Years, 2007–12

*Rural roads under bharat nirman**		*Target*	*Achievement*
New Connectivity	km	14,320	10,947
Upgradation	km	12,500	18,151
Habitations Connected	No.	3,000	2,463
Electrification under Bharat Nirman			
Village Electrification	No.	17,500	18,306
BPL Households Electrification	No.	4,700,000	3,973,327
Rural Teledensity	%	na	34%

Source: Telecommunications Regulatory Authority of India (2011a), Central Electricity Authority (2011), Bharat Nirman (2011a and 2011b).
Note: * Up to December 2010.

wagons, and acquiring electrical multiple unit (EMU) coaches (Planning Commission 2010a). Even in sectors like ports, where it has often been argued that capacity is not a major issue, the low efficiency levels of ports undermine their competitiveness and efficiency (Gulati 2010; Planning Commission 2010a). Not surprisingly, the World Economic Forum (WEF) in its *Global Competitiveness Report-2010* ranked India's basic infrastructure at the 86th position amongst 139 countries; a fall of 10 places compared to that in 2009. This fall was largely attributable to the poor quality of roads, ports, and electricity supply.

In this backdrop this chapter reviews developments in different infrastructure sectors in India during 2010–11. It also reviews the progress made in investments made so far and what is anticipated in the remaining years of the Eleventh Five Year Plan in the infrastructure sector. The chapter also reviews initiatives taken by the Government of India (GoI) to improve the availability of funds to this sector to meet its enormous investment requirements.

Investments in Infrastructure

The Planning Commission (2010a) assessed the investments in infrastructure during the first three years of the Eleventh Five Year Plan. At an aggregate level, there was an increase in investments in the sector with investments level of Rs 3,03,807 crore in 2007–8 and Rs 3,59,192 crore in 2008–9, as against the projected level of Rs 2,70,273 crore and Rs 3,21,579 crore respectively. This was largely due to an increase in investments in the telecom sector and oil and gas pipelines. Sectors like roads, railways, ports, and water supply and sanitation witnessed significant shortfalls as compared to the targets largely due to a slowdown in the award of projects. The Planning Commission has also revised the total estimates of investment in this sector during the Eleventh Five Year Plan to Rs 20,54,205 crore, which is almost equal to the initial target of Rs 20,56,150 crore.

According to the Planning Commission (2010a) infrastructure investments are estimated to touch 8 per cent of GDP by the end of Five Year 2010–11 (see Figure 27.1). Equally striking is the share of the private sector in these investments (see Figure 27.2). In 2010–11, as a proportion of GDP private investment in infrastructure is estimated to account for 2.9 per cent. As a share, almost 37 per cent of the investment in infrastructure in this year came from the private sector.

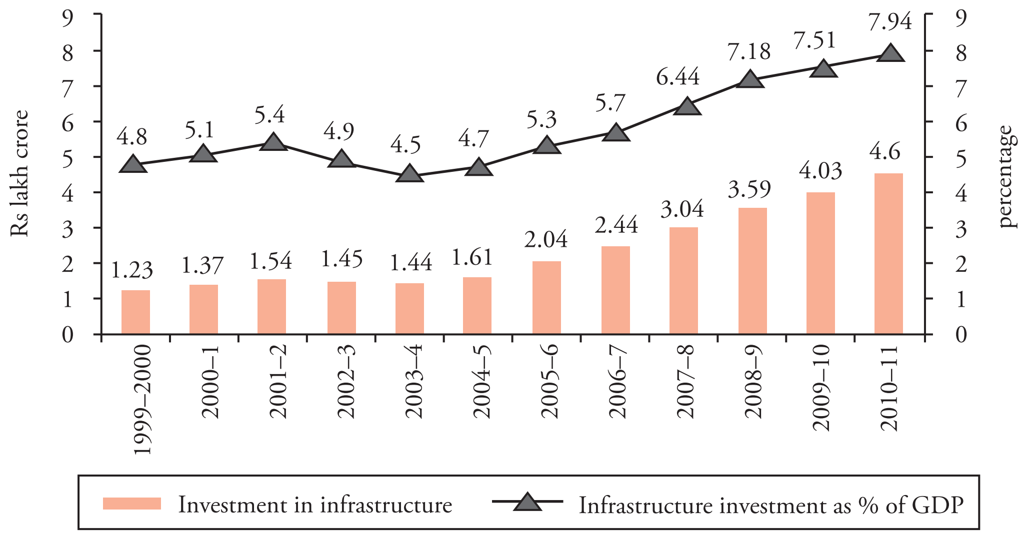

Figure 27.1 Infrastructure Investments in India (at 2006–7 prices)

Source: Planning Commission (2010a).

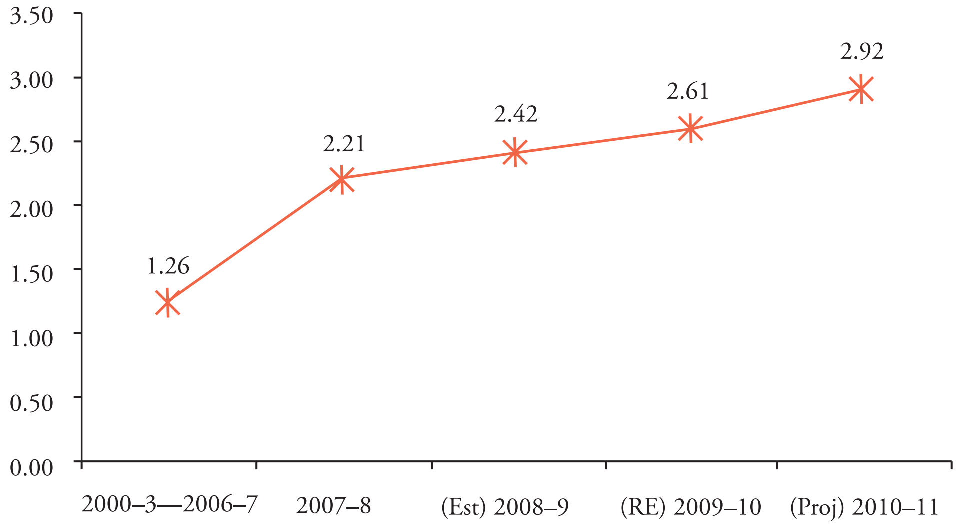

FIGURE 27.2 Share of Private Sector in Infrastructure Development as a Proportion of GDP (at 2006–7 prices)

Source: Planning Commission (2010a).
Note: Est: Estimated actuals; RE: Revised estimates, Proj: Projected estimates.

REVIEW OF SECTORAL DEVEOPMENTS

Telecom

The sector made commendable progress during 2010–11 on physical parameters. With 811.59 million connections at the end of Fiver Year 2010–11 (Telecom Regulatory Authority of India 2011a), the Indian telecom network became the second largest wireless network in the world after China. Overall teledensity touched 71 per cent (ibid).

On the policy and regulatory front, the sector was embroiled in controversies on issues relating to the allotment of new unified access services (UAS) licences and the 2G spectrum in 2007–8. A report of the Comptroller and Auditor General (CAG) of India concluded that the government exchequer incurred a loss of between Rs 67,364–176,645 crore on account of such allotment (see Table 27.2). The UAS licences had been issued at a price discovered in 2001 when the market was at a nascent stage of development as

TABLE 27.2 Presumptive Loss of Spectrum Allocated to 122 New UAS Licencees and 35 Dual Technology Licences in 2007–8

Category	*Criteria for working out potential loss to exchequer (value Rs in crore)*			
	S Tel rate	*Rates on the basis of 3G auction*	*Sale of equity by the licencees*	
			Unitech	*Swan*
New Licences	38,950	102,498	40,442	33,230
Dual Technology	14,573	37,154	15,132	12,433
Beyond contracted quantity of 6.2 MHz	13,841	36,993	14,052	12,003
Total	67,364	176,645	69,626	57,666

Source: Adapted from CAG (2010).

opposed to an appropriate market price in 2008 when the sector had undergone substantial transformation and manifold growth. Moreover, the licences were issued on a single day. These actions prompted questions regarding transparency in the licence allocation process and the failure in maximizing revenue generation for the government from the allocation of spectrum.

The CAG report had several important findings on these issues. First, it cited irregularities in the process followed by the Department of Telecommunications (DoT) for the verification of applications for UAS licences for confirming their eligibility as it lacked due diligence, fairness, and transparency. It claimed that 70 per cent of the 122 new licences were issued to companies that did not meet the basic eligibility conditions set by DoT and had suppressed facts, disclosed incomplete information, and submitted fictitious documents for getting licences and thereby access to spectrum. It further stated that licences were not awarded on a first come, first served basis as had been purported. Second, it found that DoT had not implemented the licensing regime as approved by the Cabinet and implemented only the first phase of the policy, overlooking the second phase that involved delinking the prices of spectrum from the issue of licence and devising an efficient allocation formula for spectrum along with an appropriate price. Finally, it highlighted that some incumbent operators had been allocated spectrum beyond the contracted amount.

Pursuant to these findings, GoI appointed a one man committee (OMC) in December 2010 to look into deficiencies in the formulation and implementation of internal procedures by DOT in the issuance of 2G licences and allocation of spectrum during 2001–9. The OMC concluded that the procedures adopted by DoT and its decisions with respect to grant of UAS licences (bundled with spectrum), right from 2003 onwards were neither in tune with GoI's extant policies and directions nor the recommendations of the Telecom Regulatory Authority of India (TRAI) (OMC 2011).

Following this, the Parliament set up a Joint Parliamentary Committee (JPC) in March 2011 to look into the licence and spectrum allotment process since 2000. At the same time, the Central Bureau of Investigation (CBI) and Enforcement Directorate (ED) started conducting investigations into any possible acts of corruption associated with this licence allocation process. DoT also issued show cause notices to some telecos that allegedly suppressed information to bag licences and delayed roll out of services as mandated. These telecos deposited the penalty amounts while citing several hindrances to roll outs (such as a delay in the clearances required for each site, new last-minute prelaunch testing requirements, and new equipment security clearance processes) that were beyond their control. In reality, some telecos delayed roll outs in anticipation of selling their licences. In fact, two players sold equity to foreign investors for significant profit after they were given their licences.

Another controversy in the sector was related to spectrum hoarding and exaggeration of subscriber numbers to garner additional spectrum. TRAI's visitor location register (VLR) report (TRAI 2010a and 2011a) which captured an operator's of active subscribers, revealed that only 50–60 per cent of the subscribers were active in case of two leading dual-technology telecos—Reliance Communications (RCOM) and Tata Teleservices Limited (TTSL). GSM telecos, such as Bharti Airtel and Idea Cellular had over 89 per cent and 88 per cent active subscribers respectively. The national average is 70 per cent.

In the meantime, TRAI (2010b) submitted its recommendations on the comments made by DoT's committee on the issue of allocation of access (GSM/CDMA) spectrum and its pricing. TRAI recommended the price of 1,800 MHz pan-India contracted spectrum at Rs 1,770 crore/MHz (47 per cent lower than the 3G price) and excess spectrum at Rs 4,570 crore/MHz (36 per cent higher than the 3G price). The latter is charged higher than contracted spectrum as the incremental benefits due to excess spectrum are far higher. TRAI further suggested that 3G prices be adopted as the 'current price' of spectrum in the 1,800 MHz band and that all future licences should be unified licences, with spectrum being delinked from the licence.

Other developments in the sector during the year include the 3G and BWA spectrum auctions in June 2010. In the 3G auction, the overall winning price was almost five times the reserve price and in the BWA auction it was more than seven times the reserve price. Nine companies participated in the 3G auction out of which 7 companies won the auction in various circles. In the case of the BWA auction, 11 companies participated in the auction that involved 2 blocks of 20 MHz in 2.3 GHz band and 6 companies were successful in the auctions (DoT 2011a). Bharat Sanchar Nigam Limited (BSNL) and Mahanagar Telephone Nigam Limited (MTNL), the government owned entities which had already been allotted one slot of 3G spectrum in each circle, matched the winning bids for their respective circles. The overall auction proceeds were Rs 1,06,262 crore (DoT 2011a). Almost all 3G auction winners have launched 3G services in their winning circles and are in the process of entering into roaming arrangements with other players in the remaining circles, thereby providing an all-India 3G network to their customers. However, none of the BWA auction winners have launched services as yet.

Mobile number portability (MNP) was also implemented during the year. It was introduced on a pilot basis in Haryana in November 2010 and in the entire country in January 2011. With the roll out of MNP, mobile telecom service providers will be forced to improve the quality of their service to avoid loss of subscribers. At the end of February 2011, about 38 lakh subscribers had submitted their requests to different service providers for porting their mobile numbers (TRAI 2011b).

These controversies coupled with the other pressing issues facing the sector (such as availability of spectrum, impending strategy for penetration of broadband, and security issues regarding telecom equipment procurement, messenger services, and subscriber verification) led GoI to announce a 100-day plan for the telecom sector with the objective of evolving a clear and transparent regime for the sector (DoT 2011a and 2011b). The plan will cover issues of licensing, spectrum allocation, tariffs/pricing, spectrum sharing and trading, merger and acquisitions, and introduction of new technologies. The plan will culminate in the formulation of a new telecom policy, to be known as the Telecom Policy 2011, that will replace the New Telecom Policy, 1999. It is imperative that the new policy removes all ambiguities prevalent in the sector and ensures a transparent and stable operating environment.

As part of the 100-day plan, GoI is also looking at finalizing the National Broadband Plan brought out by TRAI in December 2010 to facilitate the rapid growth of broadband. Under the plan, the minimum broadband speed will be raised from the current 256 kbps to 512 kbps from 2011 and further to 2 mbps by January 2015. The plan further targets 160 million broadband connections by 2014. To achieve these targets, a national broadband network has been proposed, which will be an open access optic fibre network connecting all habitations with a population of 500 and above.

Transport

Roads

In June 2009 the National Highway Authority of India (NHAI) drew up a mammoth plan of building 20 km of roads a day. However, it was only in June 2010 that it geared itself towards achieving this target after taking steps to improve the policy and regulatory framework for the sector in line with the recommendations of the BK Chaturvedi Committee. However, a review of the developments during 2010–11 indicates that after the initial momentum, there has been a significant slowdown in the execution of this plan.

A total of 5,083 km of new roads were awarded during the year (MORTH 2011a), amounting to about 14 km of award activity a day. While this was significantly higher than what it had been in the past few years (see Figure 27.3), it fell short of the target of 9,000 km of award set for the year. However, the completion of roads has been only about 4 km a day, much lower than the target. The main reasons for this are NHAI's failure to come up with projects of considerable size and attractiveness to the private sector, irregularities in specific appointments at NHAI and consequent enquiries about them, controversies relating to the project award, change of guard at the political level, and the absence of a full time chairman for NHAI for a substantial part of the year.

The progress of the work on the National Highway Development Programme (NHDP) also depicts a discomforting picture (see Figure 27.4). Over 50 per cent of the total road length under this programme is yet to be awarded for development. To expedite NHDP's progress it is necessary that the process of restructuring NHAI is completed urgently, thereby addressing its inadequate implementation capacity; projects be structured strictly in accordance with specifications formulated to meet the traffic demand and; the time period for pre-construction activity be reduced (Planning Commission 2010a). For NHDP's Phase-VI

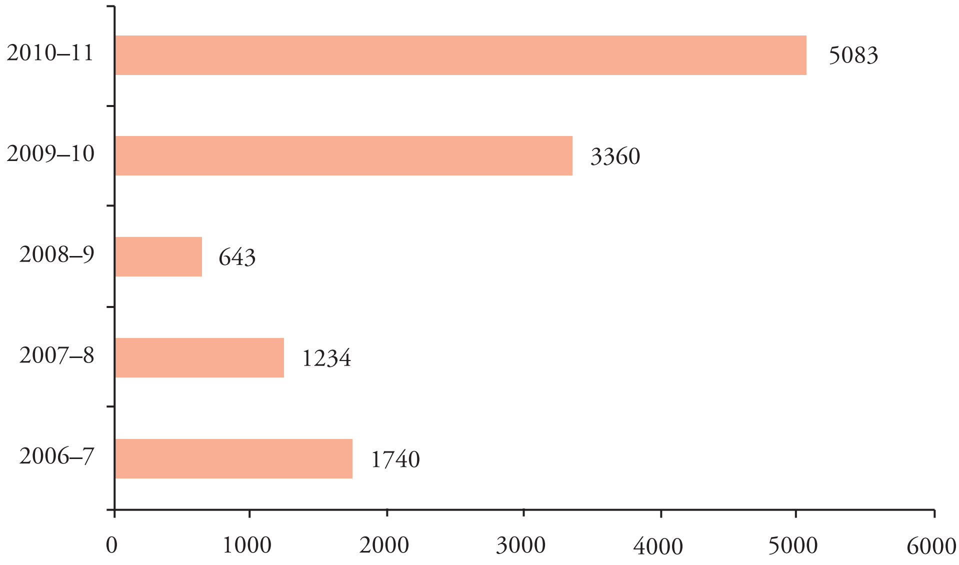

FIGURE 27.3 New Road Length Awarded for National Highways (in km)

Source: MORTH (2011a).

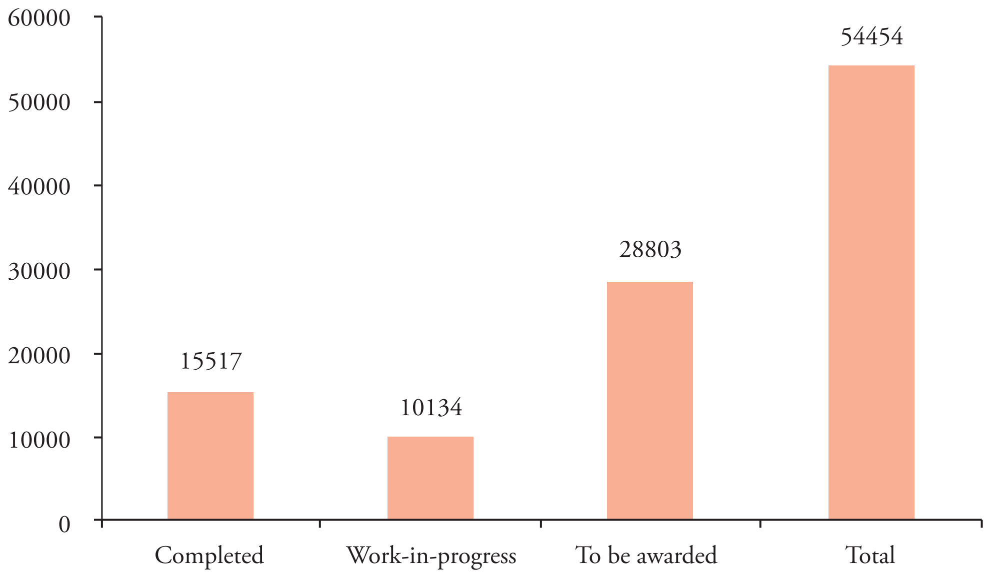

FIGURE 27.4 Status of National Highway Development Programme as on 31 March 2011 (in km)

Source: MORTH (2011b).

which envisages the development of 1,000 km of fully access controlled expressways under the public-private partnership (PPP) model following the design-build-finance-operate (DBFO) approach, GoI is working towards establishing an Expressway Authority of India (EAI). It has started consultations with stakeholders for identifying and resolving issues before the framework for EAI is given a concrete shape (Planning Commission 2010a).

NHAI has also started looking at ways and means to increase private sector interest in projects. It has proposed a yearly qualification of project developers as opposed to the current approach of project by project qualifications. This, if implemented, will reduce the time taken for bidding out projects by six months, besides eliminating the submission of the same documents in each bid process.

An area of concern in this sector has been increasing government support for national highway (NH) projects. Almost 90 per cent of these projects are being undertaken through the PPP mode along the build-operate-transfer (BOT)-toll basis or the BOT annuity basis. The Planning Commission (2010b) cited three important issues in this regard.

The first issue is that of excessive financial commitments made by a government entity against a future budget. It pointed out that in case of BOT-toll projects, NHAI has already committed VGF liability in excess of Rs 11,400 crore. Much of this VGF liability was added in a period of just seven months between November 2009 and May 2010. As against the total VGF liability of Rs 5,254 crore up to 31 October 2009, VGF liability of Rs 6,157 crore was added during the said period for just 23 projects. It has further estimated that given the number of projects in different stages of bidding, the additional VGF requirement is likely to be of the order of Rs 13,600 crore, taking the total VGF commitment to about Rs 25,000 crore. However, this liability is far in excess of the budgetary/plan allocations of the present and future years.

Similarly, in case of annuity projects, NHAI has a committed annuity liability of Rs 4,828 crore per annum for projects that have already been awarded. Additionally, projects with a likely outgo of Rs 1,450 crore per annum are under bidding and projects with a potential liability of Rs 3,200 crore per annum are in the pipeline. This implies a total annuity outflow of Rs 9,500 crore per annum as against the current cess revenues of Rs 7,800 crore per annum. Even with a rise in cess revenues, NHAI would have no resources for future development.

The second issue is the high level of funding sought by the private sector by way of VGF or annuity. In case of BOT-toll projects, the Planning Commission has highlighted that not only were a large number of bids approved in the recent past far in excess of VGF estimates approved by the Cabinet Committee on Infrastructure (CCI), but the revised VGF is close to the ceiling fixed for its provision. A detailed analysis of project-wise bids for 20 four-lane NH projects indicates that the average level of VGF approved for these projects was 38.4 per cent as against the maximum permissible VGF of 40 per cent for these projects. The excess VGF approved by NHAI over that approved by the CCI in case of these projects was Rs 3,700 crore. A related issue here is the excessive grant element involved in these projects. The Planning Commission has argued that the effective grant to the private sector in the form of VGF is much higher than the ceiling limits. Illustrating the argument with a project involving a total cost of Rs 1,000 crore (Rs 800 crore of construction cost including a 15 per cent profit element and Rs 200 crore as financing costs), it has highlighted that VGF of 40 per cent would imply that a private player gets Rs 400 crore from NHAI to fund construction costs (excluding the profit element) of Rs 700 crore. This implies an effective grant of 57 per cent of construction costs.

There is a similar concern with respect to annuity projects since the bids received for these projects require annuities which seem to be very high. An analysis of 10 projects awarded on this basis indicates that the total annuity payment per annum for these projects taken together accounted for 24 per cent of the total project costs. As far as individual bids are concerned, annuity as a per cent of total project costs ranged between 19–28 per cent.

The third and final aspect is the extraordinary returns reaped by the private sector. Annuity payments for the 10 projects mentioned earlier were based on the assumption of a 3-year construction period. However, the actual experience suggests that such projects get completed in two years, indicating that the private concessionaire receives an extra 20–25 per cent of the total project costs. As a result, the concessionaire may be able to recover its investment in about five years from the completion of the project. The inflows over the next 10–12 years are its surplus.

Ports

The performance of the ports sector in adding new capacity continues to be unimpressive (see Figure 27.5). Only 25 million tonnes of capacity was added during the year as against 45 million tonnes during 2009–10. In terms of new projects, only 8 projects worth Rs 3,250 crore had been awarded at major ports until mid-March 2011 as against the annual target of

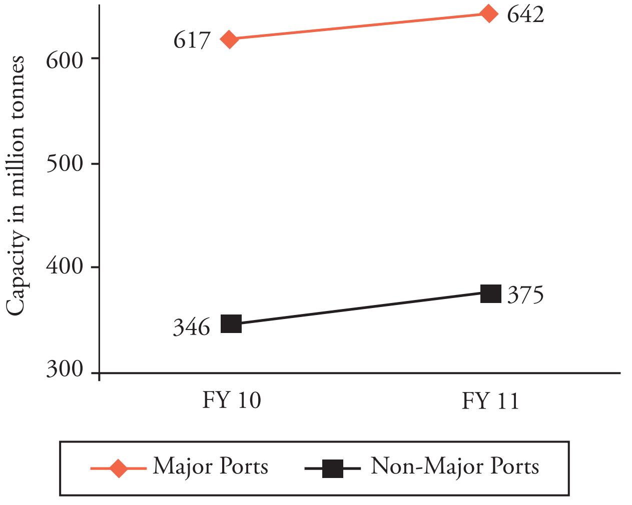

Figure 27.5 Capacity Increase at Indian Ports

Source: Indian Ports Association (2011).

awarding 21 projects worth Rs 13,890 crore. The Planning Commission (2010b) has estimated that during the Eleventh FYP, major ports would add 790–840 MT of capacity as against the target of 1,016.55 MT.

Besides the slow pace of adding capacity, ports in India continue to be plagued by inefficiencies due to large dwell time, slow pace in maintenance and capital dredging, and poor port connectivity (Planning Commission 2010b). A glaring lacuna in the sector is the absence of a comprehensive policy for its development. Although a maritime policy for the country was attempted in 2004, it was not finalized (Ministry of Shipping 2011). Consequently, the development of the sector has progressed on a needs basis. Over the years, different state governments have come up with their own policies for developing ports targeting their own priorities. Information on the progress of development or capacity of these state ports, known as minor ports, is inadequate (Planning Commission 2010a). Another area of concern is the lack of facilities at these ports even though they are leading the growth in the sector. The share of non-major ports (which are almost all private) in the traffic handled increased significantly from 26 per cent in FY 2004–5 to 32 per cent in FY 2009–10 (see Figure 27.6). However, only a few of the 176 minor ports are well developed and provide all-weather berthing facilities for cargo handling. In fact, many of these ports have not handled cargo traffic (Ministry of Shipping 2011).

Consequently, GoI has proposed a maritime agenda for 2010–20. Besides projecting traffic and estimating

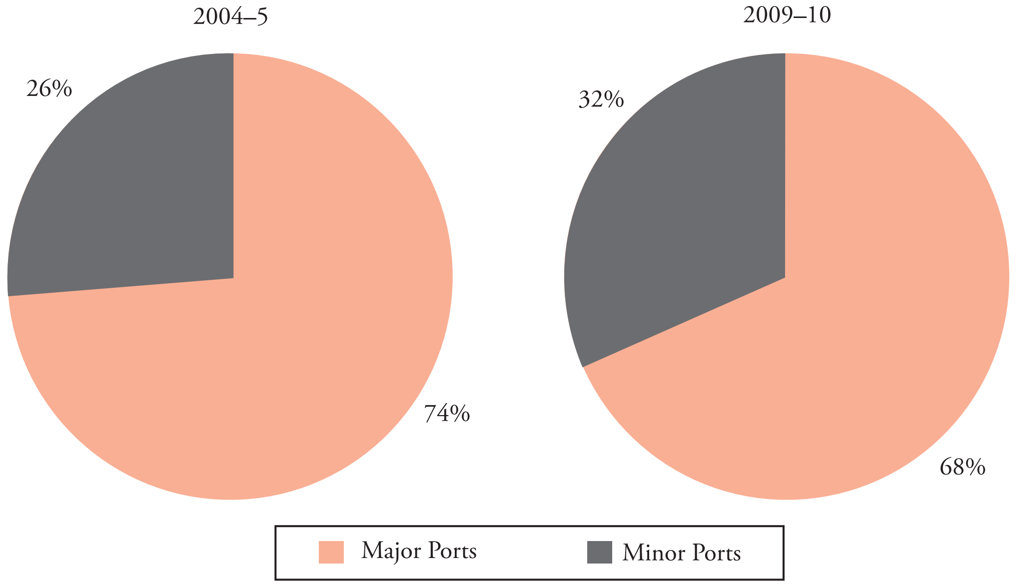

Figure 27.6 Share of Minor Ports in Traffic Handling in India

Source: Calculated by author based on data from Planning Commission and Gujarat Maritime Board, Government of Gujarat.

the capacity of ports (see Table 27.3), the agenda has identified GoI's future priorities for the sector. These include total realization of the concept of landlord ports[1] for major ports; leveraging land for optimizing the throughput and revenue of ports; corporatization of the remaining 12 of the 13 major ports; the creation of an empowered port regulator with judicial powers to issue regulations and policy guidelines, and take actions in instances of anti-competitive practices, inadequate competition, or environmentally detrimental practices; improved dredging; improved rail-road connectivity for minor ports; creation of a maritime finance corporation with equity of ports and financial institutions to fund port projects and; amending the existing legislative frameworks at the central as well as state government levels.

However, many of the priorities listed in this agenda are not new. For instance, the corporatization of major ports was mooted a few years ago. But little progress has been made on this front. Similarly, the landlord port model has been at the heart of private sector participation in the sector. But the major ports have shown no progress towards full implementation of this model. The replacement of the existing port regulator, the Tariff Authority for Major Ports (TAMP), with a Major Port Regulatory Authority (MPRA) was mooted through a bill in 2009. TAMP has no powers to enforce its own tariff rulings or penalize violation of the terms and conditions governing tariffs. MPRA would overcome all the shortcomings of TAMP and have the regulatory powers to specify and monitor performance standards for services to be provided by the port authorities and private operators and levy penalty on terminal operators. However, the bill continues to be under discussion with stakeholders in the sector.

The agenda, therefore, has little to offer in terms of carefully crafted measures for the development of the sector. Further, it does not suggest any stringent timelines for any of the priorities listed therein. In the absence of such timelines, it is unlikely that this agenda would yield much in terms of outcomes. Another factor that stands out in the agenda is the intention to empower the regulator with powers related to competition issues. Given the existence of the Competition Commission,[2] monitoring of competitive practices and resulting actions by a port regulator would only lead to the creation of multiple authorities with powers over the same issue and add to regulatory uncertainty.

Nevertheless, GoI has taken some concrete steps to improve dredging and other such capital intensive activities at ports. It is considering involving the private sector in these activities backed by a viability gap funding to improve the commercial viability of the activities. The Union Budget for 2011–12 has proposed Rs 5,000 crore of tax-free bonds for the Ministry of Shipping. The proceeds of these bonds would be utilized for

Table 27.3 Traffic Projection, Capacity Estimation, and Proposed Investments for Ports in India

	2011–12			*2016–17*			*2019–20*		
	Traffic (in million tonnes)	*Capacity (in million tonnes)*	*Investment (in million tonnes)*	*Traffic (in million tonnes)*	*Capacity (in million tonnes)*	*Investment (in million tonnes)*	*Traffic (in million tonnes)*	*Capacity (in million tonnes)*	*Investment (in million tonnes) (Rs crore)*
Major Ports	629.64	741.36	30,603.83	1,031.5	1,328.26	58,830.28	1,214.82	1,459.53	20,015.3
Non-major Ports	402.5	498.68	33,144.22	987.81	1,263.86	95,883.83	1,280.13	1,670.51	38,675.79
	1,032.14	1,240.04	63,748.05	2,019.31	2,592.12	154,714.1	2,494.95	3,130.04	58,631.09

Source: Ministry of Shipping (2011).

[1] Under the landlord port concept, the role of major ports will be limited to the maintenance of channels and basic infrastructure; the development, operations, and management of terminal and cargo handling facilities will be given to the private sector.

[2] The Competition Commission is empowered to prevent practices having an adverse effect on competition, to promote and sustain competition in markets, to protect the interests of consumers, and to ensure freedom of trade carried on by other participants in markets in India.

dredging operations and infrastructure development at major ports, and being tax-free they would enable raising funds at a low cost.

A growing debate in the sector over the years has been whether private sector participation in the ports sector could lead to private monopolies. During the year, GoI formulated a policy to prevent the creation of such monopolies. The policy stipulates that if there is only one private terminal/berth operator in a port for a specific cargo, the operator of the berth would not be allowed to bid for the new terminal/berth for handling the same cargo in the same port.

Railways

After a few years of upsurge, IR's finances have deteriorated. The growth rate in traffic and earnings achieved in the previous years were not sustained during 2008–9 to 2010–11. The average annual growth rate of freight (originating tonnage) in the first three years of the Eleventh Plan (2007–12) is estimated at 6.6 per cent as against the targeted 8.6 per cent. The low growth of freight is primarily on account of low growth in iron ore freight. Iron ore is the second largest revenue earning item for IR, the largest being coal. In fact, iron ore saw negative growth during 2010–11 due to restrictions on iron ore exports imposed by the state governments of Orissa and Karnataka and disruption of train movement in iron ore rich areas as well as in other areas.

The financial impact of the shortfall in earnings was compounded by an increase in expenditure due to the implementation of the recommendations of the Sixth Central Pay Commission (CPC)[3] in 2008–9 and 2009–10. Consequently, the operating ratio of IR declined during 2010–11 (see Figure 27.7).

The Planning Commission (2010a) estimates that rail is steadily losing freight to roads. IR planned and implemented a number of measures during the Eleventh Plan to improve its share in freight traffic. These measures include freight marketing of select commodities by third parties, liberalized wagon investment schemes, improved freight incentive policies, and creation of capacity. During 2010–11, IR revised its Railways Infrastructure for Industry Initiative (R3i) policy that aims at attracting private investments into some of the last mile rail connectivity projects with the objective of creating additional rail transport capacity and increasing rail share in freight traffic

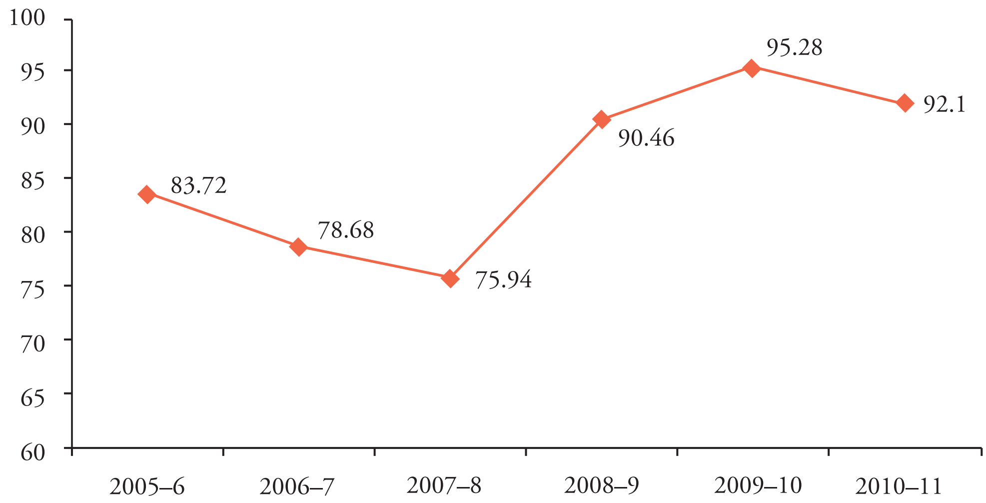

Figure 27.7 Operating Ratio of Indian Railways (in %)

Source: Ministry of Railways (2011a and 2011b).

[3] The Sixth CPC was set up to examine the principles, the date of effect thereof that should govern the structure of pay, allowances, and other facilities/benefits for central government employees and to work out a comprehensive pay package for such employees that is suitably linked to promoting efficiency, productivity, and economy through rationalization of structures, organizations, systems, and processes within the government.

(Ministry of Railways 2010). The policy provides for four models:

- Cost sharing-freight rebate model where the private sector will have to make contributions towards cost sharing in advance and will be allowed to recover this advance through a freight rebate of 10–12 per cent on incremental outward traffic. The ownership of the lines will be with the Railways.
- Full contribution-apportioned earning model where the private sector will construct and maintain the line for a period of 25 years and will receive the apportioned earnings from the line net of the operations and maintenance (O&M) costs incurred by the Railways on the line
- Special purpose vehicle (SPV) model where the Railways will form an SPV with the private sector and its share in the equity will be 26 per cent. The SPV will be given a concession to construct, operate, and maintain the line for which it will get a share in the revenue generated by the project
- Private line model where the private sector will build a private line on non-railway land acquired by it and seek connectivity to the railway network. Railways would levy a fee on the gross apportioned earnings of the line

While the applicants may choose and indicate their preferences for one of the models, the Ministry of Railways (MoR) will decide which model would be applicable. Further, only railway lines that are 20 metres or more in length (excluding the length of siding which may take off from this line) are eligible under this policy. Finally, the policy is not applicable to railway lines intending to provide connectivity to coal mines and iron ore mines directly or indirectly.

Besides R3i, IR has also come up with a policy for providing rail connectivity to coal and iron ore mines (Ministry of Railways 2011c). The policy covers only new lines of minimum 20 km length and offers two models for private sector participation—the capital cost model under which the cost of construction is fully borne by the concerned private sector or joint venture company and the SPV model where SPVs may be formed by government departments, public sector units, private players, and state governments with token participation from MoR. IR has also initiated a scheme for the development of greenfield as well as brownfield freight terminals by the private sector on private land. The scheme is expected to facilitate the rapid development of a network of freight terminals with private investment to provide efficient and cost effective logistic services to end users including door-to-door services.

Though IR has initiated several such schemes in the past few years to improve its share in freight traffic as well as for attracting private investment in rail infrastructure, it has faltered on the implementation of these schemes and private sector investments have continued to be below par in the sector. However, railway infrastructure, particularly in the passenger segment continues to be poor. IR even came up with a Vision 2020 document in 2009 which covers a wide range of issues relating to the sector as well as its priority areas. These include undertaking a complete overhaul of rail infrastructure, having more than 30,000 km of network as double/multiple lines, segregation of passenger and freight services into separate double line corridors, raising speeds of passenger trains from 130 kmph to 160–200 kmph on segregated routes and speed of freight trains from 60–70 kmph to 100 kmph, and completing four high-speed corridors covering 2,000 km to provide bullet train services at 250–350 kmph.

However, not much progress has been made in developing the ideas laid down in the Vision 2020 document or in identifying specific responses to the challenges described in this vision (Planning Commission 2010a). Unless IR backs up this vision with a long-term working plan keeping in view traffic requirements and the need for technology upgradation and modernization, it will not be able to improve efficiency and recover its market share.

The accounting reforms which were initiated by the Railways during the Tenth Five Year Plan for separating the five major segments of railway services—(i) fixed infrastructure, (ii) passenger operations, (iii) freight operations, (iv) suburban operation systems, and (v) other non-core activities have also not been concluded (Planning Commission 2010b). These reforms are critical for generating costing data on commercial lines as well as for making railway accounting in India in line with commercial accounting requirements adopted internationally for Railways. A firm timeline needs to be framed to accomplish this task.

Civil Aviation

After the slowdown in 2009, the civil aviation sector resumed growth in 2010–11. The number of passengers carried grew by 18 per cent in 2010 (over 2009) and the quantum of cargo grew by 33 per cent during the same period (DGCA 2010). Capacity utilization also improved with combined load factors for domestic and international air carriers increasing from 70 per cent in 2009 to 75 per cent in 2010 (ibid). However, development of physical infrastructure in the sector still remains inadequate to sustain the growth momentum. Progress on existing projects has been slow and has been substantially costlier than initial estimates. The latter is true for privatized airports as well as airports being developed by the Airports Authority of India (AAI). Of the 35 non-metro airports identified for modernization in June 2006, work has been completed at 20 with another 10 under progress and the remaining 5in the planning stages.

To address sectoral issues related to affordable air services to remote and underserved areas in the country, a regulatory framework for protection of consumer interests, fiscal and budgetary matters connected with the sector, and liberalization of international air services the Ministry of Civil Aviation (MoCA) has set up a Civil Aviation Economic Advisory Council (CAEAC) which comprises of experts drawn from different subsegments of the industry, economic research bodies, and consumer fora. The council will also assess infrastructure investment requirements for the sector and advise on measures to boost investment in the sector (MoCA 2010a).

MoCA has set up two working groups under CAEAC—one to prepare the regulatory framework for protecting consumer interests from the point of view of disclosure of tariffs and conditions of service by domestic airlines (MoCA 2010b) and the other to look into air cargo/express services. The former is a good measure for enhancing the welfare of consumers by enabling them to make informed choices.

While MoCA's overall initiative in setting up CAEAC is commendable, two key issues emerge. First, CAEAC lacks membership of the Airports Economic Regulatory Authority (AERA). Given that AERA is the economic regulator for the sector and learning from the experiences of sectors, such as power where the Central Electricity Regulatory Commission has made significant and commendable contributions towards developing the policy and regulatory framework for the sector, it would be worthwhile to have representation from AERA on CAEAC. Second, the initiative still does not address the forming of a comprehensive civil aviation policy. Other areas, such as development of maintenance, repair and overhaul (MRO) facilities; allowing regional airlines through a more liberal policy, provision of better infrastructure facilities, and simplified rules governing entry and; promoting tourism and trade also need to be looked into (Planning Commission 2010a).

Power

The power sector witnessed the highest capacity addition ever achieved in a single year (12,161 MW) taking the total power generation capacity of the country to 173,626 MW (Central Electricity Authority 2011). Though impressive, this capacity addition was only 57 per cent of the target capacity addition (ibid). Another factor that tempered the enthusiasm of the capacity addition achieved was the continuing trend of deteriorating viability of distribution utilities. Financial losses of the distribution business have been estimated to touch Rs 68,000 crore in the year 2010–11(Thirteenth Finance Commission 2009). Inadequacy of tariffs to cover costs (see Table 27.4), poor information base of utilities related to costs and efficiency levels, poor governance by state governments by not allowing utilities to seek tariff revisions, and a slowdown in the momentum of Aggregate Technical and Commercial (AT&C) loss reduction are the main reasons behind the rising financial losses. Utilities are now resorting to load shedding to avoid the financial burden of extra power purchase costs. There is also evidence of defaults by some utilities for such payments.[4] The cash flows of these utilities being under stress, doubts are looming about their ability to pay for power from the new capacity being commissioned.

Capacity addition in the sector is also under stress from two other factors—environmental considerations and availability of coal. The slow progress on environ-

[4] The Madhya Pradesh Electricity Regulatory Commission in the tariff order issued for distribution utilities in the state for 2009–10 has observed that the losses incurred by utilities have forced them to default against payments due from them.

Table 27.4 Status of Tariff Revision in States/Union Territories at the end of 2009

Tariffs last revised	*No. of States/UTs*	*States/UTs*
1 year	13	Andhra Pradesh, Assam, Chhattisgarh, Gujarat, Himachal Pradesh, Karnataka, Madhya Pradesh, Orissa, Punjab, West Bengal, Arunachal Pradesh, Sikkim, Delhi
1–2 years	6	Bihar, J&K, Maharashtra*, Meghalaya, Uttar Pradesh, Uttarakhand
2–3 years	2	Kerala, Tripura
3–5 years	5	Rajasthan, Jharkhand, Mizoram, Nagaland, Chandigarh
> 5 years	5	Haryana, Tamil Nadu, Goa, Manipur, Puducherry

Source: Ministry of Finance (2011a); Author's calculations.
Note: * for MSEDCL; states such as Haryana and Tamil Nadu have undertaken tariff revisions during 2009–10 or 2010–11. However, given the huge revenue deficits to be covered through tariff hikes and the consequent tariff shock to be faced by consumers, some ERCs have had to resort to creating regulatory assets. Examples include Haryana and Tamil Nadu.

mental and forest clearances (EFCs) has affected the development of hydropower. In some cases, work was stopped even on projects that were previously awarded such clearances because of the need for a cumulative environmental impact assessment of all projects in a river basin, their comprehensive bio-diversity impact, as well as their comprehensive downstream impact. EFCs have also been a contentious issue facing new coal based power projects. In fact, the two new Ultra Mega Power projects (UMPPs) announced by the Ministry of Power in Orissa and Chhattisgarh have been held up due to issues related to environmental clearances regarding the coal blocks for these projects and the dates for submission of qualification bids by developers have been extended. In the case of the Orissa UMPP, the date was extended from July 2010 to March 2011 and in the case of the Chhattisgarh UMPP, the date was extended from May 2010 to June 2011.

In the case of coal, delays in EFCs are expected to add to the growing shortage of domestic coal. The Ministry of Environment and Forests has declared more than 45 per cent of the coal mining areas as 'No-Go-Areas', which means that coal mining cannot be done in the coal reserves in these areas. The Planning Commission (2010a) has estimated that the gap between demand for coal and supply of domestic coal is likely to widen further to 200 MT in the Twelfth Five Year Plan. Even then, the standing linkage committee has not met for a long time and there have been no allocation of mines by the Ministry of Coal in the past one and half years.

EFCs for both hydro and coal based projects has been constrained by deleterious environmental and social impacts. At the same time, the reality is that the hydropower potential that remains to be tapped lies in ecologically sensitive areas and the coal needed by planned/proposed power projects lies in areas that are both environmentally and socially sensitive. However, given that coal production by Coal India Limited has stagnated over the last two years, unless issues related to No-Go-Areas, coal mine allocation, and EFCs for hydro projects are addressed, future capacity addition is likely to be severely derailed.

The Planning Commission (2010a) has suggested that in view of the constraints on expanding supply of domestic coal, the present nationalization of the coal sector needs to be reconsidered in order to open up new coal mines for private sector exploitation beyond the captive use that is currently allowed. The Planning Commission has further opined that since private sector exploitation of petroleum resources, which are much scarcer, is freely allowed, there is every reason for private sector coal development to be favourably considered.

The one positive development during the year was the consolidation of the efforts being made towards energy efficiency with the launch of the National Mission for Enhanced Energy Efficiency (NMEEE). NMEEE, which is one of the eight missions under the National Action Plan on Climate Change (NAPCC), aims to devise efficient and cost effective strategies through demand side management initiatives and promotion of energy efficient processes, products, and services. Proposed to be implemented over five years, it aims to avoid capacity addition of 19,598 MW and reduce total CO_2 emissions to the extent of 98 million tonnes (amounting to 13.6 per cent of the emissions from the electricity sector in 2007). To operationalize NMEEE, GoI has set up the Energy Efficiency Services Ltd. (EESL) as a joint venture with equity participation by four Central Public Sector Units (CPSUs)—Rural Electrification Corporation, Power Finance Corporation, Power Grid Corporation of India Ltd., and NTPC Ltd.

One of main initiatives under NMEEE is the perform, achieve, and trade (PAT) scheme that aims at improving energy efficiency in nine industrial sectors of aluminium, cement, chlor-alkali, fertilizer, iron and steel, pulp and paper, railways, textiles, and thermal power plants. Under the scheme, units in these sectors will be given individual energy efficiency improvement targets; implying that each unit will be required to reduce its specific energy consumption (SEC) by a fixed percentage, based on its current SEC (or baseline SEC). Any additional certified energy savings would take the form of Energy Savings Certificates (ESCerts) and can be traded with other units who could use these certificates to comply with their SEC reduction targets. ESCerts will be traded on special trading platforms to be created in the two power exchanges in the country. The first cycle of the PAT scheme will be operational between April 2011 to March 2014 during which all the sectors except Railways have been included. Railways have been excluded in this phase because the sectoral energy scenario and energy usage pattern in this sector are still under study.

The other components of NMEEE include an Energy Efficiency Financing Platform involving the creation of mechanisms that would help finance demand side management programmes by capturing future energy savings, market transformation measures to accelerate the shift to energy efficient appliances, and a framework for energy efficient economic development which will involve developing fiscal instruments to promote energy efficiency.

On the renewable energy front, GoI has awarded the setting up of grid connected solar power projects of 700 MW capacity under the first phase of the National Solar Mission (NSM). The projects in the first phase (up to March 2013) are being awarded in batches. In the first batch, 620 MW capacity (470 MW of solar thermal and 150 MW of PV) was taken up. Besides this, 84 MW (54 MW PV and 30 MW thermal) of projects have migrated to NSM from earlier schemes. NSM was launched in January 2010 with a target of 20,000 MW grid solar power in three phases by March 2022. However, several concerns have been raised about the viability of bids against which projects have been awarded. The bids involve heavy discounts on tariffs determined by the Central Electricity Regulatory Commission by many new and inexperienced players. There are apprehensions that these discounts will ultimately result in unviable tariffs, the use of cheap and unreliable technology and equipment, and lead to difficulties in financial closures of concerned projects.

GoI also issued guidelines for off-grid and decentralized solar application with the objective of promoting off-grid applications of solar energy for meeting the targets set in the Jawaharlal Nehru National Solar Mission for Phase-I. The scheme covers off-grid solar photo voltaic systems/applications up to a maximum capacity of 100 kW per site; off-grid and decentralized solar thermal applications, to meet/supplement lighting, electricity/power, heating, and cooling energy requirements and; mini-grids for rural electrification, applications up to a maximum capacity of 250 kW per site (Ministry of New and Renewable Energy 2010). Finally, the year also saw the launch of Renewable Energy Certificates (RECs). RECs are a market based instrument which enable entities mandated to purchase the mandated minimum level of renewable energy.

Urban Infrastructure

A noteworthy development in this sector during 2010–11 was the approval of the National Mission on Sustainable Habitat, one of the eight missions under the National Action Plan on Climate Change. The mission seeks to promote sustainability of habitats through improvements in energy efficiency in buildings, urban planning, improved management of solid and liquid waste, and modal shift towards public transport and conservation. It also seeks to improve the ability of habitats to adapt to climate change by improving the resilience of infrastructure, community based disaster management, and measures for improving advance warning systems for extreme weather events (Ministry of Urban Development 2010b). The mission is to be implemented through appropriate changes in the legal and regulatory framework, such as building bye-laws, development control, and regulation; mainstreaming of climate change and sustainable development concerns in urban planning and; promotion of modal shift in public transport through comprehensive mobility plans.

The scale of investment required for urban infrastructure development is huge. During the year, the High Powered Expert Committee (HPEC) for urban infrastructure services estimated the total investment requirements for urban infrastructure, renewal, and redevelopment (including slums) at Rs 39 lakh crore (at 2009–10 prices) during 2012–31. The largest share of this investment is required for urban roads (about 44 per cent). Water supply, sewerage, solid waste management, and storm water drains account for about 20 per cent of the estimated investment requirements. It has further projected a requirement of nearly Rs19 lakh crore for O&M. Even the largest centre driven urban infrastructure programme, JNNURM, has not been able to contribute much towards meeting the investment requirements.

During the year, the Ministry of Urban Development initiated discussions on the New JNNURM. The New JNNURM proposes to implement the 74th Constitutional Amendment; improve the level of urban services delivery, including the provision of basic level of services to the urban poor; implement modern and transparent budgeting, accounting, and financial management systems for all urban service and governance functions and; establish financially self-sustaining agencies for urban governance and service delivery through reforms of major revenue instruments (Ministry of Urban Development 2010b).

Besides the same outcomes, the measures proposed to be adopted in the New JNNURM are already largely part of the concluded JNNURM process. For instance, it will focus on the introduction of operational, financial, and institutional reforms at the state and urban local body (ULB) level besides improved resource management. It will also provide for greater autonomy for service providers to judiciously upgrade, rehabilitate, and expand distribution systems and treatment capacity as required. In case of areas, such as solid waste management, the New JNNURM talks of concepts of regional solid waste management solutions and proper waste characterization to determine appropriate treatment processes.

A few changes that have been proposed under New JNNURM also do not inspire confidence in achieving outcomes. Under the changes proposed, cities will be allowed to select reforms from a menu of options through a bottoms-up approach while keeping reforms like property tax, accounting reforms, e-governance, user charges, and internal earmarking of funds for the poor as mandatory measures. States and ULBs will be incentivized according to the set of reforms chosen by them. Some reform measures, such as introduction of a property title certification system in ULBs, simplification of the legal and procedural framework for conversion of agricultural land for non-agricultural purposes, and transfer of some of the functions under the 74th Constitutional Amendment may be relooked at. Nevertheless, the point remains that improved delivery of urban services should not be contingent on the long list of reforms proposed under JNNURM particularly when these reforms will take a long time to be completed.

The manifold increase in funding will clearly not be possible through support from existing resources. Therefore, there is an urgent need to galvanize action towards greater resource mobilization at the city and state levels. Consequently, the New JNNURM proposes to explore options like impact fee, transferable development rights, FSI, and municipal bonds besides greater reliance on PPPs. Once again, these concepts of revenue generation are not new. What is needed is greater focus on making these concepts work by examining past experiences with implementation and incorporating lessons for future implementation.

The Thirteenth Finance Commission which submitted its report during the year also expressed concerns over the financial health of ULBs. It has recommended switching over to a system for devolution of grants on a structured basis rather than on an ad hoc basis, with a part of the grant being linked to a performance component. This component will be linked to the completion of nine conditions, including an audit system for all local bodies, independent local body ombudsmen, electronic transfer of local body grants within five days of receipt from the central government, prescription of the qualifications of persons eligible for appointment as members of SFC, enabling ULBs to levy property tax, establishing a property tax board, and disclosure of service standards proposed to be achieved by each ULB with respect to the water and sanitation sector. It has recommended that the states will need to comply with these conditions by 31 March 2011 to be eligible for the performance grant during 2011–12.

Financing Infrastructure

The participation of the private sector in financing infrastructure in most sectors has been lower than envisaged so far. The slow process of awarding projects, long gestation periods, and the capital intensive nature of infrastructure projects are some of the reasons. Banks, which are the largest providers of debt finance to the sector are facing asset-liability maturity mismatch (ALM) problems due to longer duration loans required by infrastructure projects as against their shorter duration borrowings. Further, growth in bank lending to infrastructure has been primarily coming from public sector banks (PSBs). These banks have their limitations in raising fresh equity capital for growth as they need to maintain a minimum of 51 per cent government stake to retain the PSB status. So unless government infuses equity capital, PSBs cannot dilute much equity as many banks are close to the mandated 51 per cent. This curtails their growth and restricts incremental advances to be capitalized out of retained earnings.

GoI has therefore taken steps to enhance the availability of funds for the sector. In February 2010, the Reserve Bank of India (RBI) created a new category of NBFCs called Infrastructure Finance Companies (IFCs). To qualify as an IFC, an entity must have over 75 per cent of its total assets in the form of infrastructure loans, a net worth in excess of Rs 3 billion, a minimum credit rating of A and a capital adequacy of over 15 per cent (Tier-I over 10 per cent) (IDFC 2010). IFCs are allowed higher exposure norms for infrastructure than other categories of NBFCs and risk weights on their bank borrowing have been lowered from a flat 100 per cent in accordance with corporate bond ratings of 20 per cent for AAA. They can also borrow through external commercial borrowings (ECBs) under the approval route up to 50 per cent of the net owned funds.

In addition, GoI allowed an additional deduction of Rs 20,000 from personal income tax, over and above the existing Rs 1 lakh for investments in central government notified infrastructure bonds with the objective of channelizing domestic savings towards infrastructure. Besides this, GoI has initiated other measures, such as the take out financing scheme and the setting up of an infrastructure debt fund. It has also infused about Rs 20,000 crore into PSBs so that they can meet their Tier-I capital subscription as well as fund their expansion plans (Ministry of Finance 2011b). It has also allowed government entities to raise funds through tax-free bonds up to Rs 30,000 crore.[5]

As part of the Union Budget 2011–12, GoI has taken measures to increase investments in the sector from foreign institutions. First, it reduced the withholding tax rate on income to FIIs from infrastructure debt funds (reduced from 20 to 5 per cent). This could potentially bring in large amounts of long-term funds at a low cost on account of better returns due to a low withholding tax rate. Second, it increased the FII investment limit (from $5 billion to $25 billion) for investments in corporate bonds of infrastructure companies with a residual maturity of over five years. FIIs can invest in unlisted bonds, even at the SPV level, and can trade among themselves during the lock-in period of three years. While this move is positive, its impact will not be significant in the short term due to limited FII appetite currently on account of low liquidity in corporate bond markets, inherent credit risk (absence of credit enhancement agencies), and a high withholding tax rate.

Conclusion

It is projected that the Twelfth Five Year Plan will see investments in the infrastructure sector double from the level targeted during the Eleventh Five Year Plan to Rs 40,99,240 crore. It will also increase infrastructure investment from 7.75 per cent of GDP during the Eleventh Five Year Plan to 9.95 per cent of GDP. It is unlikely that investments of this order will materialize in the absence of robust plans that are backed by stringent monitoring. The Planning Commission had started an exercise of monitoring physical progress in infrastructure development on a quarterly basis against

[5] Indian Railway Finance Corporation (IRFC): Rs 10,000 crore, National Highways Authority of India (NHAI): Rs 10,000 crore, Housing Urban Development Corporation: Rs 5,000 crore, and Ports: Rs 5,000 crore.

the targets laid down for the different sectors. A review of the monitoring reports available on the Planning Commission's website shows that information on progress is available only for the first quarter of FY 2010–11. It is imperative that progress on infrastructure development be regularly monitored and regular assessments of action on the solutions recommended by the ministries themselves as well as of the Planning Commission (2010a) be taken. In the absence of such stringent monitoring and fixing of accountability for shortfalls, it is unlikely that the infrastructure needs of the country will be met any time soon.

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Cover visual: Age Fotostock/Dinodia Photo

ISBN 0-19-807885-4
9 780198 078852
Rs 695

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