

**KJA RECOMMENDATION**



# **Karnataka State Water Policy 2019**

**PREPARED BY KJA TASK GROUP**



**Karnataka Jnana Aayoga  
(Karnataka Knowledge Commission)  
Government of Karnataka**



**June 2019**





# **Karnataka State Water Policy 2019**

**(RECOMMENDATION SUBMITTED BY KJA)**

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**Karnataka Jnana Aayoga (Karnataka  
Knowledge Commission)  
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Room No. 432, 433, 438 and 439,  
4<sup>th</sup> Floor, Vikasa Soudha  
Dr. B. R. Ambedkar Veedhi  
Bengaluru – 560 001  
admnkcc@gmail.com  
[www.karnataka.gov.in/jnanaayoga](http://www.karnataka.gov.in/jnanaayoga)

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# ಕರ್ನಾಟಕ ಜ್ಞಾನ ಆಯೋಗ

(ಕರ್ನಾಟಕ ನಾಲೆಡ್ಜ್ ಕಮಿಷನ್)

## KARNATAKA JNANA AAYOGA

(Karnataka Knowledge Commission)



Karnataka Jnana Aayoga

### MESSAGE

Water is fundamental to life, livelihood, food security and sustainable development - but over years scarcity of water is becoming a major concern in the state and in the country. Karnataka has abundance of rainfall in average - almost 1200 mm per year and which results in almost 230 bcm of water for the state from rain; added to this availability is the 15 bcm of groundwater potential that is available. As against this scenario of availability, the total demand for water usage in the state works out best to about 100-120 bcm per year for all purposes - agriculture taking up almost 80-85% of the total demand while drinking water needs of state are just 5-6% of total demand. While at an average level it looks that the state has adequate water availability against demand - it is the temporal variations over the 12 months of availability that is the serious problem. The total rainfall in the state is limited within 3 to 4 months - nowadays just few weeks time and thus the major part of the total water availability is just in very small "window of time". Further, the geographic variation in rainfall is also drastic - some areas get very scanty rainfall - thus making water availability variations not just over the 12 months but also over geography of the state. Groundwater withdrawal also varies over time in different geographic areas - all of these compound to extreme variability of water availability over time vs different regions - even though the state average looks quite good. As against this, water demand is more uniform across the 12 months and across the regions of the state - though minor variations do exist. Thus, water for the state is multi-dimensional problem - of volumes vs time vs geographic region vs groundwater withdrawal vs storage capacities for the year vs groundwater recharge - all of these define the magnitude of the water problem or non-problem.

KJA has deliberated the issues related to state's water and concluded that a pragmatic policy for water is called for - a policy that addresses scientifically the multi-dimensional nature of water availability vs water demand and to consider best methods of conserving, utilizing and re-cycling water usage in the state. I am happy that the KJA Recommendation on Karnataka State Water Policy is addressing some of the critical aspect of water and its utilization. The policy has been arrived at, over more than a year of discussions, and ultimately proposes a paradigm shift in the way water needs to be managed - moving away from current 'supply side' to 'demand side' management and of integrated management of surface, ground and waste water in a scientific and real-time water balance estimation at high granularity.

We need to seriously address some key and critical points related to water - how to reduce agricultural usage of water by adopting less water-intensive agriculture and making farming more locally sustainable; making our irrigation systems efficient and demand-driven; maximizing conserving and storing water in surface bodies and underground aquifers; recycling waste-water - especially in urban areas and promoting secondary water utilization; optimizing ground water exploitations by technological and legal means; creating highly-granular water data management systems across the state; creating large-scale awareness of water policy and many other localized aspects of water. At same time, health of people is related to water quality and thus all efforts are required to measure and maintain water quality and address pollution of surface and ground water.

In the overall context of the state, Bengaluru is a massive "outlier" as far as water is concerned - both from availability point of view and also from high demand point of view. Other cities - Mysuru, Hubli-Dharwad, Belgavi etc could also slowly move to water stressed scenario - more so because of rapid urban growth. A good strategy and action plan is required for Bengaluru and other urban areas -



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through technological, economic and social aspects. After all these urban areas do contribute significantly to the economic and social development of the state and have a cascading effect on overall development. Industries also require water - but they have the capacity to utilize water at costs included in production. However, pollution is something that industries need to address and also look at high-level of water rec-cycling. The need for a legal framework for groundwater and regulatory and service-guarantee mechanisms for water is also called for - this needs to be considered.

The KJA Recommendation on Karnataka State Water Policy (KSWP) proposes a paradigm shift and necessitates structural reforms in the current water governance system. The state has to shift towards an integrated, knowledge based, transparent and participatory governance framework to ensure future water security. The Policy proposes an innovative mechanism for scientific collection of data on water availability, water usage, sectoral demand - recommending establishing an advanced, state-of-art real-time, highly granular, decision-support system - Karnataka Water Information Network and Decision-Support System (K-WINDS) which is a GIS based water data platform based on automated data analytics and Artificial Intelligence principles - providing real-time water status in different parameters at local level. The KSWP has also recommended a State Water Governing Council, headed by Chief Minister to address the inter-ministerial policy, strategy and action related to water, including various departments.

I would like to commend and thank Prof. Mihir Shah, for leading the KJA Task Group on Karnataka State Water Policy (KJA TG-KSWP) and Sri. S.V. Ranganath for his overarching guidance and steering the policy report preparation. I thank each Member of the TG, in particular Dr. Sharachchandra Lele, for their immense contribution and participation in the TG deliberations. Special thanks are due to Dr. Mukund Rao, Member Secretary of the KJA, supported by the KJA Secretariat, for steering and driving the TG and also for his contributions for K-WINDS concept. All the SG Members of the TG, various experts and stakeholders who were engaged by the TG need to be acknowledged for their invaluable contribution.

In preparing the KSWP, KJA obtained valuable inputs and suggestions from Sri. T.M. Vijaya Bhaskar, Chief Secretary, GoK; Ms Vandita Sharma, Development Commissioner and Shri RK Singh, ACS of Water Resources Department, alongwith many excellent officers of the WRD and GOK - on behalf of KJA I would like to thank each of them.

On behalf of KJA, I am happy to submit the KSWP to Government of Karnataka and hope that it will be considered for implementation in an appropriate manner.

(K. Kasturirangan)

Chairman, KJA

August 26, 2019



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## KARNATAKA JNANA AAYOGA

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### FOREWORD

Civilizations have thrived and perished due to water - water has the capacity to become a sub-critical resource leading to a great crisis in society. This crisis can threaten the basic access to drinking water of our citizens; it can also put the livelihoods of millions - in farming, in industries etc at risk. On the other hand, the vagaries of climate, resulting from global climate change, poses newer challenges rapidly with changing rates and profiles of precipitation, evapo-transpiration patterns and temporal deficiency/excess patterns that are impacting the hydrologic cycle in a major way, which in turn leads to vagaries of droughts, local floods, extreme snow-fall, inundations, water pollution and many other water-related disasters. Resilience of our total ecosystems needs, therefore, to become a central plank of integrated and "holistic" management for water resources. Large areas in agriculture depend on surface or groundwater for irrigation. While the relative contribution of canal irrigation has been un-controlled and un-regulated, use of groundwater, especially which is extracted through tube-wells, for agriculture has rapidly grown in significance over the past many years. Potable water demand is determined by population and life-styles but demand is concentrating exponentially in few urban areas to un-sustainable levels. Governance requires water to be provided to every citizen for domestic consumption and also to every patch of land for agriculture, industries or other activities. Thus, water need is almost in every part of the state all round the year BUT we must also have a mechanism to "measure" water availability - from rain, groundwater etc in every part of the state and all round the year. A highly-granular and real-time water balance systems is called for.

Karnataka is endowed with abundant rainfall – ~1248 mm of annual rainfall but there is a large variation in the rainfall with almost 4000 mm in coastal districts to as low as 500mm in the drought prone districts of Bijapur, Raichur, Bellary etc. The state has 7 major river systems which yields annually about 35 bmc of water. The state has prepared master plans for surface water utilisation under major, medium and minor irrigation projects. Groundwater availability of the state has been tapped upto almost 70%. There is rampant growth in number of bore-wells that tap groundwater; Karnataka has also taken good steps in rainwater harvesting and watershed conservation. But the state is afflicted with extreme disparity in water availability and water demand at certain times - it becomes so critical that citizens become helpless with unavailability of water at times. It is the temporal variability of water availability and water demand that is the cornerstone of water sustainability and citizen happiness.

Today, Karnataka is on a high growth path – estimated to grow at almost 8-10% GDSP. There is large-scale urbanization and huge centres of economic activities emerging in 4-5 cities in the state, led by mega-city of Bengaluru. Agriculture demand of water is very high and un-regulated use of water for irrigation purposes leading to un-sustainable water usage vs un-sustained agriculture vs loss of soil fertility and quality. The demands of a rapidly industrializing economy, urbanizing society and agriculture dependence comes at a time when the potential for augmenting water supply needs to be invigorated with sustained conservation of rain-water in lakes/ponds/tanks/reservoirs and balanced use of surface and groundwater resources. In particular, Bengaluru city has large number of bore-wells with un-scientific withdrawal of water leading to large-scale ground water fluctuations and shortages. Water pollution due to sewerage, industries, natural leaching etc also need to be monitored - at same time, cities must drive re-cycling of waste-water and usage of secondary water for many human activity.



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## KARNATAKA JNANA AAYOGA

(Karnataka Knowledge Commission)



Karnataka Jnana Aayoga

Karnataka Jnana Aayoga (KJA) is a recommendatory body established by Government of Karnataka and consisting of experts/professionals from different walks of life - tasked to recommend actions for institution building, policy innovation and excellence in the field of education, health, S&T, industry, entrepreneurship, research and innovation, traditional knowledge, agriculture, e-Governance, rural development and ANY other relevant areas. Till now, KJA has submitted 17 important policy and technology recommendations to Government of Karnataka. In 2018, KJA took up discussion on above water related issues and decided to work out a comprehensive and pragmatic Water Policy for the state. KJA recognized that importance of water as a resource for the state to spur progress and development in agriculture and industrial development, besides meeting the critical requirement of water usage for the state's citizens, requires a holistic study and policy outlining.

For developing a comprehensive Karnataka State Water Policy, KJA constituted a Task Group of experts/specialists - led by Prof Mihir Shah - an eminent water policy expert and Mr SV Ranganath, former Chief Secretary of GOK and involving experts from various expertise related to water. The Task Group was entrusted the task to prepare a pragmatic Karnataka State Water Policy (KSWP) which would ensure long-term "water security" in the state for its citizens and also ensures adequate availability of water in support of various social and economic development activities of the state. The TG held 8 meetings and series of consultations during its tenure which lasted for over a year. TG in turn, had constituted 14 sub-groups, composed of domain experts from across the country, to have focused deliberations on identified areas. In all, the TG consulted over 100 experts to draft this policy.

Once the TG submitted its KSWP report, the full KJA considered the report of the TG in its 8th meeting held on May 8, 2019 and adopted and finalised the KJA Recommendation on KSWP. The Policy has looked into the social, economic and hydrological aspects of water with specific reference to Karnataka's geographic location, river basins, aquifers, groundwater table, precipitation and inter-state water sharing. Policy recommends key action for the agriculture sector to adopt less water-intensive cropping, demand based irrigation techniques, establishing a highly granular Karnataka-Water Resources Information and Decision Support System (K-WINDS), rural water needs, urban and industrial water requirements, water quality issues and legal and policy framework required for water management. As a way forward the Policy recommends for constituting a State Water Governing Council, headed by Chief Minister and involving various Ministers of cross-cutting departments; an Executive Committee, headed by the Chief Secretary and involving all departmental Secretaries and a Knowledge Group with technical experts from within the government and from outside.

On behalf of the Aayoga, I would like to acknowledge the yeomen contributions of the KJA Task Group on preparing the KSWP - in particular the eminent Prof. Mihir Shah, who was ably supported by Mr SV Ranganath and Dr. Sharachchandra Lele and many expert members for their intense discussions, technological analysis and tireless efforts in drafting the TG report. 14 Sub-Groups were constituted by the TG and almost 100 experts were involved - I would like to thank all of them for their very important inputs on various topics to the TG - much of what is there in the TG report was the SG contributions. In particular, I would like to commend and acknowledge the valuable discussions of Prof Mukund Joshi; Dr VS Prakash; Prof Ramesh and Prof Mohan Kumar with Chairman, KJA and their contributions at various stages which helped bring clarity on innumerable issues related to the KJA Recommendation on KSWP and the subsequent action plan generation activity.





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Within the Government of Karnataka, the guidance and ideations of Mr Vijay Bhaskar, Chief Secretary; Ms Vandita Sharma, Development Commissioner and Mr RK Singh, Principal Secretary to WRD has been immensely valuable and definitive for working out Action Plan for KSWP. They and their departmental experts have provided ideations, data, inputs and practical suggestions that has helped KJA in finalizing the KSWP and in working ahead for the Action Plan generation.

I also take this opportunity to thank all the KJA Members - who provided the guidance and direction for the TG and also in finalizing these KJA recommendations of the Aayoga. Dr K Kasturirangan, Chairman of KJA has been the driving force for the KJA and also in finalizing these KJA Recommendations of KSWP - untiringly he navigated various contrasting and complex discussions and perspective and knitted multitude of ideas into the policy framework. Dr Kasturirangan provided the vision direction and a deeper systemic understanding of water - its availability, its usage, the social and technological aspects of water and the future; policy perspectives in a major way - thanks and respectful gratitude to Dr Kasturirangan - the leading light for KJA.

The KJA Secretariat, in particular coordinated by Dr BS Padmavathi and ably supported by Dr M Jayashree and Ms Rashmi - all three of them have played a very crucial back-end Secretariat role - taking care of the nitty-gritty tasks of linking/stitching together all the various notes/discussions/ideas/minutes; numerous meeting coordination; interfacing with WRD for getting data and inputs and helping in finalizing this KJA Recommendation - not once but many times over. They challenged themselves to automate and convert various pdf files to final Word files as per KJA requirements - something that is unique that they have done for this recommendation.

I am happy that the KJA Recommendation on Karnataka State Water Policy (KSWP) is being submitted to Government and I am confident that the Recommendation would be considered by the government and appropriately taken up for implementation. As decided by KJA, in its 8th meeting, an Action Plan is important outlining the clear steps that the state government will have to take for the policy implementation. To that end, KJA is committed to work with WRD and other departments of Government of Karnataka on best effort basis. With the Action Plan, KJA is confident that specific actions can get implemented by the departments in a holistic manner and bring water security and water happiness to present and coming generations of the state!!

  
(Mukund Kadursrinivas Rao)

Member-Secretary, KJA

[Mukund.k.rao@gmail.com](mailto:Mukund.k.rao@gmail.com)

August 26, 2019



# PREFACE

As in the rest of the country, the water crisis facing Karnataka is reaching unmanageable proportions. This is reflected in grave agrarian distress but also in acute shortage of safe drinking water for the people of the state, in both rural and urban areas.

The Government of Karnataka has consistently responded to the water crisis with appropriate policies. The state adopted a water policy in 2002 and an urban water and sanitation policy in 2003. These policy documents made a major contribution in the shaping of water related strategies and programmes in Karnataka. However, as outlined in this report, the 21<sup>st</sup> century has seen dramatic changes in demography, economy and agriculture, and hence in the demand for water in the state. The last few decades have also seen an intensification in the impacts of climate change, landuse modifications and urbanization on the hydrology of river basins, as also the finalization of inter-state tribunal awards on multiple river basins. All these developments have substantially complicated and aggravated the water challenges in Karnataka.

In recent years, the understanding of water has also greatly evolved and there is a growing realisation all over the country that there is a need for a fundamental paradigm shift in the management of water resources. It is no longer enough or even possible to continue to increase supply of water, without paying requisite attention to its sustainable management on the demand-side. River basins, one after the other, are nearing closure, with the possibilities of further reservoir construction reaching ecological, social and financial limits. Groundwater has been so badly over-exploited that both its levels and quality are in serious decline.

In view of this crisis, in December 2017, the Karnataka Jnana Aayoga (KJA) set up a Task Group to draft a new water policy for the state, which would reflect a 21<sup>st</sup> century understanding and perspectives on water, taking into account the fresh challenges emerging on the ground. And would thereby provide a new direction to the management of water resources in Karnataka, which would yield solutions to the water crisis and make water available for the people, as also for the economic development of the state, in a sustainable and equitable manner.

In preparing this Water Policy, the Task Group has been greatly assisted by the draft prepared by the Advanced Centre for Integrated Water Resource Management (ACIWRM) in 2016 and the Urban Wastewater Policy of 2016. Our policy builds upon both these efforts.

Some unique features of this Water Policy may be briefly summarised here:

1. As with the other policies drafted by the KJA, this Water Policy is nestled within a larger Report, which provides the necessary background and detailed justifications for the proposals put forward in the Policy;
2. The Policy puts forward a fresh perspective on water that reflects its common-pool character, recognises the inter-connectedness of different elements in the water cycle, takes a holistic view of water in all its dimensions and tries to address the multiple concerns of the people of Karnataka vis-à-vis water;
3. Perhaps for the first time in India, we have tried to reflect the diversity of water conditions and challenges within the state, in the proposals contained in the Water Policy;
4. The Policy is also unique because unlike most other Water Policy documents, it does not confine itself to pious expressions of intent but goes much further to also enunciate broad strategic directions needed for the successful implementation of the Policy;

5. The Policy has sought to imbibe learnings from choicest best 21<sup>st</sup> century approaches and practices in water from across the globe but does so in a manner adapted to the unique conditions found within the state.

It is our conviction that this Water Policy, if implemented effectively within Karnataka, could become a trail-blazer for path-breaking water reforms across the length and breadth of India.

For giving us this opportunity to draft something unique and unprecedented, we would like to express our heartfelt thanks to Dr. K. Kasturirangan, Chairperson, KJA, who was truly the inspiration for this entire endeavour. It was his commitment to reforming Karnataka's water sector that has made this Water Policy possible.

Our greatest thanks are to all the members of the Task Group and the special invitees, whose deep scholarship and years of experience working on water has shaped this Water Policy. It was a privilege to be able to work with them in this effort. Special mention needs to be made of Dr. Himanshu Kulkarni who has given multiple contributions to this Report, at all stages of its formulation, responding to our at times quite unreasonable demands, with great understanding and in a spirit of true team-work. Many independent experts became part of the Sub-Groups set up by the TG and provided their valuable time and expert inputs. Dr. Mukund Joshi and Dr. Sujith Koonan went a step beyond and contributed significantly to the writing of their Sub-Group reports. We greatly appreciate these contributions.

A special thanks also to Shri K J Joy (SOPPECOM), Dr. Jagdish Krishnaswamy (ATREE), Shri Karthik Madhyastha (IIHS) and Shri P.S. Vijay Shankar (Samaj Pragati Sahayog), who prepared important background papers and analyses on select topics at short notice. The ATREE Ecoinformatics Laboratory provided valuable GIS support for making the maps in this report, and Ms. Linitha Mathew from NLSIU provided vital editing help at crucial times.

Dr. Mukund Rao, Member Secretary, KJA facilitated the entire work of the Task Group. The research team from KJA—Dr. Padmavathi, Ms. Rashmiraj, Dr. Jayashri, Ms. Nandhini and Ms. Rachana provided invaluable support to the TG's work by not only carefully compiling all discussions but also making valiant efforts to get us the necessary data and reports from various sources. The administrative team at KJA facilitated the work very efficiently. We are grateful to all of them.

Many officials from the Government of Karnataka were extremely helpful in various ways: coming to TG meetings and additional one-on-one meetings at the KJA, sharing documents and reports where possible, and sharing data. These include Director (Ground Water Directorate), Chief Engineer (WRDO), Chief Engineer (KUWSDB), Special Secretary (Water Resources Department), Additional Chief Secretary (Urban Development Department), Principal Secretary (RDPR), Director (KSNDMC), Director (Directorate of Economics and Statistics), Director (KSRSAC). We thank all of them for their help.

A very special thanks to Shri T.M. Vijay Bhaskar, Chief Secretary, Government of Karnataka for supporting our work in more ways than can be listed here. Also to Shri Luthfulla Atheeq, Principal Secretary, Rural Development and Panchayath Raj Department, Government of Karnataka for responding with great diligence and alacrity to many difficult questions from our side. And to Shri Avinash Mishra, Adviser, Water Resources, Niti Aayog, Government of India for providing several crucial pieces of information and insight.

Mihir Shah, Chair

S. V. Ranganath, Co-Chair

Sharachchandra Lele, Member-Secretary

April 12, 2019

# MEMBERS OF KJA TASK GROUP ON KARNATAKA STATE WATER POLICY

1. Professor Mihir Shah, Shiv Nadar University, Former Member of Planning Commission (Chair)
2. Shri. S. V. Ranganath, KJA Member and Vice-Chairman of Karnataka State Higher Education Council (Co-Chair)
3. Dr. Sharachchandra Lele, ATREE, Bengaluru (Member Secretary)
4. ACS/PRS, Water Resource Department, GoK
5. Director, Karnataka State GW Department, GoK, Bengaluru
6. Dr. Mukund Rao, Member Secretary, Karnataka Jnana Aayoga, Bengaluru
7. Dr. Himanshu Kulkarni, Executive Director, ACWADAM, Pune
8. Prof. Mohan Kumar, Indian Institute of Science, Bengaluru
9. Ms. Jayamala Subramaniam, Director, Arghyam Foundation, Bengaluru
10. Dr. M.K.Ramesh, Professor, National Law School of India University, Bengaluru
11. Shri. V. Balasubramanian, Former Additional Chief Secretary, GoK, Bengaluru
12. Dr. Aromar Revi, Director, IIHS, Bengaluru
13. Dr. Rochi Khemka, Program Director, (Karnataka), 2030 WRG
14. Prof. Gopal Naik, Professor of Economics and Dean, IIM, Bengaluru
15. Maj. Neil Castelino, Director & Karnataka State Head, CII, Bengaluru
16. Shri. S. Vishwanath, Biome Trust, Bengaluru
17. Prof. Ashok D. Hanjagi, Department of Geography, Bangalore University
18. Prof. Mukund Joshi, Professor of Agronomy, UAS, Bangalore, Special Invitee to TG
19. Dr. V.S. Prakash, Former Director, KSNDMC, Bengaluru, Special Invitee to TG

Supported by:

1. Dr. B. S. Padmavathi, Senior Research Associate, KJA (TG Convenor)
2. Ms. Rashmiraj, Senior Research Associate, KJA
3. Dr. Jayashri, Senior Research Associate, KJA
4. Ms. Nandhini, Research Associate, KJA (Former TG Convenor)
5. Ms. Rachana Research Associate, KJA (Former TG Convenor)

<https://www.karnataka.gov.in/jnanaayoga/Govt%20Order%20%20Circulars/OO%282%29-%20KJATGWaterPolicyOfficeOrder.pdf>

KJA Recommendation

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Karnataka Jnana Aayoga expresses its grateful thanks to all the TG/SG Members, experts and officers of GoK for sharing their expertise in drafting this Report:

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- Sri. S.V.Ranganath, Former Chief Secretary, GoK for overarching guidance and support as the Co-Chair of TG and as KJA Member;
- Sri. Rakesh Singh, ACS, Water Resource Department, GoK, for his keen participation in deliberation;
- Prof. Mihir Shah, Former Member, Planning Commission of India, for sharing his expertise and leading the TG deliberations as the Chair of the TG;
- To all the TG Members and Special Invitees, for their deep involvement and knowledge sharing, especially Dr. Sharachchandra Lele, for his support in drafting the report as TG Member Secretary;
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- Sri. Prabhuraj, Director, KSRSAC, GoK for providing high resolution Command Area map in GIS format for the entire state;
- Director, KSNDMC for providing data rainfall and river basin;
- Sri. Govindraju, Deputy Secretary, Minor Irrigation Department, Gok for providing reports, critical for the TG;
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# LIST OF ABBREVIATIONS

ABHY	Atal Bhujal Yojana
ACWADAM	Advanced Centre for Water Resources Development and Management
ACIWRM	Advanced Centre for Integrated Water Resource Management
AESR	Agro-Ecological Sub-Regions
APDAI	Andhra Pradesh Drought Adaptation Initiative
APFAMGS	Andhra Pradesh Farmer-Managed Groundwater Systems
BFI	Base Flow Index
BWSSB	Bangalore Water Supply and Sewerage Board
CII	Commercial-Industrial-Institutional
CPCB	Central Pollution Control Board
CGWB	Central Ground Water Board
CRZBNF	Climate Resilient Zero-Budget Natural Farming
CEO	Chief Executive Officer
CSO	Civil Society Organisations
CWC	Central Water Commission
DES	Department of Economics and Statistics
DSM	Demand Side Management
EC	Electrical Conductivity
EPA	Environment Protection Act
FAO	Food and Agricultural Organisation
Gol	Government of India
GoK	Government of Karnataka
GP	Gram Panchayat
GR	Green Revolution
GWD	Ground Water Directorate
ICDS	Integrated Child Development Scheme
IMD	India Meteorological Department
IRWS	International Recommendations for Water Statistics
IPC	Irrigation Potential Created
IPU	Irrigation Potential Utilised
IISc	Indian Institute of Science

IRRI	International Rice Research Institute
IUWRM	Integrated Urban Water Resource Management
IWP	Irrigation Water Productivity
KAMIC	Karnataka Antarganga Micro Irrigation Corporation
KJA	Karnataka Jnana Aayoga
KBG	Knowledge Bank Group
KSPCB	Karnataka State Pollution Control Board
KRSAC	Karnataka State Remote Sensing Applications Centre
KLCDA	Karnataka Lake Conservation and Development Authority
KSNDMC	Karnataka State Natural Disaster Monitoring Centre
KUWSDB	Karnataka Urban Water Supply and Drainage Board
K-WINDS	Karnataka Water Information Network and Decision-Support System
MAR	Managed aquifer recharge
MDMS	Mid-Day Meal Scheme
MID	Minor Irrigation Department
MIS	Management Information System
MoU	Memorandum of Understanding
MSP	Minimum Support Prices
MWA	Milli-Watershed Association
MVWS	Multi-Village Water Supply Scheme
MWS	Mini Water Supply Scheme
NABARD	National Bank for Agricultural and Rural Development
NAQUIM	National Project on Aquifer Management
NHP	National Hydrology Project
NNL	Neeravari Nigam Limited
NRDWP	National Rural Drinking Water Programme
O&M	Operation and Management
PET	Potential Evapotranspiration
PIM	Participatory Irrigation Management
PDS	Public Distribution System
PGWM	Participatory Ground Water Management
PRI	Panchayati Raj Institution
PWS	Piped Water Supply Scheme



RBA	River Basin Authority
RDPRD	Rural Development and Panchayath Raj Department
RO	Reverse Osmosis
SRI	System of Rice Intensification
SBA	Swachh Bharat Abhiyan
SWGCG	State Water Governing Council
TDS	Total Dissolved Solids
TLF	Tryptophan-like fluorescence
TGWP	Task Group for Water Policy
TTC	Thermotolerant Coliforms
UDD	Urban Development Department
UFW	Unaccounted For Water
ULB	Urban Local Body
USDA	United States Department of Agriculture
WASSAN	Watershed Support Services and Activities Network
WRDO	Water Resources Development Organisation
WRD	Water Rights Division
WDD	Watershed Development Department
WENEXA	Water Energy Nexus
WMC	Water Management Committees
WALMI	Water and Land Management Institute
WRRS	Water Resources Regulatory Function
WUA	Water Users Association
ZBNF	Zero-Budget Natural Farming





# KARNATAKA STATE WATER POLICY 2019

## 1. The Water Crisis in Karnataka

Karnataka is a state with water extremes. The highest rainfall in peninsular India occurs in the Karnataka Western Ghats at Agumbe (>8000mm per annum), and the Western Ghats in general receive heavy rainfall (>3000mm), resulting in a lush green forest cover, but the eastern plains are relatively dry, with some parts getting 600mm or even less rainfall per annum. Most of this rainfall is limited to the south-west monsoon period. So Karnataka also has the second or third largest area classified as semi-arid in the country. It also has a variety of aquifers, but again the aquifers in the eastern plains are largely hard-rock aquifers with low recharge rates and storativity. Thus, Karnataka's natural water endowment is varied, complex and challenging. The demand for water is also distributed in complex ways and growing fast in recent years. Urbanisation is rapidly expanding domestic and commercial water demand in some pockets, especially Bengaluru. On the other hand, agriculture water consumption is highest in the relatively less endowed eastern plains because of the presence of large-scale irrigation projects and groundwater pumping. Water management in Karnataka has to thus confront large differences in rainfall, climate, groundwater features, demography, livelihood systems, economic activity and inter-regional dependencies. Water stress and water possibilities vary widely across the State and call for region-specific strategies.

The current status of the water sector in Karnataka today is a matter of serious concern. First, the summer season flows in most rivers are declining and there is evidence of some rivers (Arkavathy, Dakshina Pinakini, etc.) almost drying up. This is visible in declining inflows into major reservoirs. Thousands of minor irrigation tanks have also dried up completely. And these declines are not so much to do with climate change, being primarily a result of increased water use in the catchments. Second, groundwater levels have been dropping at an alarming rate for several decades in many parts of the state. 44 of the 176 talukas in the state have been declared as 'over-exploited', 14 are in the 'critical' category and 21 are in the 'semi-critical' category with regard to groundwater exploitation, all in the eastern plains region. Indeed, groundwater depletion is also one of the major drivers of declining summer season flows in rivers. Third, surface water bodies across the state are partly or heavily polluted, including 13 out of 17 river stretches that are being monitored, and most urban tanks. Sewage is the single biggest source of such pollution, but contamination from industrial effluents is beginning to show up in several pockets. Geogenic contamination is also being reported from many regions, with fluoride being detected in 1038 habitations spread across 18 districts, and other locations showing arsenic, nitrate or salinity problems. All this is happening in the context of a high frequency of droughts, possibly highest in the country. For instance, between 2001 and 2016, the state experienced drought in 12 years.

Along with water scarcity, unsustainability and pollution, there is also a concern that access to water for life and for livelihoods is highly unevenly distributed. While some farmers grow water-intensive sugarcane and paddy crops even in semi-arid regions, others are forced to cultivate only rainfed crops or are dependent upon an ever-declining source, viz., groundwater. A similar pattern is visible in the domestic sector. Consumption varies from 340 litres per capita per day (lpcd) or more in parts of Bengaluru to less than 50 lpcd in the poorer households and in many small towns, and 60% of Karnataka's rural habitations are only partially serviced, with less than 40 lpcd water supply. During the summer season, most households in the state experience some water scarcity. Finally, the industrial sector also faces significant uncertainties about the availability and quality of water. In other words, water resources in the state are coming under severe stress that is endangering the water security of most of rural and urban Karnataka.



## 2. Socio-hydrological Foundations of the Water Policy

Water has certain key socio-hydrological features that make its management challenging:

- Water is essential for the sustenance of life in all its forms, an integral part of the ecological system, sustaining and being sustained by it; a basic requirement for livelihoods; a cleaning agent; a necessary input for economic activity such as agriculture, industry, and commerce; a means of recreation; an inseparable part of a people's history and culture.
- Water is a finite, annually replenished, seasonal, uni-directionally flowing common-pool resource. Its renewal is not stock-dependent, but depends upon precipitation.

Surface water and groundwater are highly interconnected, with the annually replenished (or dynamic) groundwater simply being a temporary phase of the cyclical movement of water i.e., the unified hydrological cycle.

- Deeper groundwater is water that escaped from the hydrological cycle over millennia. It is therefore non-renewable, limited in quantity and requires much more energy to extract.
- Water that flows in rivers and into estuaries and oceans is critical to the survival of aquatic organisms.
- Wastewater can be a threat to public health and ecosystems, but is also a potential resource if properly treated.
- The amount of water available annually is thus fixed, and 'new' water can only be created through recycling, or by desalination of oceans, which is very energy-intensive.

Furthermore, in Karnataka:

- Availability:** The availability of water is highly **seasonal** and with large **variations** between agro-climatic zones: Malnaad (with rainfall of ~4000mm per year), coastal (with rainfall of ~ 2500mm per year) and eastern plains regions (ranging from 900mm to 300mm per year). About 2/3rds of the state receives less than 750mm.
- Demographics:** Karnataka's **population has increased** from 4.5 crores in 1991 to 5.3 crores in 2001 to 6.1 crores on 2011 and to an estimated 6.8 crores in 2018—an increase of more than 50% since 1991. The **urban share** in the population has grown from 30% in 1991 to 39% in 2011, and to an estimated 42% in 2018, showing the rapid pace of urbanization.
- Economic growth:** Karnataka has one of the fastest growing economies in India, with an estimated annual growth rate of 7% or more in its State Domestic Product for the last decade.
- Growing and varied demand:** The demand for water in Karnataka is therefore **growing because of urban and industrial demand** are being added on top of a pre-existing agricultural and livestock demand. The demand also varies significantly by region, with high urbanization rates in regions (such as Bengaluru) that have low natural availability.



- **Socio-economic differences:** There are significant **socio-economic differences** between communities in the ability to pay for water, to access water and to become involved in decision-making about water. The state has more than 30% families below the poverty line, and 16% of its population is in Scheduled Caste, and 6% is in Scheduled Tribe category. And although Karnataka ranks 7<sup>th</sup> in the Gender Vulnerability Index, women continue to be on the sidelines in most decisions related to water.
- **Downstream commitments:** Karnataka is located upstream in two major east-flowing river basins (Krishna and Cauvery), and therefore has significant commitments to downstream states. Similarly, there are environmental commitments in west-flowing rivers.
- **Climate change** is already under way. Current projections suggest that the Cauvery basin and north-eastern Karnataka may see reductions in total annual rainfall, the frequency of droughts will increase in the eastern plains region as a whole, there could be complex shifts in seasonal patterns, and increased intensity of rainfall.

In light of the above, what is required is a **paradigm shift** in how water resources are managed in Karnataka state. From an era when building more dams and drilling more borewells so as to increase water supply infrastructure was the goal, the state needs to shift to a paradigm of **managing water within the available water budget**.

### 3. Goals of Karnataka's Water Policy

All water management and governance in Karnataka must strive to ensure:

- a) **Water for life and livelihoods: Adequate, clean and affordable** water for domestic use (water for life) and for meeting livelihood needs of the people
- b) **Water for birds, animals and other living beings, and for maintaining cultural values:** Adequate and appropriate provision will be made for environmental flows, culturally valuable flows, and consumption by livestock and wildlife.
- c) **Maintaining public and ecosystem health:** Water must be of a quality appropriate and safe for the use it is put to, and the wastewater resulting from its use must not result in further pollution of surface or groundwater or soils.
- d) **Equity and fairness:** Water must be shared fairly. Within any sector in a region, users must have equitable access to water, at similar cost for similar consumption. Equity includes social justice, which is the factoring in of the socio-economic position of resource users. In terms of priorities amongst uses (life, livelihoods, ecosystems and cultural values), water for human life will have highest priority, followed by the minimum needs of biota and associated cultural values, rural livelihoods and then industrial activity.
- e) **Sustainability and resilience:** Water must be used in such a way that our ability to continue to use it in the future is not compromised, nor should water management involve unsustainable use of other resources such as energy or land. Water management must also be able to accommodate and recover from extreme climatic events and fluctuations.



- f) **Democratic and participatory processes:** All decisions regarding water governance must meet high standards of democratic decision-making, including transparency, accountability and public participation in all major decisions.

## 4. Meeting the Goals: Approach and Operating Principles

### 4.1. Approach: Paradigm shift

In order to meet the multi-dimensional goals in the challenging situation outlined above, water governance must make undergo a paradigm shift:

- a) From supply-side to demand-side management
- b) From fragmented management (mainly focused on surface water) to integrated management combining surface, ground and waste water
- c) From depleted groundwater for a few to restored groundwater for all
- d) From exclusively Engineering thinking to a holistic Ecosystem perspective
- e) From state-private dichotomy to water as a commons, held in public trust
- f) From top-down to participatory and deeper democracy, following environmental subsidiarity principles.

This policy document spells out how this paradigm shift can be achieved in every sector.

### 4.2. Operational principles

In identifying strategies for this paradigm shift, the following operational principles will be kept in mind:

- a) Water will be treated as the common heritage of the people, held in public trust, for the use of all, subject to reasonable restrictions, to protect all water and associated ecosystems. In its natural state, such as river, stream, spring, natural surface water body, aquifer and wetland, water is a common pool resource, not amenable to ownership by the state, communities or persons. The state at all levels holds water in public trust for the people and is obliged to protect water as a trustee for the benefit of all.
- b) The responsibility of the state as public trustee shall remain even if some of the functions of the state in relation to water are entrusted to any public or private agency.
- c) Among the different uses of water: for life, livelihoods, ecosystems and cultural values, water for life will have highest priority, but the state will ensure a minimum availability for other biota and associated cultural values, and will ensure cost-effectiveness, environmental due diligence and region-specificity as outlined below.
- d) Evaluation of alternative strategies/projects for achieving particular outcomes will be mandatory, so that cost-effective and environment-friendly strategies are identified.
- e) Rigorous environmental impact analysis and scrutiny are a must for all strategies/projects and alternatives; precautionary principle must be the cornerstone.



- f) Norms & strategies will be region-specific. Specifically, for domestic supply, the norms will be 100 lpcd for all citizens in the eastern plains region, and 150 lpcd for citizens in the Western Ghats and coastal regions. Additional demand may be met at higher price if the resource is available and through recycled water.
- g) Pricing will be use-sensitive & user-sensitive, determined in an open, transparent and participatory manner, while meeting O&M costs in the aggregate.
- h) Use of local runoff, ground water & treated wastewater will be maximised before importing from outside the basin or sub-basin or over long distances; inter-basin transfers will be taken up only as a last resort, even for drinking water.
- i) Rivers, water bodies, aquifers and wetlands shall be recognised as ecological systems both in themselves and also as parts of larger ecological systems, and protected from over-use/depletion, abuse, pollution/contamination, and degradation. Wetlands, floodplains and riverbeds shall be recognised as integral parts of the rivers themselves. Rivers shall be protected from construction on their floodplains and from sand mining.
- j) Where water sources, catchments, drainage paths, river flows, water bodies, aquifers, wetlands, flood plains or riverbeds have already been encroached upon or interfered with, efforts shall be made to stop further encroachment or interference and reverse the adverse impact already made, to the utmost extent possible.
- k) Environmental flows adequate to preserve and protect a river basin as a hydrological and ecological system shall be maintained
- l) Environmental subsidiarity will be kept in mind, i.e., water will be allocated within basins to sub-basins and aquifer-scales and then within that day-to-day management will be at local scales as much as possible.
- m) Clear distinction to be maintained between drinking water, other domestic water, and commercial-industrial-institutional use of water, which otherwise gets subsumed under the label of 'drinking water'.
- n) Integrated management with transparency, open data, public participation and accountability must be the cornerstones of all decision-making.
- o) Separation of regulatory functions from provisioning functions of state organizations, and devolution of both responsibilities and concomitant authority as much as possible will be followed.

## 5. Transforming Agricultural Water Use

Agriculture is the producer of food to sustain human life and also the source of livelihood for the majority of Karnataka's population today. At the same time, agriculture is the biggest user of water: an estimated 85% of water withdrawals (from streams, rivers or aquifers) go for irrigated agriculture, which is dominated by rice and sugarcane cultivation. Therefore, without a drastic reduction in the demand for water in this sector as a whole and better distribution *within* the sector, there will just not be enough water for the domestic needs of the people of the State, or for sustaining farming in the future, not to mention the needs of industry or the services sectors. Simultaneously, increasing farmer suicides indicate the economic crisis in the farming sector. Thus, the water crisis cannot be addressed without fundamental changes in the agricultural sector.



The new paradigm for agriculture and irrigation in Karnataka will have 6 main prongs:

1. Improve productivity, profitability and sustainability of farming while maintaining low water demand, by moving away from chemical agriculture towards sustainable agriculture;
2. Reduce the demand for water by diversifying the cropping pattern away from water-intensive rice and sugarcane cultivation, towards millets and pulses, and other crops, and fruits and vegetables, based on what is appropriate for each agro-ecological region of the State;
3. Improve crop water use efficiency and overall irrigation efficiency in agriculture through changes in agricultural practices and technology, especially in paddy and sugarcane cultivation;
4. Better utilizing the irrigation potential created in major and medium irrigation projects through improved participatory management of water in irrigation commands;
5. Integrate watershed development, irrigation tank revival, and groundwater management in the predominantly rainfed regions of the State.
6. Break the groundwater-energy nexus, while ensuring that policy changes in the electricity sector that are taken up to reduce the financial burden due to free electricity supply for pumping do not inadvertently result in increased groundwater draft.

### **5.1. *Improve productivity and sustainability of farming systems while reducing water use***

Increasing farmer suicides are just the final symptom of the declining profitability, sustainability and health of farming systems that emerged from the Green Revolution. Intensive use of chemical fertilizers and pesticides is not only affecting groundwater quality and farmer health but also demanding much more irrigation water than otherwise required. It is also making farming increasingly unviable, both financially and ecologically. The water crisis is thus integrally linked to the crisis in farming, and addressing the water crisis will require changes in agricultural policy that promote 'natural' or 'low-input' sustainable farming methods extensively. This can be a win-win-win for farmer incomes, farming viability, water use reduction and consumer health.

- a) In a very location-specific manner, based on a scientific assessment of requirements, farmers will be facilitated to shift to more diverse farming systems that are more sustainable, less risky, less input-intensive and more productive. As appropriate, these alternatives could include organic farming, zero-budget natural farming (ZBNF), low external input sustainable agriculture (LEISA), conservation agriculture, and other similar alternative agricultural practices, all emphasizing organic manuring and mulching, limit use of chemical pesticides, and use indigenous seeds to the extent possible;
- b) There will be a transformation in the agricultural extension system in the state that develops far greater capacities within the state department to support farmers to move in the direction of sustainable, natural farming;
- c) Large-scale capacity building of farmers will be undertaken through Community Resource Persons or Extension Farmers who would have received prior training in the new approach (training of trainers)





## **5.2. Incentivise shift from rice and sugarcane to less water- intensive millets and pulses**

In Karnataka, the Green Revolution was primarily a **rice and sugarcane** revolution. These are the crops that the government has incentivised farmers to grow, as they are virtually the only crops that the state procures or buys through institutionalized channels. Unfortunately, they are both highly water-intensive crops: while they occupy less than 20% of the state's cropped area, they consume an estimated 71% of its irrigation water! Sugarcane cultivation area has continued to grow even as the water crisis has intensified in the last two decades.

Farmers will be incentivized to shift away from irrigated paddy and sugarcane towards millets (ragi, jowar, other millets) and pulses (tur, chana, urad, moong) by:

- a) Increasing the Minimum Support Prices (MSPs) for Ragi, Jowar, Sajje and other millets and pulses;
- b) State procurement of millets and pulses at these attractive MSPs, especially in the water-scarce regions of the state;
- c) Encouraging Farmer Producer Organisations in the marketing of these crops;
- d) Supply of millets and pulses in a region-specific manner through the Public Distribution System (Ragi in the southern Maidan region, Jowar in the northern maidan region);
- e) Requesting the Centre to also replace 50% of the rice and wheat supplied in the PDS, with locally procured ragi and jowar;
- f) Supplying ragi and jowar and other millets-based meals through the Mid-day Meal Scheme (MDMS) and the Integrated Child Development Scheme (ICDS);
- g) Encouraging a shift in consumer diets by consciously promoting millets and pulses through mass media and people's campaigns.

## **5.3. Improve irrigation efficiency**

Karnataka is lagging behind in irrigation water productivity, with the lowest physical water productivity ( $\text{kg}/\text{m}^3$  of water applied) in rice amongst 16 major rice growing states and similar lags in maize, chickpea and other crops.

Efficiency of water use in agriculture will be promoted through:

- a) Facilitating adoption of drip, sub-surface drip and sprinkler irrigation by farmers, with weather-data input where possible,
- b) System of Rice Intensification (SRI), Alternative Wetting and Drying (AWD) and Direct Seeded Rice (DSR) technologies in farming,
- c) Incorporation of organic matter in the soil through green manuring and farm yard manure, as well as in-field bund management,
- d) Trash mulching and skip furrowing for sugarcane,
- e) Pipe-based irrigation supply and lining of canals to reduce conveyance losses,
- f) Ensure volumetric charging for water supplied in all major and medium irrigation commands, including charging for conjunctive use of groundwater,



- g) Helping farmers integrate rainwater into irrigation planning.

#### **5.4. Improve Participatory Irrigation Management (PIM) in Command Areas**

Expansion of irrigated area by building more dams in the state is becoming prohibitively expensive, both because of emerging hydrological limits (as river basins have reached or are approaching closure) and financial constraints (the cost of adding to irrigated area by building dams has become very high). Not to mention the added problems of human displacement, submergence of fertile land and other environmental damage. The way forward is Participatory Irrigation Management (PIM) to bridge the large gap between irrigation potential created (IPC) and irrigation potential utilized (IPU) in *existing* major and medium irrigation projects. In this way, the state can add as much as 9 lakh hectares to irrigated area at very reasonable cost. Simultaneously, PIM will also help solve the issues of

- a. Tail-ender deprivation, which is above 25% and sometimes as high as 90% in canal command areas, as head-reach farmers appropriate more than their fair share of the irrigation water;
- b. Salinity and waterlogging, which are significantly affecting command areas.
- c. Groundwater pumping based on seepage from canals, which amounts to consuming state-supplied irrigation water without paying for it.
- d. Financial sustainability, which is currently endangered, since the recovery of irrigation water charges is only 25-50%.

Thus, to ensure equity, efficiency and accountability in surface irrigation projects, the state will:

- a) Focus investments more on completing existing projects and bridging the IPC-IPU gap, especially completion of last-mile connectivity of field irrigation channels, not on new dam projects, whose costs and time-lags continue to spiral out of hand;
- b) Make drip or sub-surface drip irrigation mandatory in command areas of all major and medium irrigation projects;
- c) Ensure measured release of canal water at every level, reflecting crop water budgets to encourage more efficient water management;
- d) Replace system of flowing surface irrigation from field to field by independent outlets for all the fields covered by each field channel;
- e) Mandate adoption of 'on and off' system of distribution for the entire irrigation command so as to ensure equitable distribution.
- f) Improving drainage in command areas to reduce waterlogging and associated salinity-induced productivity losses.
- g) Implement Participatory Irrigation Management in Mission mode in all major and medium canal commands with the following features:
  - i. Statutory recognition of WUAs (at village level) and WUA Federation (at distributory and command area level);



- ii. Strict definition of responsibilities of Neeravari Nigams as bulk suppliers of irrigation water, and clear mechanism for water release, negotiation and conflict resolution;
- iii. WUAs to retain fraction of irrigation service fees collected upfront, to be used to meet O&M expenses;
- iv. Renovation of the canal network *before* the WUA signs an MOU with the NNL;
- v. Elimination of the CADAs, while strengthening the WALMI to play a supportive role;
- vi. Factoring in groundwater use in the irrigation service fee and in water allocation in general, and
- vii. Increasing the involvement of women and marginalized socio-economic groups at all levels, and overall capacity-building of WUAs.

### **5.5. *Integrated Management of Groundwater, Watersheds and Minor Irrigation Tanks outside the Major/Medium Command Areas***

While government investments continue to focus on major and medium surface water irrigation projects, the landscape outside the canal commands has evolved in complex ways. First, groundwater has in fact become the dominant form of irrigation in the state. Today, 56% of the area irrigated in Karnataka is from groundwater irrigation (predominantly—45%—coming from borewells). Unfortunately, what was seen as a solution to the limited reach of surface irrigation projects has now become the major problem in the water sector, viz., declining groundwater tables and increasing contamination of groundwater. This is particularly because of the nature of aquifers in Karnataka. This not only jeopardises future availability, but also increases inequity as poorer farmers cannot drill deep borewells and replace failed borewells. Second, minor irrigation tanks are in disuse, as farmers in the command areas shift to groundwater, and upstream groundwater pumping and check-dam construction reduces inflows into the tanks. Third, watershed development has been pursued vigorously over the past 25 years, but has failed to achieve long-term sustainability because the additional recharge has often been pumped out by unregulated groundwater use. In short, groundwater depletion is wiping out farmer investments, making water inaccessible to the poorer farmers, imposing higher electricity costs on the state, and undermining all the gains from watershed development and tank rejuvenation programmes.

Serious defects in the legal and organizational framework for regulating groundwater use as well as lack of awareness, information and knowledge on the utilization rates, sustainability and interconnections in groundwater use at the local level are the causes of this 'tragedy of open-access' of this common-pool resource. The hard-rock nature of most of Karnataka's aquifers (the highest area of hard rock formations in the country) means low recharge rates, unpredictable availability, unclear aquifer boundaries and unclear boundaries between the shallow and deeper aquifer. The integral links between watershed development, groundwater use and surface runoff and baseflows is also poorly understood. Similarly, the protection of springs in the Western Ghats has not received adequate attention.

Thus, regulation in some form is essential. However, in a state with at least 13 lakh private irrigation wells (and potentially 25,000 minor irrigation tanks) top-down state-level regulation has been and will be impossible. The rejuvenation and sustainable management of groundwater, watersheds and minor irrigation tanks in Karnataka can only happen through



decentralised participatory management, and major strengthening of the monitoring and knowledge-information system on groundwater. This will be done by:

- a) Initiating participatory Gram Panchayat-scale Integrated Water Management Planning, beginning with the Atal Bhujal Yojana in groundwater over-exploited blocks;
- b) Extending the aquifer mapping work under the National Aquifer Management Programme (NAQUIM) to the micro-watershed scale, and enhancing capacities for integrated water management at all levels (state-district-gram panchayat), through large-scale partnerships with knowledge institutions and civil society groups.
- c) Legislating a revamped groundwater regulation act that makes groundwater part of all water as a common pool resource held in public trust, and that provides Water Management Committees (WMCs) at the Gram Sabha level the authority to keep total water use within water use limits allocated by River Basin Authorities, to distribute water access internally, and to implement programmes for recharge, protection and tank rejuvenation and management.
- d) Merging the Watershed Development Department with the Minor Irrigation Department and Groundwater Directorate, and making Integrated Water Management in Rainfed Areas the mandate of this combined department, with its role focused on providing funding and technical support to WMCs and Milli-Watershed Associations, while leaving implementation and day-to-day management/water allocations decisions to the latter.
- e) In the Western Ghats region, following an inventory of springs, a dedicated participatory springshed management programme to be taken up.

### **5.6. Break Groundwater Energy Nexus**

- a) Implement feeder separation with farmer involvement to improve the reliability of rural electricity supply
- b) Implement electricity metering and charges at low rates to farmers after feeder separation, and in tandem with pump improvement subsidies, to reduce electricity losses and incentivise water conservation.
- c) Ensure that in any solar-PV based irrigation scheme, total water pumped for irrigation is kept unchanged or reduced by simultaneous monitoring of water use, and making micro-irrigation and fertigation mandatory in such schemes.
- d) Make Gram Panchayat level groundwater budgeting and Participatory Integrated Groundwater-Tank-Watershed Management, a pre-requisite for initiating solar-PV based pumping.

## **6. Rural Domestic Water Management**

With 60% of its current population still living in rural areas, providing safe and adequate water for drinking and other domestic uses must rank as the single most important duty of the Government of Karnataka. The state has implemented rural drinking (domestic) water supply programmes vigorously over the last two decades. Yet, of the nearly 60,000 rural habitations in Karnataka, as many as 60% are only partially covered, with less than 40 lpcd water supply. One widespread problem is that since 87% of drinking water supply schemes are dependent on groundwater, there is a tendency for the aquifer supplying this water to get depleted over time, because the same aquifer is used for the much greater consumer of water, viz., irrigation.



Another challenge is the threat of contamination by fluorides, nitrates and in some pockets arsenic, but also increasingly biological contamination from sewage, because of lack of integration of the Swatchh Bharat Abhiyan with drinking water supply schemes. RO based drinking water supply—opened in every Gram Panchayat—is also facing challenges of financial and source sustainability, with major concerns regarding disposal of the higher concentration reject water. An estimated 25-50% of these plants may already be non-operational now. The state shall therefore:

- a) Ensure priority for domestic water use in Gram Panchayat-level or village-level participatory Water Security Plans;
- b) Implement integrated groundwater-watershed-tank management programmes in a way which ensures that water use for irrigation does not jeopardise supply of drinking water;
- c) Set equitable allocation and access of water to all socio-economic classes as an explicit policy goal;
- d) Integrate sanitation and domestic water supply programmes, ensuring better siting and maintenance of sanitation facilities, at a safe distance from drinking water sources;
- e) Implement safe distance between drinking water sources and mining activities;
- f) Ensuring involvement of local communities in planning and execution of the multi-village (surface water import) schemes.

## 7. Urban and Commercial-Industrial-Institutional Water Management

Karnataka is urbanizing rapidly, with the urban fraction in the population having risen from 29% in 1991 to more than 40% by 2018, and total urban population from 1.35 crores in 1991 to ~2.86 crores in 2018. Rapid economic growth, mostly concentrated in urban areas, has increased the demand from the commercial-industrial-institutional (CII) sector. And this growth has also been lop-sided, with 40% of the urban population located in the city of Bengaluru. The state has responded to this growth primarily by investments in building more pipelines from different sources to these urban areas, and experimenting with privatised 24x7 supply schemes. Nevertheless, the status of urban water supply continues to be precarious. Many urban local bodies (ULBs) do not meet the current norms even on average, and many segments of the population in each ULB, including Bengaluru, have to manage with water supply that is far lower than the norm, either year-round or seasonally. For instance, 50% of even Bengaluru's households get less than 90 litres per capita per day (lpcd). But at the same time the top 10% averages 340 lpcd. Water tariffs generally do not reflect the O&M cost of supply, and are implemented erratically and often inequitably. And with more than 50% of the ULBs being partially or full dependent upon groundwater, sustainability is an increasing challenge. Unfortunately, active groundwater management is not part of urban water policy or programmes. Lack of regulation and high tariffs for CII users have prompted them to switch to unregulated groundwater pumping. Wastewater management is far below capacity and under-performing, resulting in heavy pollution of urban lakes and rivers and is jeopardising the health of downstream farmers and their produce. Caste discrimination in sewage management continues, leading to an average of 7 deaths per year amongst sewerage workers in Bengaluru alone. Neglect of stormwater drains causes both flooding and blockage of inflows into urban tanks. Fire and froth in Bellandur and Varthur lakes are just the last stage in a deeper malaise. Citizen groups have mobilised around urban tanks/lakes, but citizen



participation in urban water management is not institutionalised and information flows and accountability are poor. Anticipatory planning for the dramatically urbanising megalopolis of Bengaluru is inadequate: the Master Plan 2031 contains very little concrete planning for water and wastewater. A multi-pronged mission for Integrated Urban Water Management is therefore required.

### **7.1. Set region-specific and use-specific quantity norms and quality standards**

- a) For domestic users, lpcd norms must reflect the agro-climatic or hydro-climatic zone they are living in. So the minimum domestic lpcd norm in the eastern plains should be 100 lpcd, whereas the norms in the Western Ghats and the coastal zone can be higher (150 lpcd).
- b) For commercial, industrial and institutional users, there is need to co-define (in collaboration with industry associations) the best practice water use standards for each type of establishment, and set a 5-year period for existing establishments to achieve those efficiency standards. Set up regular water audits of all industries.
- c) Standards for quality of water supplied should also be realistic. Instead of insisting that all water supplied to domestic users be potable, the water may be bathing quality, provided additional sources of affordable drinking quality water are made available (such as RO-based water ATMs).
- d) Use awareness building on consumption norms and information on individual bills to 'nudge' high-end consumers towards lower consumption.

### **7.2. Integrate groundwater into urban water supply planning and management**

- a) Groundwater will be treated on an equal footing with imported river water, and will be seen as valuable local resource that provides inter-seasonal storage, to be used sustainably by the ULB/BWSSB in the public interest.
- b) Groundwater may be supplied in separate lines or blended with river water and/or stormwater, depending upon the quality.
- c) Private groundwater pumping will be metered, and its use for commercial purposes (both in-house and for sale in the form of water tankers) will be charged at CII rates.
- d) Mapping of aquifers and identification and protection of recharge zones will be part of the ULB/BWSSB's mandate.
- e) Groundwater management strategies will be adapted to the nature of the aquifer.

### **7.3. Maximise local water use and wastewater reuse before external water imports**

- a) Encourage (not penalise) rainwater harvesting by individual users. Mandate rainwater harvesting for commercial, industrial and institutional (CII) users
- b) Encourage (not penalise) wastewater reuse by individual users, and mandate wastewater reuse for CII consumers.
- c) ULBs to get external river water only after they meet minimum rainwater harvesting, tank rehabilitation and wastewater reuse norms (rainwater harvesting target: 25% by



2030; wastewater reuse 25% by 2025, and 50% by 2030 as laid down in Urban Wastewater Policy).

- d) Link building plan sanction to availability of water and wastewater facilities.
- e) Reduce Unaccounted For Water (UFW: leakages and thefts) to below 15% by 2025 in all ULBs.
- f) Initiate flood management by mandating adequate infiltration zones in new construction, encouraging increased infiltration in existing construction, and construction of recharge structures in public lands and public buildings. Provide support to ULBs for removal of encroachments on stormwater drains.
- g) Promote innovation in technologies and planning for alternative approaches to wastewater treatment that are neighbourhood scale, encourage biological solutions that are financially less expensive and have lower energy consumption, separating grey and black water, linked to markets for sludge, and passive technologies where possible.
- h) Mandate use of recycled water for all public parks/gardens/green spaces and all corporate gardens.

#### **7.4. Ensure equitable access and charging**

- a) Set service benchmarks and evaluate ULB/BWSSB water supply performance at ward and sub-ward level w.r.t. universal coverage, water quality, fair pricing, sewage treatment and reuse, efficiency (leakage reduction), and O&M costs.
- b) Introduce volumetric charges in tandem with lifeline rates for weaker sections in all ULBs.
- c) More than “24x7” projects for whole cities, focus on storage needs of the weaker sections; initiate community storage for slums; retain stand-posts for groundwater supply; involve women in the design and monitoring of these programmes.
- d) Meter and charge groundwater use by CII users and tanker companies at commercial rates.
- e) Provide to the public detailed calculations and justifications of tariff components such as “sanitary cess” or capital expense recovery (“betterment charges”).

#### **7.5. Protect and use urban lakes as multi-functional entities**

- a) Integrate of urban lakes or tanks into urban water management, and use them for both aesthetic/recreation/conservation purposes and storing stormwater, floodwater, and/or treated wastewater for reuse locally.
- b) Establish lakeside sewage treatment, in-lake treatment using constructed wetlands, storage in and reuse of treated wastewater from the lakes, as part of integrated urban water management.
- c) Prioritize improving of sewage collection and treatment in lake catchments over desilting and civil works in the lake bed.



## 7.6. *Institutional changes*

- a) Set and publicly monitor performance benchmarks for all ULBs, including universal coverage, adequacy, equity, affordability, quality, reliability, source sustainability and financial sustainability;
- b) Separate roles by allocating KUWSDB the task of bulk supply and infrastructure development only, and ULBs the task of distribution and O&M.
- c) Increase democratic governance, transparency and accountability of all para-statal.
- d) Ensure an explicit mandate, staffing and training for Participatory Integrated Urban Water Management for all ULBs, at the ward-level or Town Panchayat level, which includes local and imported water, surface and groundwater, as well as recycled wastewater, and the management of urban lakes and urban flooding.
- e) Ensure adequate scrutiny of urban drinking water supply projects (because they are actually domestic and CII water supply projects) in terms of cost-effectiveness and socio-environmental impact (as compared to demand-side management, recycling and local water resource use).

## 7.7. *Special efforts for Bengaluru Metropolitan Region*

### 7.7.1. BBMP area

- a) Reduce leakage and theft losses to below 15% in 3 years
- b) Revise BWSSB's mandate to plan in terms of all water, i.e., including local and imported water, surface and groundwater, rooftop and wastewater. Performance to be measured against goal of providing adequate water (100 lpcd) of necessary quality (or qualities) to all Bengaluru citizens, and other users where possible, while limiting imports to Cauvery stage V and reducing polluted outflows to standards set by the CPCB.
- c) Initiate integrated Ward-level water management planning at ward-level in collaboration with BBMP (which is responsible for lakes and stormwater drains). The measures should include:
  - i. Integrating groundwater with planning and supply of surface water. Lay parallel supply lines for groundwater, surface water and treated wastewater (or partially treated stormwater) where possible.
  - ii. Incentivising (not penalising) rooftop rainwater harvesting in all buildings, starting with government buildings.
  - iii. Exploring ways of using lakes as multi-function water bodies, including aesthetic/spiritual functions, biodiversity habitat, groundwater recharge, stormwater or treated wastewater repositories.
  - iv. Decentralise wastewater treatment as much as possible to lakeside STPs wherever possible. Enable reuse of treated wastewater from apartment complexes and buildings.<sup>1</sup>

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<sup>1</sup> Newer decentralized wastewater management systems can address multiple problems: catering to the un-served areas and minimize the pressure of transporting to a single location, reducing the cost of treatment and O&M costs (if sewer lines infrastructure costs are factored in), and minimizing land requirement for treatment.





- v. As far as possible, move towards biological methods of wastewater treatment, with lower financial and energy costs
  - vi. Mandate the use of treated wastewater for all public irrigation purposes.
- d) Prioritise under-served areas and low-income areas, address needs of slums through community storage tanks linked to metered supply (with low tariffs).
- e) Rationalise water charges, sanitary charges, and betterment charges such that water charges meet annual average O&M costs for all except the poorest customers, and to the extent possible rising water tariffs slab rates apply uniformly based on per capita consumption, not per building consumption.
- f) BWSSB should takeover O&M of STPs (instead of privatising them) and make them transparent and visible to the public as a matter of principle. Invite independent monitoring of effluent quality.
- g) BBMP should strictly link building permits to water availability in a ward or sub-ward.
- h) Restructure BWSSB as follows:
- i. Restructure the Governing Board of BWSSB to ensure BBMP representation, representation of Bengaluru's civil society, and representation of independent multi-disciplinary water experts, while drastically reducing the number of ex-officio members.
  - ii. Require public consultation for all major projects, following full disclosure of detailed project reports/plans. Ensure consistent criteria of cost-effectiveness and comparison of alternatives, including demand-side management and dual or triple-sourcing of water.
  - iii. Separate the operations, staffing and accounting of the Cauvery (or bulk) water supply division from the water distribution and sewage management functions, splitting 'new projects' also along similar lines.
  - iv. Reorganize/decentralise planning and operations to carry out planning of imported water, stormwater and wastewater at the ward level, including lakes.
  - v. Set performance benchmarks for staff at the smallest unit (ward) that include adequacy, affordability and access to all citizens, quality, reliability, source sustainability and financial sustainability.
- i) Introduce latest technologies for supply and quality monitoring, ensure rigorous monitoring of groundwater tables, and use best possible reporting technologies to make all data publicly accessible and understandable in English and in Kannada.
- j) Use various media tools to provide end-users with information on how they are performing in terms of water use efficiency and vis-à-vis adequacy norms.
- k) Over a 5-year period ensure that all CII users are monitored for groundwater consumption and charged for total water use. Work with KSPCB to link the Consent to Operate (issued by KSPCB) to metering of groundwater, use latest technology to install tamperproof meters.



- l) Carry out ward-level planning and management for flood-control using multiple complementary measures (rainwater harvesting in rooftops and public spaces, reduction of concrete to enable more infiltration, removal of solid waste, and lake management to absorb some of the floods).

### 7.7.2. Larger BMR area

- a) Revise RMP 2031 to include infrastructure plan and location for water supply, treatment and reuse that combines local groundwater and stormwater use (via lakes and rooftops), recycling, and sharing of Cauvery water with BBMP, along with rejuvenation of TGHalli (as its catchment urbanises), for the RMP's area outside BBMP boundaries.
- b) Set up special OneWater Boards—one for each of the 3 catchments surrounding /overlapping with Bengaluru—for such integrated planning and development of water infrastructure and water plans. The governance of these Boards should be jointly between KUWSDB, BMRDA and the existing local civic bodies (ULBs and Gram Panchayats), and subsequently to whatever new urban governance structures that emerge for these areas. The staffing should be multi-disciplinary.
- c) The water infrastructure plans must be integrated with the rest of the urban planning, especially zoning, building rules and building plan sanctioning processes.
- d) The state government to commit adequate funds for both the planning and the implementation of key infrastructure *before* the region gets heavily urbanized.

## 8. Water Quality, Pollution Control and Ecosystem Health

Water quality in Karnataka is facing threats from multiple directions. Geogenic pollutants, especially fluoride but also arsenic, are making groundwater unpotable in many habitations across 18 of the 30 districts. The main reason for the mobilization of geogenic pollutants is the pumping of water from deep aquifers—following the depletion of the shallow aquifer. The provision of reverse-osmosis (RO) filter plants is temporarily alleviating the problem, but creating the challenge of safe disposal of RO-reject water. Coastal salinity ingress is also resulting from depletion of coastal groundwater. Nitrate and pesticide contamination are two other threats that originate from the overuse of fertilizers and pesticides in agriculture.

However, the major threats to surface and groundwater quality, and therefore to public and ecosystem health, are from biological contamination (originating in untreated or poorly treated domestic sewage) and chemical contamination (originating in untreated industrial effluents). Biological contamination is ubiquitous in all urban settlements, and industrial contamination around all industrial clusters. Inadequacy of sewerage and sewage treatment infrastructure, clandestine disposal of effluents by industries, malfunctioning of individual and common wastewater treatment plants, weak standard setting, monitoring and enforcement, as also non-integration of programmes for sanitation with drinking water supply schemes are the major reasons for this state of affairs.

### **8.1. Geogenic pollutants, nitrates, pesticides and salinity**

Overall, the state will aim to become free of the threat of these pollutants by 2025, by:

- a) Incorporating RO-reject management costs and plans into the RO plant installation and operation programme; reject water to be used only for non-food crop irrigation.
- b) Limiting the installation of RO Plants to areas with TDS > 2000 mg/l to avoid the unnecessary creation of reject water hazard.



- c) Incorporating RO plant operations in source management programmes such as water security plans and watershed development.
- d) Taking up rejuvenation of the aquifer in areas affected by geogenic pollution by implementing strict limits on groundwater pumping.
- e) Focusing on rainwater harvesting into sumps in coastal areas (which are also high rainfall areas) to reduce dependence on groundwater.
- f) Improving the rigour of monitoring of output water quality, through third-party audit to and continuous tracking of geogenically affected habitations, incorporating high quality datasets generated by research organizations, verifying and incorporating where possible citizen-generated data, , and public display of these results.
- g) Initiating extensive monitoring for pesticide presence in groundwater and streams agricultural areas
- h) Developing regulatory policies around use of pesticides in agriculture
- i) Modifying Swachh Bharat Abhiyan guidelines to avoid the nitrate problem by increasing spacing requirements or changing technologies, including twin-pit toilets.
- j) Promoting organic and low-input agriculture.
- k) Ensure coordination between public health departments and water-related departments through inter-departmental forums.

### **8.2. Water pollution control**

The state will take up mitigation water pollution from domestic, industrial and agricultural sources on a mission mode. For mitigating domestic pollution, the primary responsibility will lie with ULBs and Gram Panchayats, whereas for industrial pollution, the primary responsibility will lie with the industrial units. The strategies will include a combination of improved standard setting, greater investments, changed technologies and scales, creating stakeholders in treated water, enhanced and reliable monitoring, and improved enforcement and accountability.

- a) Setting ambient water quality standards for all surface water bodies through a process of public consultation and identification of designated best use; and deriving effluent concentration and load standards based on the designated ambient quality and ecological carrying capacity; revision/issue of discharge permits accordingly.
- b) Set quality standards for water use that include criteria for not only biological contaminants but also for heavy metals and other chemical contaminants.
- c) Ambient quality monitoring to cover all major surface water bodies and all river stretches; 24x7 automated monitoring on all stretches adjacent to industrial areas; monitoring of groundwater contamination on a monthly basis in a 2km radius around all industrial estates; inclusion of heavy metals in all monitoring protocols; contaminant plume modelling to be part of the monitoring strategy. Third party scientific monitoring of effluent discharge to be taken up regularly and citizen monitoring also to be encouraged.
- d) Involve chambers of industry and commerce in promoting self-regulation and common effluent treatment by industries.



- e) Incentivise decentralised sewage treatment plants. Incentivise separation of greywater and black water and in situ treatment of greywater. Incentivise dual plumbing for reuse of treated water for flushing. Provide technical support for those adopting these measures.
- f) Adopt multi-scale sewage treatment technologies, including in-stream treatment, lake-side treatment, and apartment-level treatment. For centralised treatment plants, ensure sewerage connectivity is completed in parallel with plant construction. Emphasize low-energy, biological technologies wherever possible, including constructed wetlands.
- g) ULBs /parastatals will operate sewage treatment plants themselves and shall not outsource operations, so as to ensure quality and accountability.
- h) Ensure integration of sewage treatment plans with reuse plans, and lake management plans. First charge on treated wastewater will be green spaces and lakes.
- i) All STPs and treated wastewater diversions are to be subjected to environmental clearance procedures including public hearings.

### **8.3. Environmental Flows in Rivers**

Minimum environmental flows are essential for livelihood security, to ensure the survival of aquatic species and ecosystems, of wildlife dependent upon river water, and to support the spiritual and cultural needs of people. Environmental flow requirements are not just about the quantity of flow in lean seasons but also about maintaining monsoon-to-summer variations and ensuring productivity of estuaries.

In Karnataka, excepting a few undammed rivers such as the Aghanashini in Uttara Kannada district, most rivers have seen extensive changes in their flow regimes. Currently, the rivers particularly affected by inadequate environmental flows include the Cauvery (at multiple locations) and the Tungabhadra (downstream of the Tungabhadra dam). The Kali and Sharavathi are most affected by the evening out of flow regimes. The Netravathi and the Mhadei are the most threatened by ongoing diversion or hydro projects.

The state shall maintain environmental flow regimes in rivers to ensure a threshold of ecosystem integrity, livelihood security and cultural benefits. It will do so by:

- a) Modifying current dam releases so as to maintain minimum environmental flows in lean season of at least 10% of average dry season flow that prevailed in the pre-dam period, and maintaining salinity gradient of 20 ppt at estuary declining to 5 ppt at 20km upstream in west-flowing rivers.
- b) Maintaining tributaries of highly regulated/dammed basins including Kali and Sharavathi in an undammed state.
- c) Maintaining salinity levels in river water in estuaries of west-flowing rivers of at least 20 ppt in the dry season, reaching 5 ppt at about 20 km upstream.
- d) Protection of catchments of all rivers originating in the Western Ghats, permitting no further major forest conversion, especially of riparian forests. Similarly strict conservation of mangrove forests in river estuaries.
- e) Enabling fish migration on dammed rivers through provision of fish ladders and other measures



- f) Maintain the ban on sand mining in river beds throughout the state.

## 9. Managing Floods

Unlike states in the Ganga or Brahmaputra flood plains, Karnataka is blessed with a generally low flood risk, because almost all the rivers in the state originate in the state, and the state is therefore located in the higher reaches of each major river basin. However, the construction of multiple large dams for irrigation on east-flowing rivers has increased the human role in flood management, and the changing intensities of rainfall have increased the chances of high inflows that can aggravate the risk of flooding.

- a) While flooding cannot be fully prevented, the flood risk in regions downstream of the dams will be mitigated by the use of real-time monitoring and forecasting technologies and support provided by the National Disaster Management Agency should be combined with provision of some flood cushion during high rainfall periods and improved communication between dam managers and flood plain administration, including inter-state administration.

Urban floods are a recently emerging risk due to the increasing in frequency due to a combination of excessive concretization of land surfaces, choking and encroachment of storm water drains, and increasing intensity of rainfall due to climate change. Recognizing this risk,

- b) Urban flood management, especially storm water management, will be included in the Integrated Urban Water Management programmes in all cities, and
- c) The state will provide special support to all ULBs to remove encroachments from storm water drains, reduce concretization, and improve solid waste management.

## 10. Water Governance Reforms: Organizational

Water management is not simply a techno-managerial or techno-economic problem. Water has multiple uses, multiple stakeholders, and by its scarcity and hydrological nature it connects these stakeholders in complex ways. This requires both types of governance interventions: water resource **development** (making water available to users) and **regulation** (preventing over-appropriation, over-use or pollution). Governance of both kinds takes place through **institutional arrangements**, i.e., **organizational**, **financial** and **legal** instruments and processes through which these decisions about development and regulation are taken.

The current structure of water governance in the state is largely development oriented, from an era when water was seen as abundant and the main challenge was to make it accessible or available to those who desired to use it. However, the recognition that the state has now transitioned to an era of water scarcity—with basin closure and depleting groundwater—requires reforms/realignment of the governance framework to enable the paradigm shift articulated in this Policy, which also reflects a new 21<sup>st</sup> century understanding of water in all its dimensions. The state will, thus, seek to move towards a more normative, integrated, nested, knowledge-based, transparent and participatory governance framework and will carry out requisite organizational reforms for the same as spelt out below.



### **10.1. A 4-tiered structure for water allocation and regulation**

Recognizing the need for an integrated, transparent and knowledge-based regulatory system to govern this complex and scarce resource, the state will create a **4-tiered Water Resources Regulatory System**. The 4 tiers would be:

1. State-level Water Resources Regulatory Council;
2. Basin-level River Basin Authorities for allocating water;
3. Sub-basin level agencies, and WUAs and their Federations in command areas; and
4. Water Management Committees at Gram Sabha level in non-command rural areas, and Ward-level committees in ULBs for regulating surface and groundwater use within their jurisdictions.

The higher tiers will make allocations to the lower units, and the lowest units will actually plan, manage and regulate across all users on a day-to-day basis. The structure will be autonomous, multi-disciplinary, participatory and professional, backed by an integrated water data agency. The details of this regulatory system will be worked out within one year through a consultative process, incorporating learnings from other states.

### **10.2. Participatory Irrigation Management (PIM) in major and medium command areas**

PIM will be the statutory foundation for water management in command areas in collaboration with autonomous Neeravari Nigams managing the dams. In particular:

- a) Water distribution structures will be refurbished and then transferred to statutorily created WUAs consisting of all adult members of command area villages.
- b) WUAs will be authorised to collect water charges and retain their share; water charges will include charges for conjunctive use of groundwater in the command.
- c) Federations of WUAs covering each command area will enter into agreements with the respective NNLs regarding the quantum and timings of water supply, which will in turn be governed by the overall allocations specified at the basin and sub-basin level by the River Basin Authority.
- d) The work, funds and staff of the CADAs will be transferred to the Federations.
- e) The Neeravari Nigams will be given more autonomy to function as bulk water suppliers, with their own dedicated staffing, a full-time CEO, and a governing board that is greater representation of stakeholders/citizens of the river basin in which that NNL functions.
- f) Irrigation Consultative Committees for each command area will be statutory bodies for taking seasonal water release decisions, and will consist of only representatives from that command area and the corresponding NNL.

### **10.3. Participatory Integrated Groundwater, Watershed and Tank Management**

- a) Areas outside major and medium project commands will be managed by village-scale Water Management Committees (WMCs). They would plan and participate in the development of water budgets and integrated planning and implementation of watershed development, tank renovation and groundwater (and all water use)



regulation and distribution. The WMC would be the recipient of all government grants for these activities. It would also raise funds for operation and maintenance through appropriate water charges.

- b) Milli-Watershed Association (MWA) will be formed to cover multiple WMCs within a single catchment. The MWAs will be responsible for renovation, cleaning and excavation of feeder channels and repairs to diversion weirs/ regulators on feeder channels. They will also help resolve conflicts across WMCs within the cascade on water sharing and maintenance responsibilities.
- c) Technical Support Teams within Taluka Panchayats or Zilla Panchayats for providing monitoring and training programmes for WMCs and MWAs.
- d) This process of participatory integrated water planning and groundwater regulation will be initiated through the Atal Bhujal Yojana and expanded to the rest of the state, including ULBs. Partnerships with knowledge institutions civil society organizations will be an integral part of implementing this Yojana. A cadre of trained resource persons at local level will be created to support this process for the long run.
- e) The Watershed Development Department will be merged with the Minor Irrigation Department and Groundwater Directorate. Integrated Water Management in Rainfed Areas will be the mandate of this combined department, with its role focused on providing funding and technical support to WMCs and MWAs, while leaving implementation and day-to-day management/water allocations decisions to the latter.
- f) A similar structure will be used for planning at the ward- or small ULB-level for Integrated Urban Water Management.

#### **10.4. Ensuring adequate and transparent environmental and social impact assessment of new projects and more rigorous enforcement of pollution control**

- a) All water resource related public and private projects (whether for irrigation, industrial or domestic use, including so-called drinking water projects) or involving inter-watershed diversion will be subject to clearance by the basin-level water resource regulator for which transparent and credible environmental and social impact assessment and public hearings will be conducted, and projects modified in light of feedback received.
- b) The SEIAA which currently scrutinizes category B projects will ensure that the hydrological and socio-environmental impacts of all water-related projects are analysed thoroughly.
- c) To strengthen enforcement, KSPCB will increase citizen involvement and create dedicated divisions for water pollution-related enforcement (separate from air and noise pollution) in each of its regional offices.

#### **10.5. Separation of functions and clarity of mandates**

- a) The Karnataka Urban Water Supply & Drainage Board will be tasked with only development, implementation and operation of bulk water supply projects, i.e., provision of bulk water to ULBs or multiple villages. It will not engage in distribution, which will be the domain of ULBs and Gram Panchayats. It will also execute groundwater based water supply projects and sanitation projects for handover to relevant agencies (ULBs or gram panchayats).



- b) The Bangalore Water Supply & Sewerage Board will be renamed the Bengaluru Water Board, and it will have the mandate of 'managing and distributing all water', including local rain, storm and groundwater, wastewater and imported water for the citizens of Bengaluru (BBMP area). The bulk water supply division of BWSSSB (the one maintaining Cauvery stages) will be merged with KUWSDB.
- c) KTCDA will be a strictly regulatory body dealing only with tank encroachment. It will be an independent authority with an independent chairperson and professional staff and CEO. Custodianship of all urban tanks will be transferred to the respective ULBs and of rural tanks to the respective Gram Panchayats or Gram Sabhas.
- d) The NNLs' functions will be restricted to bulk supply of surface irrigation water. The CADA's functions will be handed over to the WUAs and their federations. The WALMI will be entrusted with the function of providing technical support to all WUAs and their Federations for planning and execution of conjunctive water management in the command areas and all associated developmental functions.

### **10.6. *Transparent and Accountable Governance and Professional Management***

- a) BWSSB's governance structure and procedures will be modified for greater professional management, for ensuring greater public input, expert input, transparency and accountability to the citizens of Bengaluru. It will have fixed term independent chairperson and more independent (expert and public) members and less only 3 ex-officio members. It will be required to facilitate and work closely with the ward-level committees for IUWRM. Its Chairperson and CEO will be selected through open well-defined selection processes.
- b) KUWSDB's governance structure will be modified for greater professional management, for ensuring greater public input, expert input, transparency and accountability, and it will be renamed suitably in light of the redefined mandate. It will have fixed term independent chairperson and more independent (expert and public) members and only 3 ex-officio members. Its Chairperson and CEO will be selected through open well-defined selection processes.
- c) The Neeravari Nigams will be restructured to ensure independent professional management, independent staffing, and governing bodies that have greater representation from citizens/stakeholders from the river basin in which that NNL functions.
- d) The Karnataka State Pollution Control Board will be restructured to increase its autonomy, ensure professional management, greater public and expert participation in its governance and greater transparency and accountability in its functioning. Its staff strength will be enhanced fourfold, and its monitoring and enforcement wing will be separated from its consent-management wing. Its regional presence will be enhanced in line with pollution hotspots, and its legal cell will be strengthened. Its financial resources will be augmented with a special environmental levy.
- e) The Environmental Appellate Authority set up under the Water and Air Act will be strengthened substantially to become an effective green court (or dispute resolution mechanism) at the state level. This will require selection of highly qualified members, expansion of benches to regional centres, provision of support staff for research and investigation and building awareness of the availability of the AA as an alternative to the more expensive court process.





## 10.7. Staffing and Training

- a) The staff strength for groundwater monitoring and regulation will be **increased manifold at all levels** (state, regulatory agency, ULB, Gram Panchayat) and in all agencies: monitoring, irrigation management, urban water supply, and pollution control.
- b) Water resource agencies will recruit hydrologists with training in groundwater, surface water and eco-hydrology and an orientation towards integrated water management, not surface water development or groundwater prospecting alone.
- c) All agencies involved in water distribution, whether rural, agricultural, or urban, will include community organizers and outreach staff. Moreover, “change management” training will be provided to all staff to improve their public interface and ability to meet new performance criteria.
- d) The water and sewerage divisions of all ULBs and BWSSB will be strengthened by expanding staff strength, and training in IUWRM, induction of groundwater specialists and social workers, and change management training to improve their public interface in general, and their ability to engage in participatory management, and to meet multiple performance criteria.
- e) The newly proposed regulatory agencies in the 4-tier WRRS, including River Basin Authorities and village-level bodies, will be provided with adequate support staff from multiple disciplines mentioned above. Again, training in integrated management and public interface will have to be part of their induction programmes. Refresher courses must be held every 10 years or so for all staff.
- f) KSPCB will expand its legal cell manifold, expand its overall staff strength, and induct economists to better estimate public and private costs and benefits of regulation.

## 11. Water Governance Reforms: Legal

The current legal framework for water governance is based on outmoded legal principles, with surface water being treated as state property, groundwater as an open-access / privatizable resource (based on land ownership) and wastewater having no clear legal status. This neither reflects the emerging realities of the water sector in the state or the new perspective inherent in the paradigm shift proposed in this Policy. Rights to water are *de facto* linked to land ownership, making its distribution inequitable. There is no explicit right to water for life, nor is there clarity on claims of basin-dwelling communities versus those dwelling outside the basin. The laws framing the creation of water supply agencies (urban or irrigation) authorize and empower the agencies, but do not specify their duties and responsibilities and the rights of citizens to be heard or to participate in decision-making.

Reforms in the legal framework will strengthen the normative, integrated, nested, knowledge-based, transparent and participatory water governance framework by complementing the organizational reforms proposed in this Policy. They will recognise that water is a common-pool resource to be held in public trust, and that the state at all levels from the village to the state government is the custodian of the resource, while explicitly repealing British common law and other outdated legal doctrines that come in the way of the paradigm shift enunciated in this Policy.

### 11.1. Water Framework Law

The state will adopt a water framework law that



- a) Specifies the normative goals of water governance, viz., adequacy, equity, environmental sustainability, environmental subsidiarity, and decentralised, transparent and democratic governance;
- b) Recognizes water for life as a basic human right,
- c) Adopts the Public Trust Doctrine, viz., that all water resources within a basin are a commons to be held in public trust by the state, primarily for citizens within that basin.
- d) Adopts the Precautionary Principle when taking decisions involving pollution, environmental flows, and sustainable use.

### **11.2. Separate PIM Act**

A separate PIM Act, embodying the elements outlined in section 10.2 will be enacted. It will replace the CADA Act.

### **11.3. Separate Act for Participatory Integrated Groundwater Management**

A separate Integrated Groundwater Management Act, covering watersheds and minor irrigation tanks, will be enacted, building on the Model Sustainable Management of Groundwater Bill 2016, and incorporating the elements outlined above in section 10.3.

### **11.4. Regulating rural tanks and urban lakes**

The KTCDA Act will be amended to create an authority that:

- a) Has the primary goal of ensuring tank and lake conservation;
- b) Is substantially autonomous from the state departments, including MID, with an independent, qualified CEO and a governing body that has substantial representation from civil society, experts, ULBs, and Gram Sabhas that are managing tanks;
- c) Has separate wings for rural tanks and urban lakes;
- d) Is given the role of only a regulator and facilitator, with powers to provide technical appraisal of tank rejuvenation proposals, adjudicate conflict resolution between cascaded tanks/lakes (till the WRRS is set up), to approve tank conversion proposals and water diversion proposals, and technical support.
- e) Mandates custody and management rights of rural tanks to the local Gram Sabha and of urban tanks to the ULBs. These rights will include fishery rights, and rights to manage all water use. In the rural areas, tank management will be part of the integrated water management structure proposed in section 10.3 above.

### **11.5. Domestic water supply and sewerage**

- a) Notify quality standards for drinking (not all domestic) water, applicable to both state and private suppliers.
- b) Amend BWSSB Act to change its mission and governance structure as outlined in sections 10.5 and 10.6.
- c) Amend the KUWSDB Act to change its mission and governance structure as outlined in sections 10.5 and 10.6.



- d) Amend urban and rural water supply laws to clarify that the agency or individual (in the case of decentralised wastewater treatment) who treats the wastewater is the 'owner' of the treated wastewater, but they must respect any customary use rights of that may have developed by downstream use before they take decisions to divert the treated water to other uses or users

### **11.6. Water Pollution Regulation**

- a) Notify ambient water quality standards suitable for each such desired best use. These standards will include thresholds for heavy metal and other industrial contaminants also.
- b) Notify a process by which the intended best use of each surface water body is arrived at through a participatory process, whereby the desired water quality of that water body is identified and it becomes incumbent on the KSPCB to take measures to meet those goals.
- c) Notifying additional standards for (treated) effluent discharge into water bodies and reuse in the form of treated wastewater for irrigation and for groundwater recharge, so as to include heavy metals and other industrial contaminants. Notify (under the EPA 1986 environmental clearance requirements for large-scale wastewater based irrigation or groundwater recharge projects. DPRs submitted for all such clearances will include multiple options for achieving similar outcomes, including demand-side management, leakage reduction, local supply augmentation, recycling, and so on. Public hearings will a mandatory part of such clearances, and will be seen as a positive opportunity to seek public input.
- d) Amend Karnataka Water Rules to make the appointment process for Chairperson of KSPCB more credible, and a professional selection and long-term appointment of the Member-Secretary (effectively CEO) directly by the Governing Board.
- e) Urge the Centre to amend the Water Act in order to ensure better representation of the affected public and independent experts in the Governing Body, renaming Member-Secretary as CEO, and clear naming of Governing Body. Till such amendment, creative use of the provisions of the Water Act will allow for significant shifts in the composition of the Governing Body.
- f) Request the Karnataka High Court to set up a green bench at the High Court and Trial Court levels to expedite pollution cases.

### **11.7. Strengthen Environmental and Social Impact Assessment**

- a) Under the central EPA, notify environmental clearance for all water projects involving non-drinking domestic and commercial use components.
- b) Make environmental clearance also be mandatory for wastewater diversion or groundwater recharge projects.
- c) Require that DPRs submitted for such clearances must include multiple options for achieving similar outcomes, including demand-side management, leakage reduction, local supply augmentation, recycling, and so on.

## 12. Systems for Data, Analysis, Knowledge Generation and Outreach

**Data** on water availability (rainfall, streamflow, groundwater levels) and water use (withdrawal, consumptive use) and their conversion to usable **information** at the appropriate scale are critical to the management of water resources. In turn, this requires building long-term **knowledge** about cause-effect relationships and technological options for water management.

The state of Karnataka has invested significantly in data collection on rainfall and weather data through WRDO and more recently through KSNDMC. But the systems for monitoring streamflow, water availability in reservoirs and (most important) groundwater aquifers is inadequate in comparison with the scale and complexity of water flow and use. Streamflow measurements are taking place in less than 40 locations (apart from a similar number of locations monitored by the Central Water Commission). A state with ~15 lakh wells has an observation well density of 1 in 200 km<sup>2</sup> and almost no information on aquifer boundaries at a practically useful scale. Monitoring of groundwater extraction is non-existent, as also of consumptive use (evapotranspiration) in agriculture or vegetative uses in general. Monitoring of ambient water quality is very limited, allowing polluters to evade detection. Monitoring of the health of aquatic ecosystems is non-existent. Most of this data is not available in real-time. There is no explicit policy on public access to water related data. Investments in supporting long-term generation of relevant socio-hydrological knowledge are very limited

The new paradigm of water management will also require data, analysis and knowledge generation to go beyond conventional approaches. If water is to be managed and governed with an eye towards equitable distribution, sustainable use and multi-level governance, then the data-analysis-knowledge needs of this paradigm are vast and multi-scalar. Meeting them will require a judicious combination of the latest high quality (but increasingly low-cost) instrumentation, sophisticated data management coupled with 'barefoot hydrology and hydrogeology' wherein users are involved in data gathering and analysis so that they can relate to and trust the decisions being made about their water resources. It will also require building long-term partnerships with knowledge institutions.

The state will build a comprehensive, coherent and open water data and information system supported by rigorous knowledge generation. To achieve this, the state will launch a **Jal Jnana-Vijnana Mission** that will include strategies along four dimensions: expanding water data gathering and access, creating systems of data analysis for decision-support, knowledge generation, and awareness building.

### 12.1. Strengthening data gathering

1. The network of stream gauges, reservoir level monitoring and observation wells will be expanded to a high level of granularity, viz., at least 1 observation well, stream gauge and tank/reservoir level monitoring point per Gram Panchayat. The data gathering will be a 50-50 combination of automated and manual measurements, and made available in real-time (for automated sensors) and near-real-time (for manual measurements) an open-access GIS platform (see below). These will be complemented by data gathered through citizen science wherever possible. All data will be validated by independent researchers on a regular basis. Substantial additional staff with background in surface hydrology, groundwater hydrology and agro- and eco-hydrology will be recruited for this purpose at all levels (state, district and taluka), and provided training in IWRM.
2. Aquifer mapping at the village or Gram Panchayat scale will be taken up on a priority basis. This will adopt a participatory approach, integrating with the water security



planning at village or Gram Panchayat level. At least 50% of the state will be covered in the next 3 years.

3. Updating updated stage-volume curves for all major, medium and minor irrigation tanks and urban water bodies using latest technology in bathymetry.
4. A major new initiative will be measurement and estimation of consumptive water use (especially evapotranspiration) by a) setting up a minimum of 25 ET measuring stations (using flux tower and other methods) located in irrigated agriculture, rainfed agriculture, forests, and other landscapes, and b) estimation of season-wise irrigated areas and cropping pattern at micro-watershed scales using remote sensing, drone-based mapping, and field measurements to build seasonal (and eventually monthly) estimates of consumptive water use.
5. The water quality monitoring network will be extended beyond current GP level monitoring of drinking water to monitor pollution in surface and groundwater as already indicated in section 8.2.
6. All data collected by all state agencies as well as central agencies (CWC, CGWB, IMD) will be made available in near-real-time in the public domain on an open-data GIS platform. This platform could be the Karnataka Water Resource Information System being prepared by ACIWRM or the Karnataka GIS system managed by KRSRAC. It will meet high standards of integration, inter-operability, timeliness, openness and user-friendliness.<sup>2</sup>
7. Encourage R&D institutions and industries to develop and commercialise low-cost, indigenous flow meters that can be made available to private and public water users for measuring pumping rates as well as consumption rates.

### **12.2. Data analysis for decision support (K-WINDS)**

1. The conversion of data into usable information at multiple scales will be facilitated by a Karnataka Water Information Network and Decision-Support System (K-WINDS). Such a decision-support system would take data from the GIS water data platform mentioned above, and
  - a. Generate village-scale or micro-watershed scale water balances that can be compared with commitments made or allocations given by the River Basin-scale Regulatory Authorities.
  - b. Generate information on water service delivery again at a highly granular scale to help identify areas of shortfall and reasons for the same.
  - c. Generate preliminary hydrological, environmental and social impact assessments for any new water transfer or dam project proposed in the state.
  - d. Compile annual State Water Balance based on nested water balances at basin and sub-basin scale by integrating all dimensions of water availability and use.
  - e. Encourage development of service providers who can provide Well Health services on the K-WINDS data.

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<sup>2</sup> The Andhra Pradesh government's APWRIMS (<http://www.apwrims.ap.gov.in>) provides a good starting template.



2. To enable the above data collection and analysis to be carried out in an integrated manner, a Jala Vijnana Mission Directorate will be created for next 5 years, with the following objectives:
  - a. to collate across agencies and make available water resource related data at village/ward scales, and to generate an understanding of the inflow, use and outflow of water (i.e., a disaggregated water balance) in the sub-basins and at finer scales on a regular basis.
  - b. To implement/coordinate all the additional data gathering activities mentioned above and carry out the additional analyses mentioned above.
  - c. Make publicly available all these data on an open data GIS platform, for both viewing and downloading for analysis by all.
  - d. This Mission will be headed by a professional and will be organized at basin, sub-basin and micro-watershed scale. It will be staffed at each scale by a multi-disciplinary team.
  - e. Eventually, the Mission will coalesce with the WRDO and the GWD (the two lead agencies for water data monitoring) to form a single Karnataka State Water Data and Information Agency.
  - f. This Mission/Agency will be governed by an inter-ministerial council to ensure that it answers to the needs of, and gets cooperation, from all water-related ministries (Water Resources; Minor Irrigation; Forest, Ecology & Environment; Urban Development; Rural Development).
  - g. The council will include the representatives from the Basin-level Water Resource Regulatory Authorities as the major data user, from independent experts, and from civil society who can guide the socio-technical dimensions of data gathering and analysis.
  - h. A process of external peer review to ensure data quality and analytical rigour will be built into all activities.
3. Given the decentralised approach to water management and regulation proposed above, a cadre of 'barefoot hydrologists' at the Gram Panchayat and ULB Ward level will be built who will service the regulatory apparatus at those scales, beginning with the Gram Panchayat-scale Water Security Plans under the ABY programme, and then extending to the entire state. Partnerships with CSOs and educational organisations will be built to provide the necessary support, and these barefoot hydrologists will be involved in all aquifer mapping, monitoring and analysis activities. The team of barefoot hydrologists will have the capacity to generate data analysis for community-level decision support systems.

### **12.3. Knowledge generation**

1. The state shall devote at least one percent of all (revenue + capital) annual expenditure in the water sector for supporting independent, high quality, multi-disciplinary socio-hydrological research on salient water issues in the state. An independent Research Advisory Board will be formed by the Water Resources Department for screening and guiding such research.



#### **12.4. Public outreach and awareness-building**

1. A parallel process of massive outreach and citizen awareness building to spread understanding of the nature and gravity of the water crisis facing the state and the need for holistic, equitable and sustainable solutions will be taken up.

### **13. Implementing the Policy**

To ensure full-fledged and consistent implementation of this water policy and the set of strategies outlined therein, the following structure is proposed:

- A State Water Governing Council (SWGCG) headed by the Chief Minister and including the Ministers for Water Resources, Minor Irrigation, Agriculture and Urban Development will be created. It will meet on a half-yearly basis to review progress in implementation and remove policy bottlenecks.
- An Executive Committee (EC), headed by the Chief Secretary, will serve the GC. It will include the Development Commissioner, relevant Secretaries and key knowledge and implementation partners from the Knowledge Bank Group who will be from outside government. The EC will take all operational decisions. It will meet on a monthly basis.
- A Knowledge Bank Group (KBG) with experts from within and outside the government will be created to render continuous technical support and advice to the Executive Committee. This will be housed in and supported by ACIWRM.

Given that the proposals contained in this water policy entail a huge paradigm shift in water management in Karnataka, to foster its widespread acceptance, as also given the urgency of action required on the ground in the multifarious elements of water policy, a 5-year multi-media campaign will be initiated to spread the key messages contained in the policy, with the help of PRIs and various knowledge and civil society organizations in the state. One of the functions of the KBG will be to plan and execute this campaign with the support of the EC and the guidance of the SWGC.



# Karnataka State Water Policy 2019







# CHAPTER 1. THE WATER CRISIS IN KARNATAKA: AN OVERVIEW<sup>1</sup>

## 1.1 *Water Diversity in Karnataka*

Karnataka is a state with water extremes: the highest rainfall in peninsular India occurs in the Karnataka Western Ghats at Agumbe (>8000mm per annum), and the Western Ghats in general receive heavy rainfall (>3000mm) that results in a lush green forest cover. The Western Ghats are also where most of the rivers of this state originate: the west-flowing ones (such as Kali, Aghanashini, Sharavathi, Varahi or Netravathi) that flow through the generally lush green coastal region into the Arabian Sea, and the east-flowing ones (such as the Ghataprabha, Malaprabha, Tunga, Bhadra, and Cauvery) that flow through the eastern plains towards the Bay of Bengal. But Karnataka's eastern plains have large areas of low rainfall, ranging from 600mm down to 300mm per annum, resulting in Karnataka having the second or third largest share in the region classified as semi-arid in the country.[4] These large variations in rainfall are depicted in Figure 1.

<sup>1</sup> This chapter draws upon the reports of Sub-Group 5 of the TGWP on "Groundwater and its Integration with Surface Water" led by Dr.Himanshu Kulkarni and Sub-Group 7 of the TGWP on "Water Quality" led by Dr.Sharachchandra Lele.

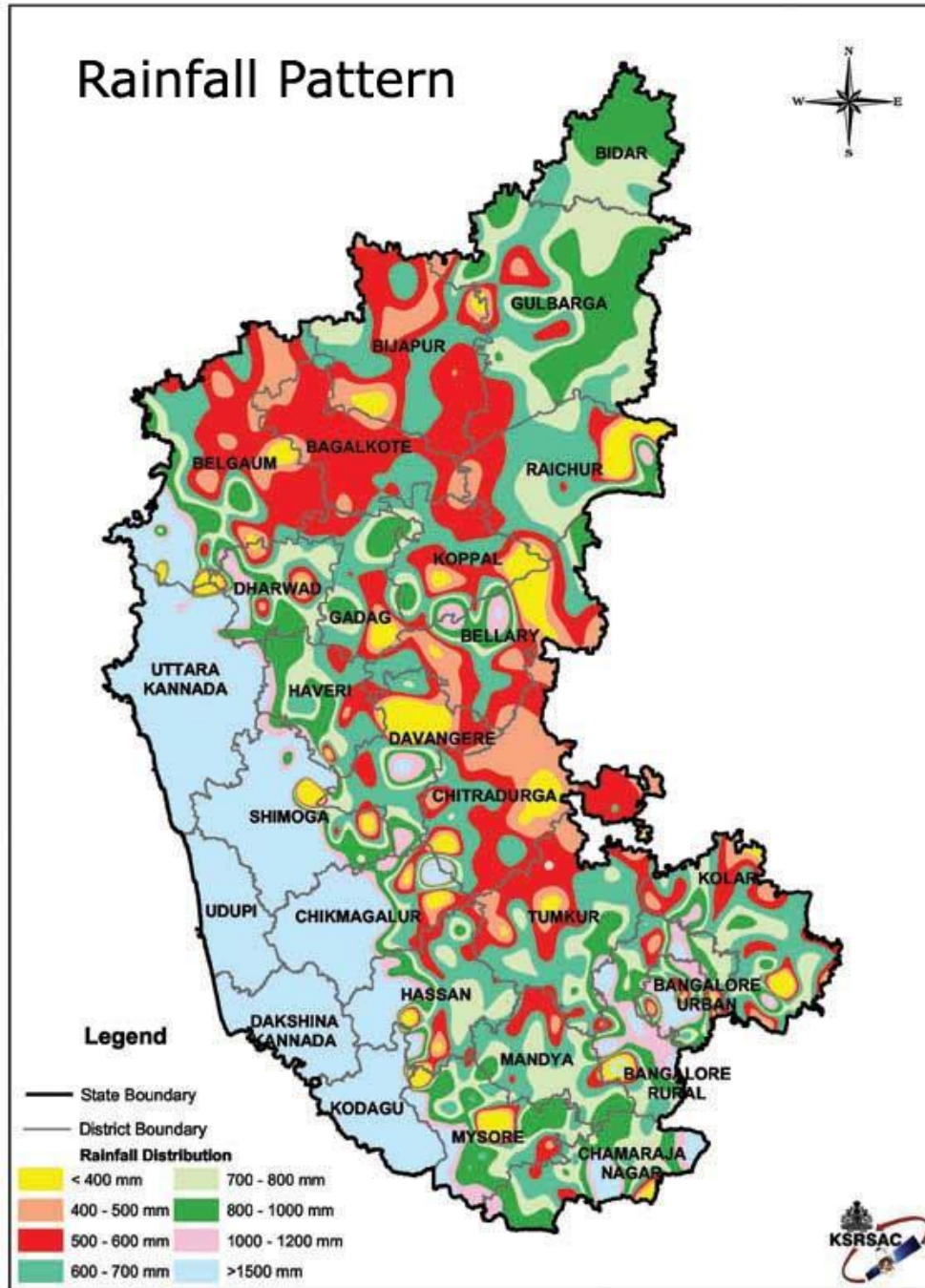


Figure 1. Rainfall variation across Karnataka (Source: KRSAC)



The many parts of the eastern plains therefore depend to some extent on the inflows from the Western Ghats region, as do downstream states of Telangana, Andhra Pradesh and Tamil Nadu. The major river basins of Karnataka are depicted in Figure 2. The state is drained through 7 river basins but is dominated by areas that fall within the Krishna and Cauvery river basins. The west-flowing smaller basins forming the third most significant river basin system. And the agro-climatic zones resulting from the combination of rainfall, temperature and soil conditions are depicted in Figure 3 with the state being divided into 10 different agro-climatic zones. The Krishna river basin itself encompasses 6-7 of these agro-climatic zones. National level analysis, which divides Karnataka into 7 Agro-Ecological Sub Regions points out that only the coastal zone and the hilly zone (Western Ghats) have a positive annual water balance (i.e., Rainfall>PET). (See Table 1)

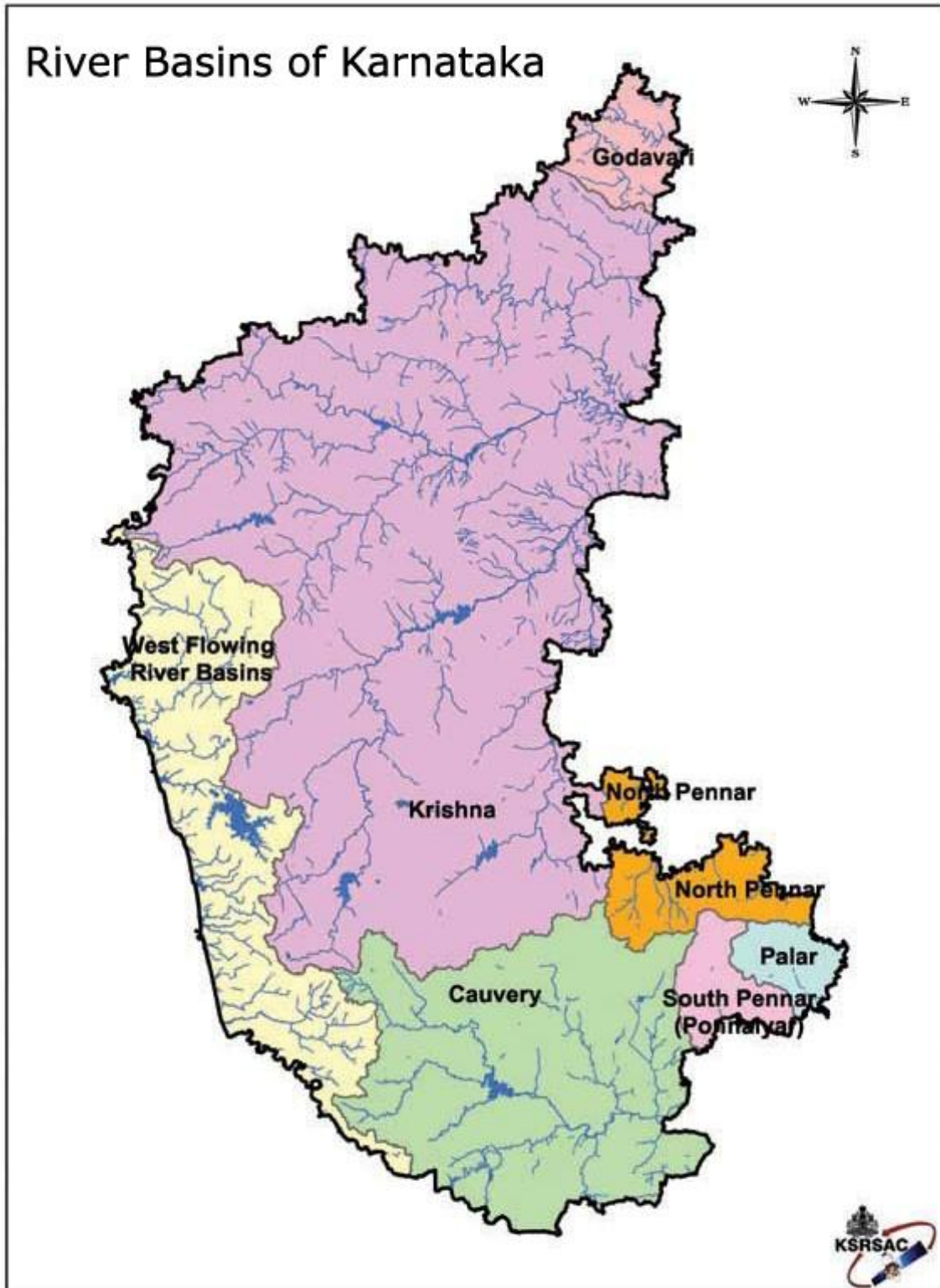


Figure 2. Major river basins of Karnataka (Source: KRSAC).

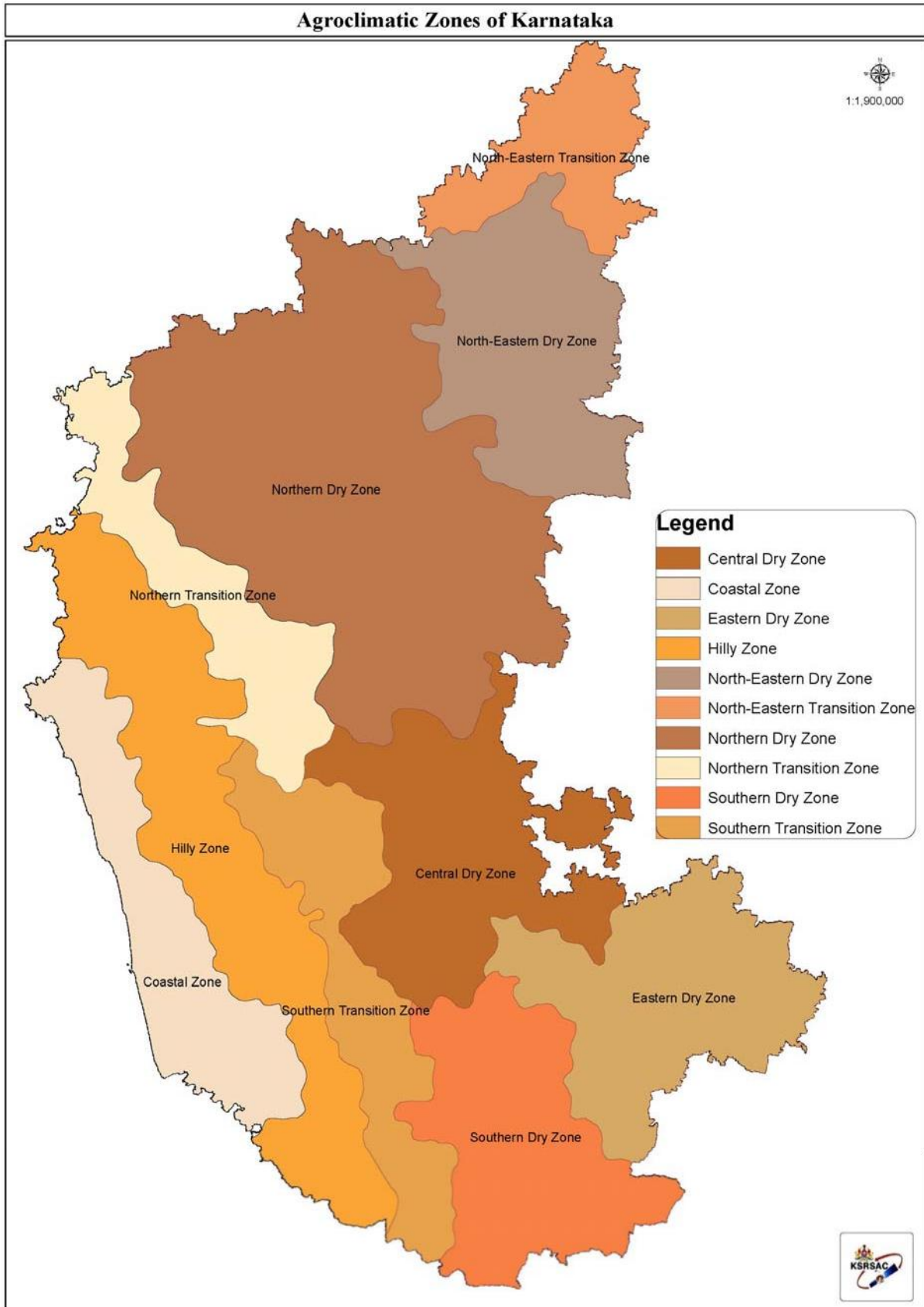


Figure 3. Agro-climatic zone classification of Karnataka (Source: KRSAC).

**Table 1. Agro-Ecological Sub-Regions (AESRs) of Karnataka.**

AESR No	Description	Distribution	Area (Million Ha)*	Length of Growing Period (Days)	Rainfall (mm)	Potential Evapo-Transpiration (mm)	Annual Water Balance
3	Deccan (Karnataka) Plateau, hot arid ecosystem with mixed red and black soils	Bellary and Southern Raichur, Bijapur, Northern Chitradurga and Tumkur	4.9	60-90	400-500	180-1900	Negative
6.1	Deccan (Western Maharashtra) Plateau, hot semi-arid ecosystem with medium to deep black soils	Bijapur (North Part), Raichur and Dharwar (East Part)	7.6	90-120	600-750	1500-1800	Negative
6.2	Deccan (East Maharashtra, North Karnataka) Plateau, hot, semi-arid ecosystem with shallow black soils	Bidar, Gulbarga					
6.4	Deccan (Western Maharashtra and Karnataka) Plateau, hot semi-arid ecosystem with shallow black soils	Belgaum, Dharwar, Eastern Part of Uttar Kannada (Karwar)	5.4	150-180	1100-1200	1600-1700	Negative
8.2	Deccan (Karnataka) Plateau, hot semi-arid ecosystem with red loamy soils	Eastern Part of Shimoga and Chikmagalur, Hasan, Mysore, Mandya, Bangalore, Chitradurga (South), Kolar, Tumkur	6.5	120-150	600-900	1600-1800	Negative
19.2	Western Ghats (Sahyadri) , hot moist sub-humid to humid and per humid ecosystem with red and lateritic soils	Western Part of Uttar Kannada, Shimoga, Dakshin Kannada (Mangalore), Western part of Chikmagalur and Kodagu (Madikeri)	6.9	210-270	2000-3000	1400-1800	Positive
19.3	Western Coastal Plains, hot per humid ecosystem with alluvium-derived soils	Narrow Coastal Strip of Karwar, Mangalore	2.0	240-270	>3000	1400-1700	Positive

Note: \* Area refers to the whole AESR and not only to its Karnataka part

Source: [5]



There are also many differences in the types of aquifers prevailing in the state (see Figure 4). The major type, prevailing in the eastern part of the state, is hard rock aquifers (granite, basalt, gneisses, schists and charnockites). These hard-rock aquifers not only have poor storativity but have highly variable transmissivities leading to a high degree of heterogeneity. Recharge rates in these regions are also quite limited. Indeed, Karnataka has the largest area of hard-rock aquifers within the country. On the other hand, the area underlain by potentially high storage aquifers is much smaller and is constituted by sedimentary rock formations such as sandstones and limestones, mostly in the northern parts of the state.

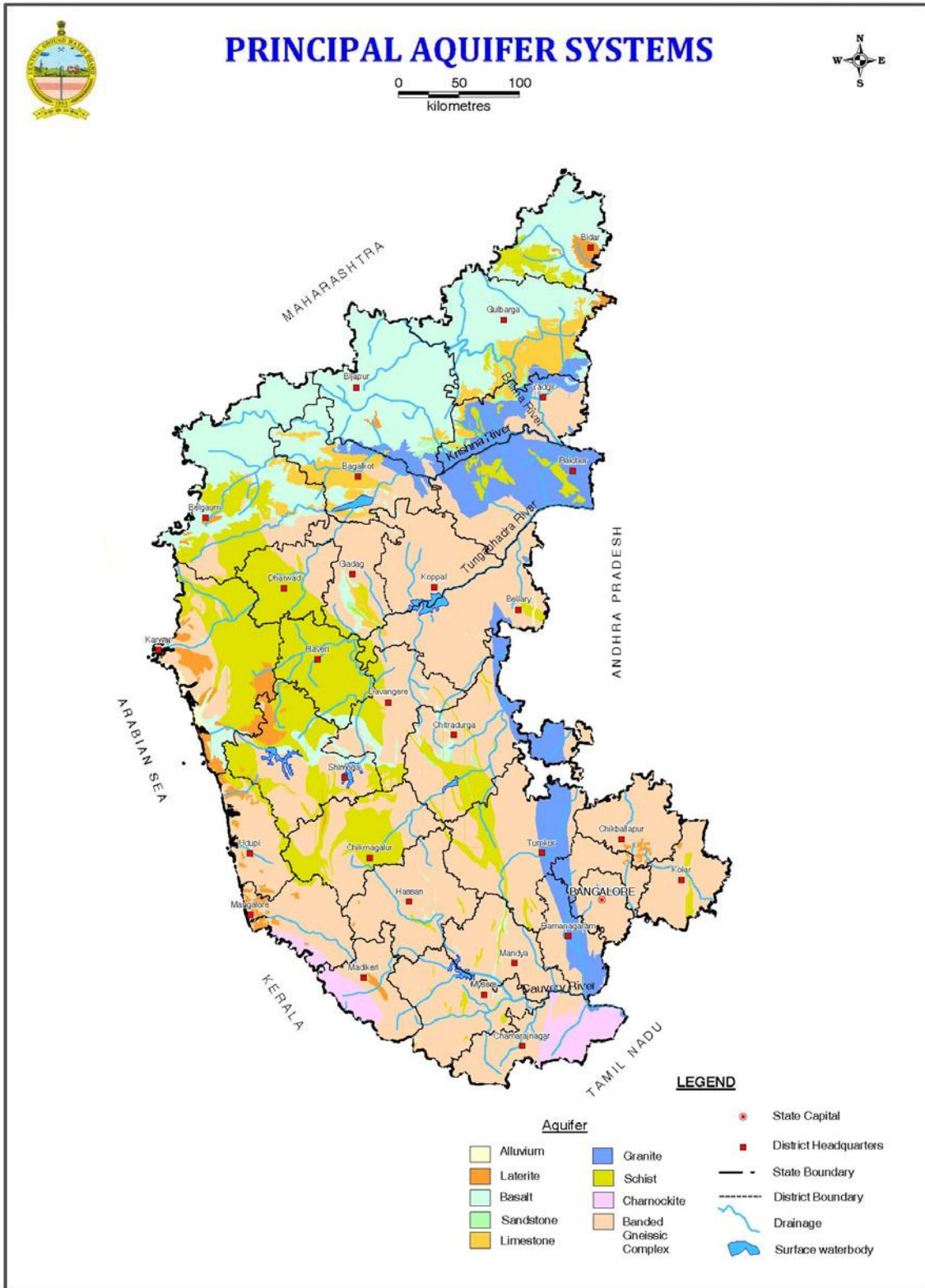
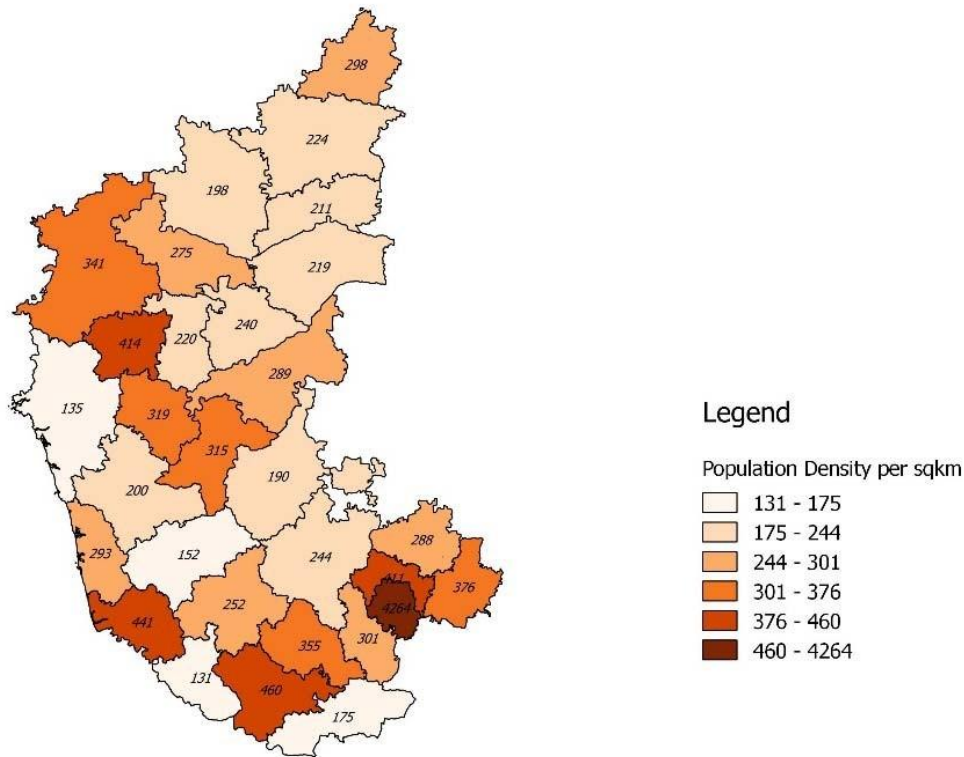


Figure 4. Principal aquifer systems of Karnataka (Source: Ground Water Directorate, GoK)





**Figure 5. Population Density of Karnataka's districts as per Census of India, 2011**

Similarly, the demand for water is also extremely variable. In particular, the distribution of population in Karnataka is highly skewed (see Figure 5), with Bengaluru district, which has become a megalopolis, and a few other districts (Mysore, Dakshina Kannada and Dharwad) hold much of the population. Bengaluru in particular is located in a region of only 900mm annual rainfall and far away from any major river, but has a very high demand for water by virtue of the concentration of population and commercial-industrial activity. On the other hand, agricultural demand for water has evolved over time in certain rural parts especially command areas of major reservoirs such as the KRS dam in the Cauvery basin and the Tungabhadra and Narayanpur-Almatti dams in the Krishna basin.

Water management in Karnataka has to thus confront large differences in rainfall, climate, groundwater features, demography, livelihood systems, economic activity and inter-regional dependencies. Water stress and water possibilities vary widely across the State and call for region-specific strategies.

### 1.2 Current status of surface water resources

The current status of water resources in Karnataka is a matter of major concern. First, the status of surface water sources: rivers, streams and tanks/reservoirs are showing clearly signs of decreasing flows.

To begin with, many rivers are showing signs of declining flows in general and declining summer flows in particular. The drying up of the Arkavathy River near Bengaluru, where

inflows into the Thippagondanahalli reservoir declined by 90% during a 70-year period is a classic example. It has been shown that this decline cannot be explained by changes in rainfall or temperature, and is driven by the expansion of eucalyptus cultivation and the over-exploitation of groundwater in the TG Halli catchment. [6]

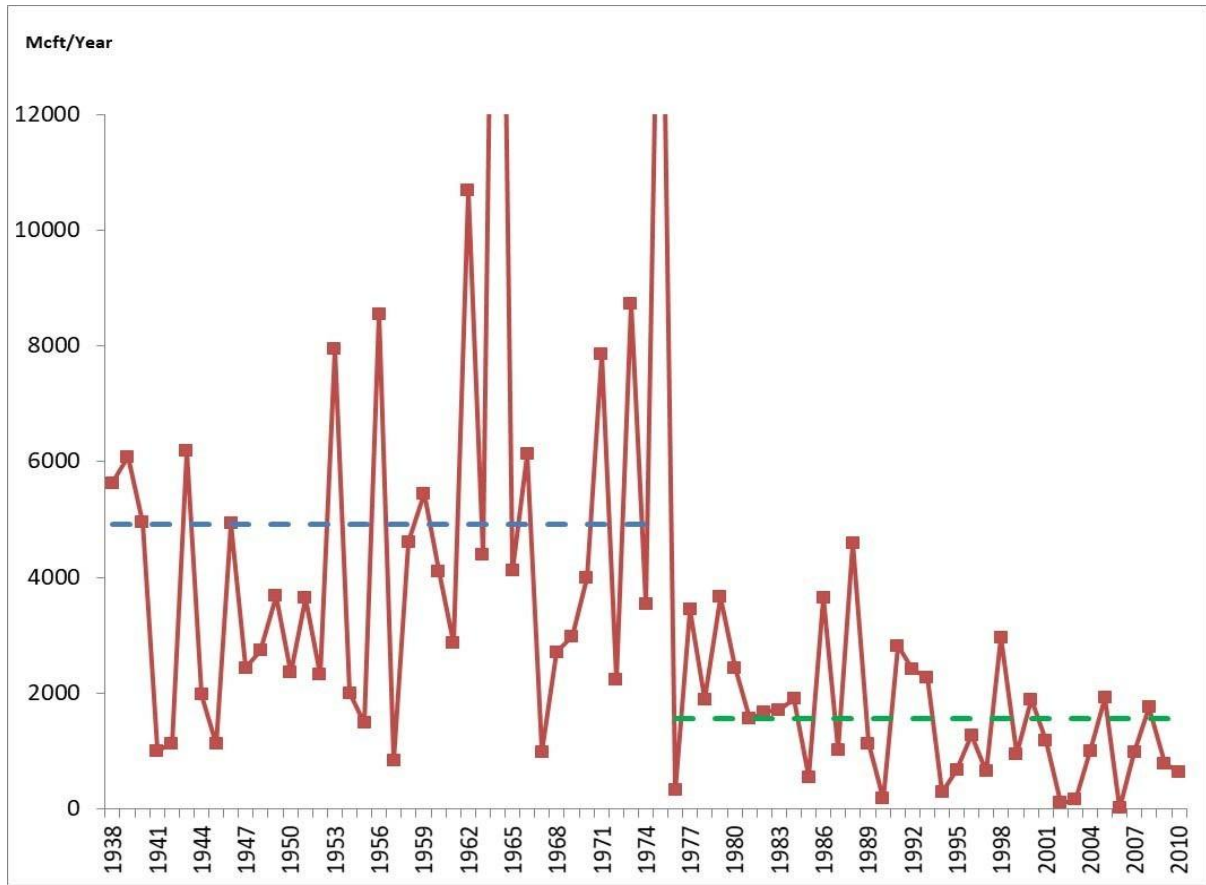


Figure 6. Dramatic decline in inflows into TG Halli reservoir on the Arkavathy river (Source: [6]).

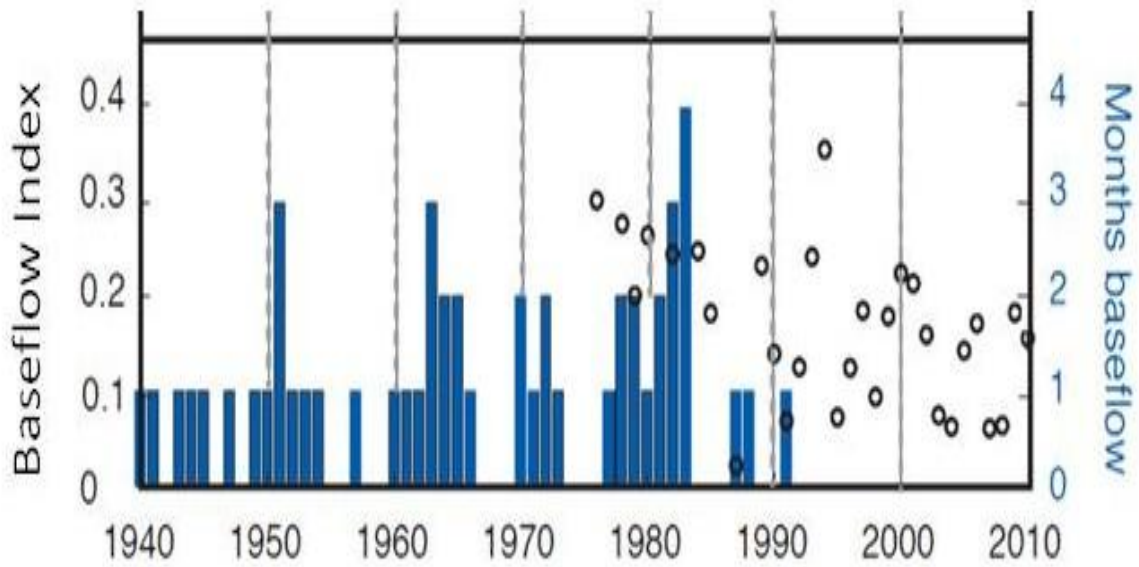


Figure 7. Data showing declines in post-monsoon flows (bars) and baseflow index (circles) in the TG Halli catchment (Source: [6]).

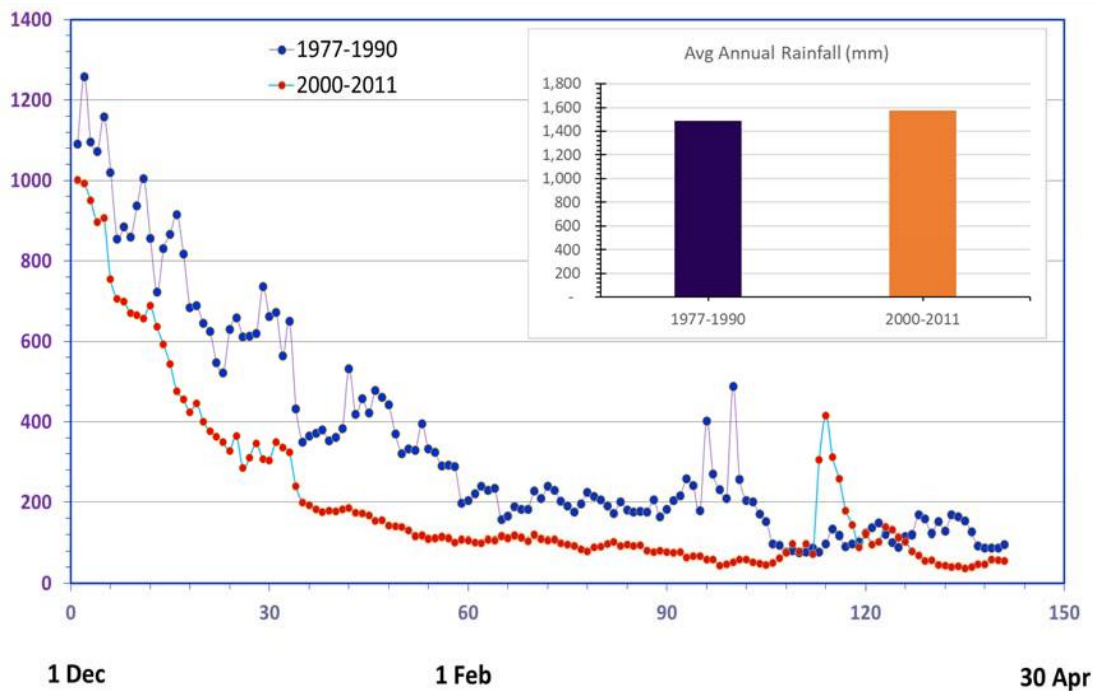


Figure 1. Declining post-monsoon flows in the Hemavathy river (Source: Ponni & Sekhar, IISc, unpublished data)

Another example is the Hemavathy river, where post-monsoon flows (Dec to Apr) have been significantly lower in the 2000-2011 period as compared to the 1977-1990 period, even though the average rainfall during these two periods has been very similar (in fact slightly higher in the later period). (See Figure 8).

Similarly, the inflows into the Malaprabha dam show a systematic decline over a 30-year period: while rainfall levels were similar during 1975-80 and 2000-2003, the flows in the earlier period were 55% of rainfall, whereas the later period saw flows of less than 30% of the rain. Again, the main reason for this decline is the dramatic increase in groundwater pumping in the Malaprabha dam catchment for the cultivation of water-intensive crops, primarily sugarcane.[7]

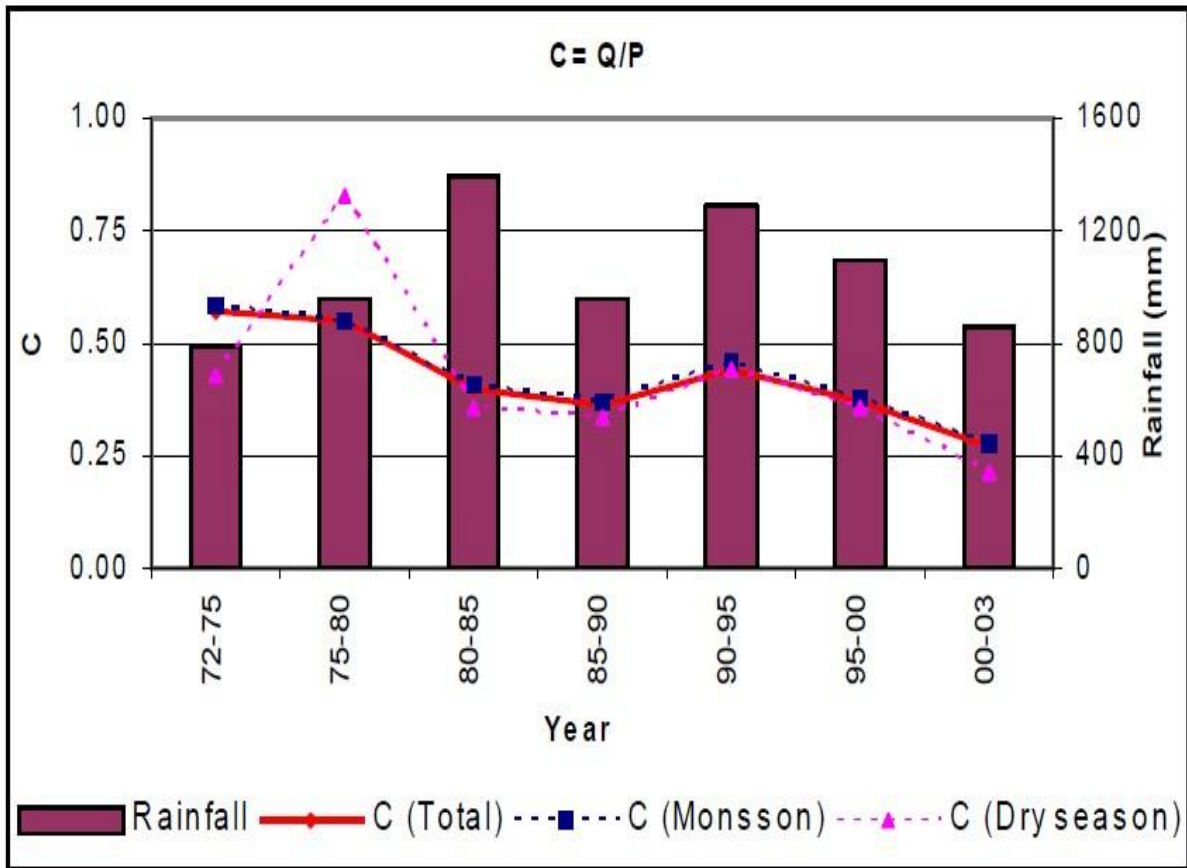


Figure 9. Declining Q/P (ratio of streamflow to rainfall) at the Malaprabha dam (Source: Reshmidevi & Badiger, 2007)

Even west-flowing rivers have not spared such human-induced flow declines. The Gurpur or Polali river of Dakshina Kannada district showed a declining base-flow index as seen in Figure 10. And analysis of climate data, land use changes and field investigations indicate that this is not due to deforestation but due to increase pumping by farmers from the river bed.[8]

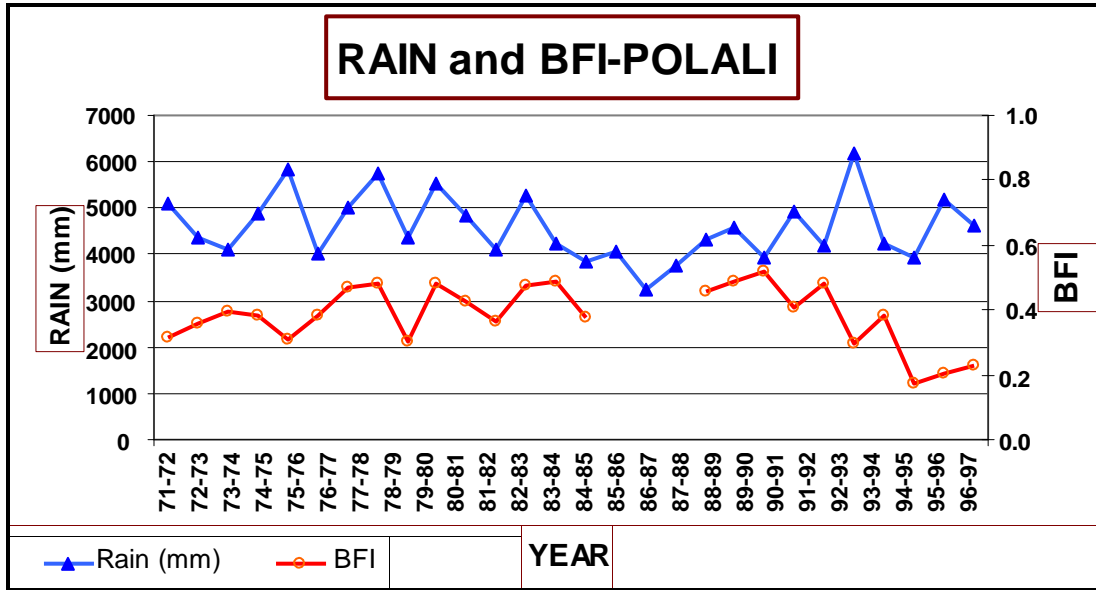


Figure 10. Declining baseflow index in Polali River (Source: Lele and Vaidyanathan, 2007)

The decline in streamflows is also reflected in the status of minor irrigation tanks in the state. Whereas Karnataka at one point boasted of nearly 25,000 such tanks, today, even the 3,500-odd tanks officially managed by the Minor Irrigation Department are facing significant shortages of inflows: For instance, a long-term study of all tanks in the Arkavathy basin using remote sensing showed that most tanks in the upper Arkavathy were drying over the years, whereas many tanks in the lower Arkavathy, where they received wastewater flows from Bengaluru, were ‘wetting’ (see. Figure 11)[9].

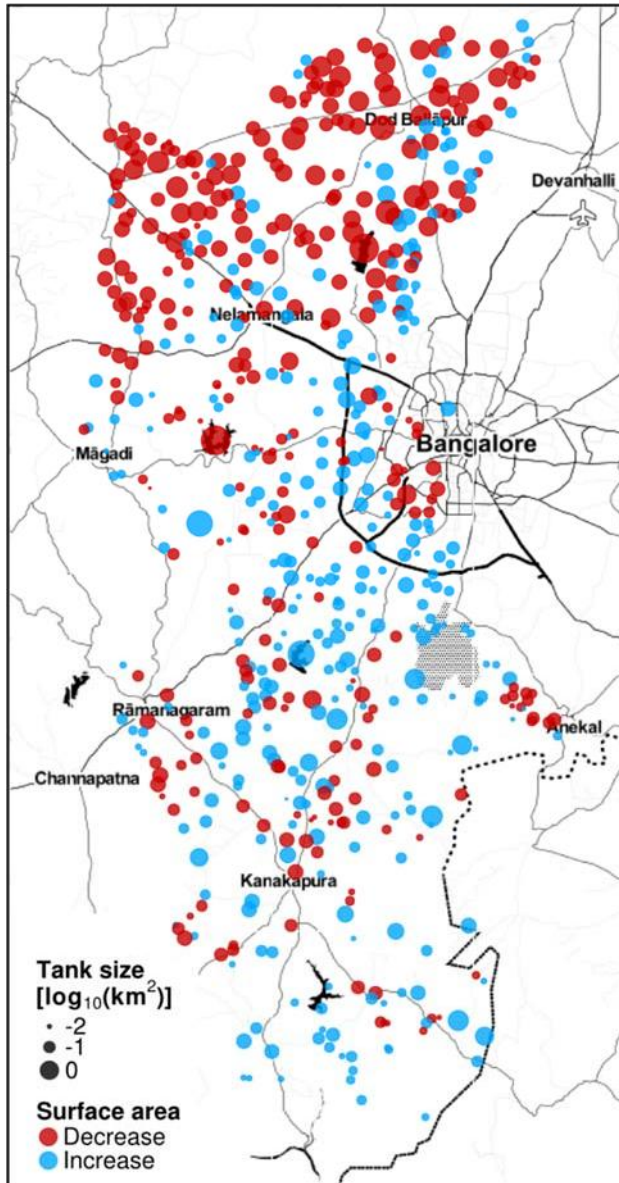


Figure 11. Drying and wetting trends in irrigation tanks in the Arkavathy sub-basin (Source: Penny et al., 2018)

A major factor that explains declines in river flows, is the increasing over-exploitation of groundwater, which accounts for a decline in the post-monsoon flows in these rivers. This problem is clearly a reflection of the unitary nature of water, a perspective on which this water policy must be founded given such a close interdependency of the dual problem of groundwater exploitation on one side and declining river flows on the other.

### 1.3 Current status of ground water resources

Groundwater is declining at an alarming rate across the whole state, in both levels and quality. As Figure 12 and Figure 13 show, many parts of the eastern plains suffer from groundwater over-exploitation, and the area of such over-exploitation has only increased between 2003 and 2013. As of 2017, 43 out of 176 talukas of the state are considered over-exploited, 14 are considered critical and 21 are in the semi-critical category [10].

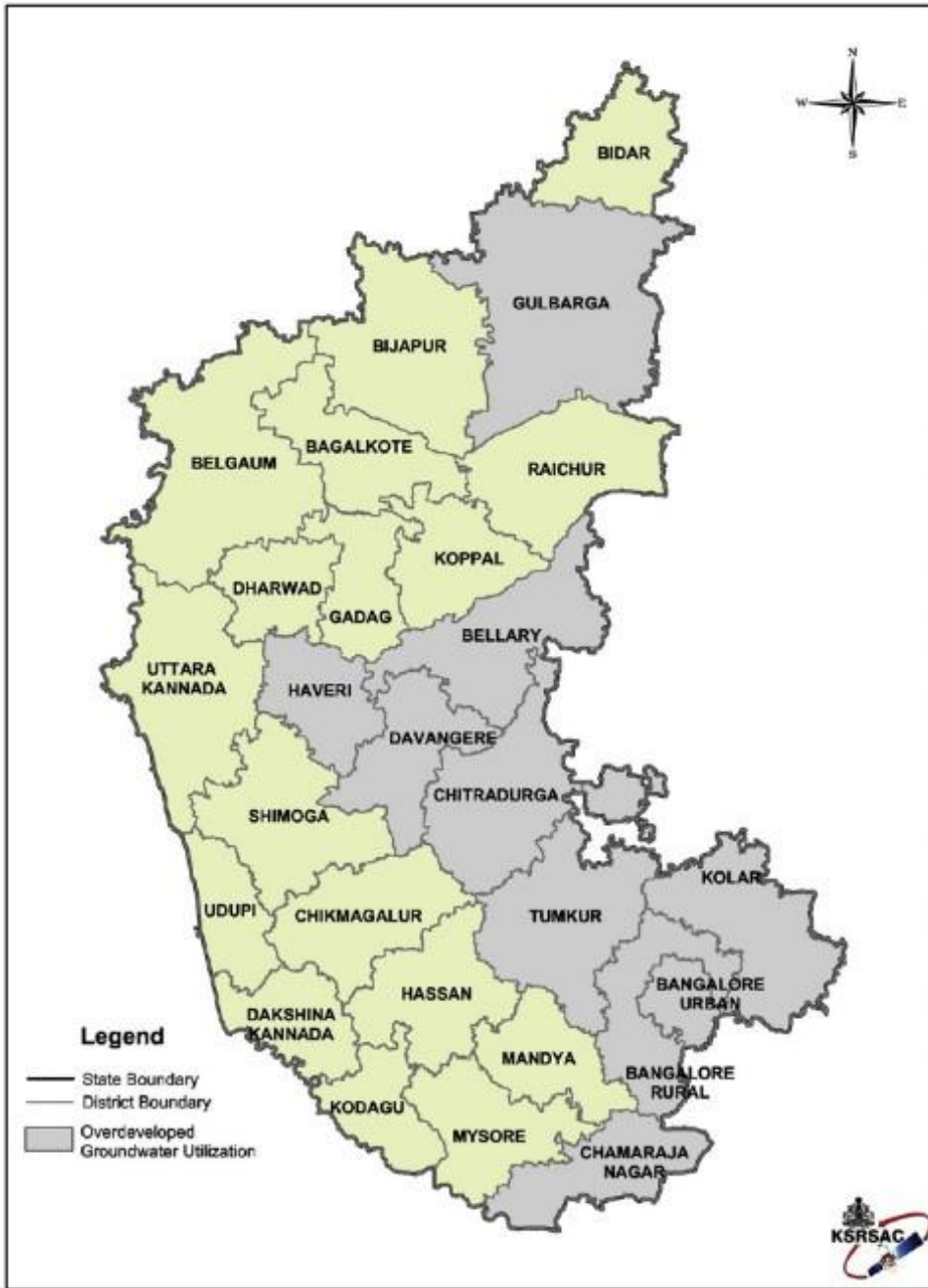


Figure 12. Status of Groundwater in Karnataka in 2003 (source: EMPRI's State of Environment Report 2003)

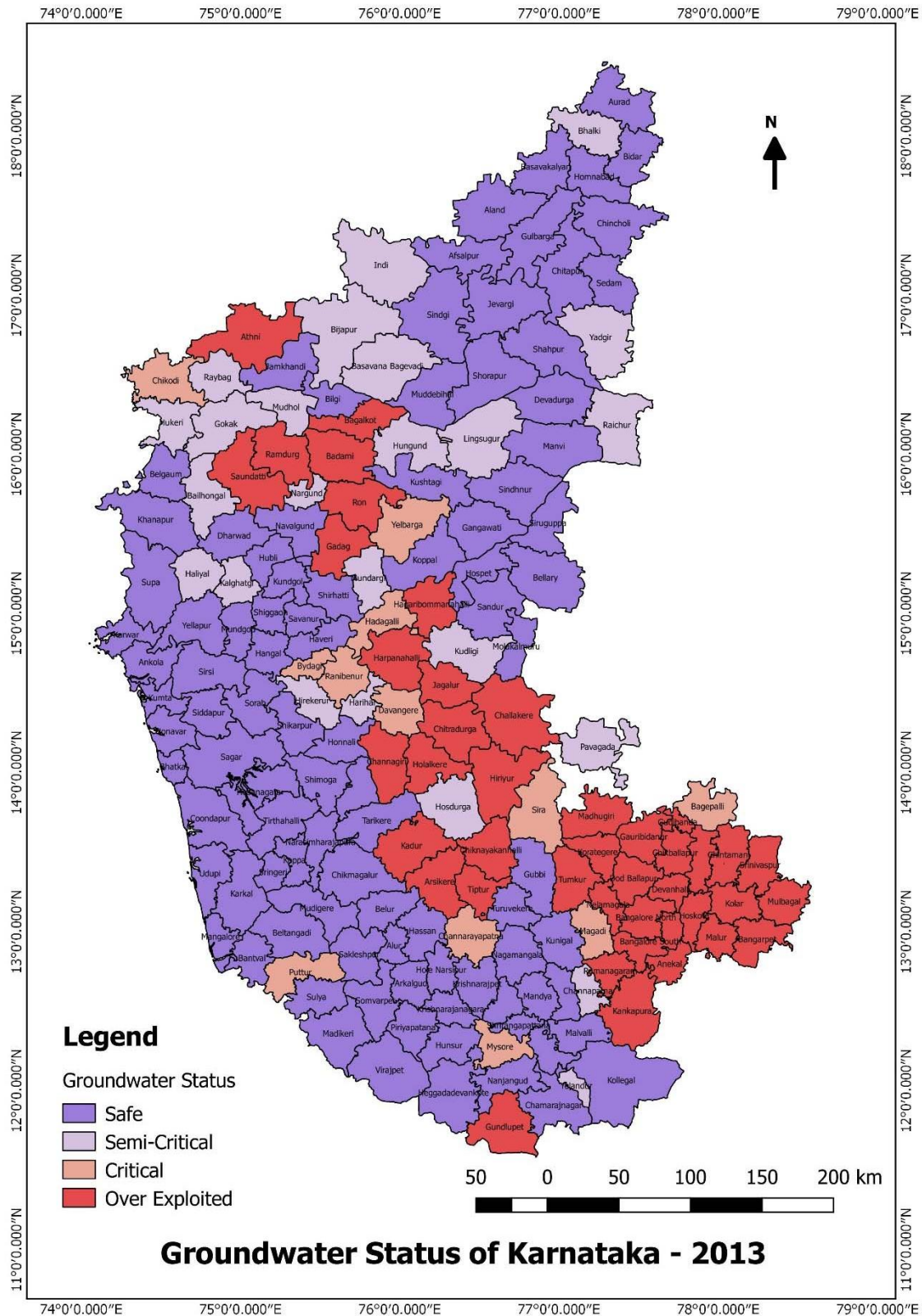


Figure 13. Status of Groundwater in Karnataka in 2013 (Source: Data from Ground Water Directorate)



When one overlays groundwater status with agro-climatic zones (Figure 14), one sees that the southern eastern and central zones (mostly the plains) are suffering the most from over-exploitation along with the northern transition zone. The north-eastern dry zones are not suffering as much, because of a combination of geology and being recipient of Krishna waters. Much of the overexploited zones are dominated by crystalline rock aquifers (hard-rock aquifers). Note also that regions receiving irrigation from major dams (such as Bellary district that receives Tungabhadra dam waters) do not show over-exploitation.

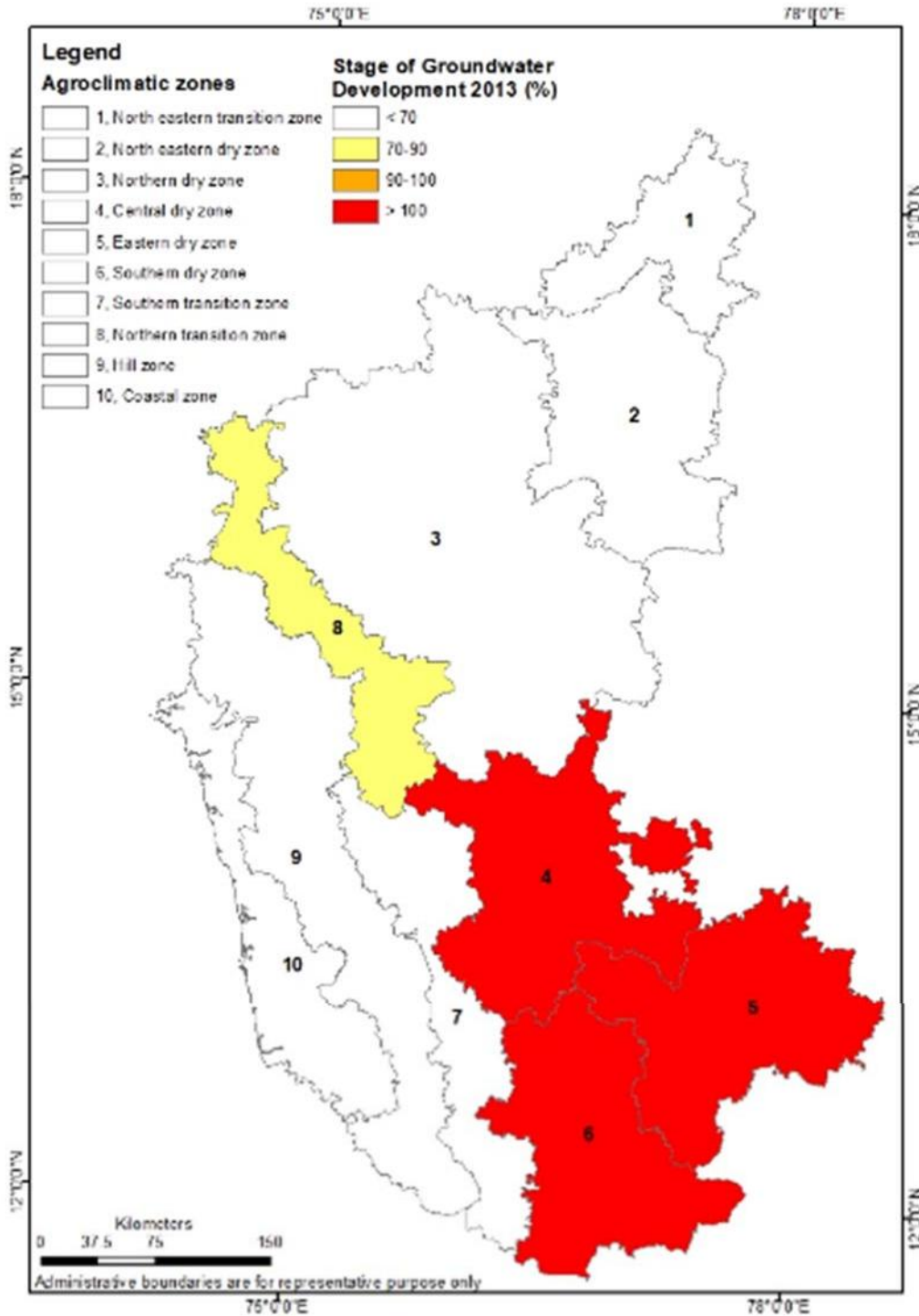


Figure 14. Overlay of agro-climatic zone and status of groundwater exploitation in Karnataka

The outcome of overexploitation is that almost all open wells in these regions have dried up or have water for only a short period during the year, and borewell failure rates are as high as 50% in many parts. [e.g., 11] and water tables continue to fall as studies in the Arkavathy basin [12] (See Figure 15) and elsewhere have shown.<sup>2</sup>

The overexploitation of groundwater not only reduces its future availability but also (as mentioned in the previous section) has also contributed to declines in base-flows in all the major river basins. The drying up of most of the minor irrigation tanks in the state is also partly related to declining groundwater levels in their catchments.

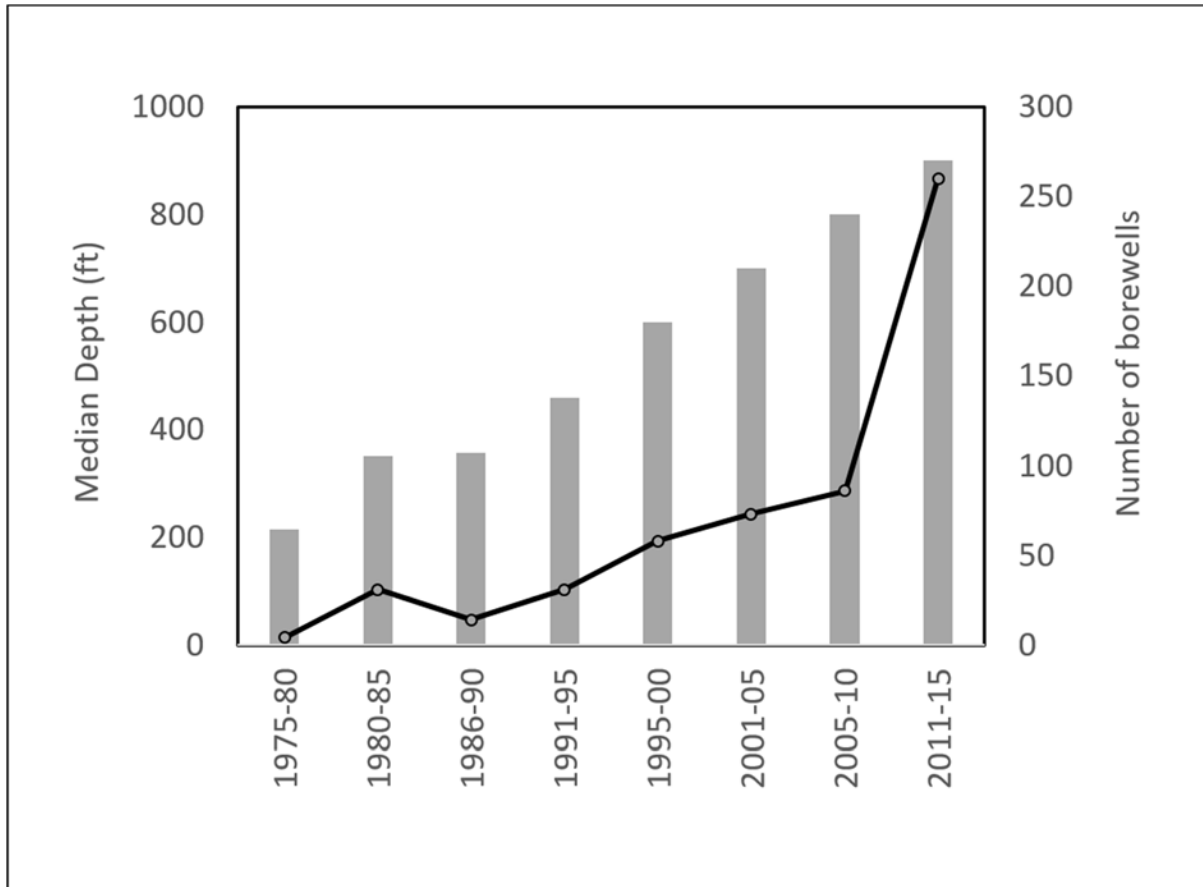


Figure 15. Increasing depth to water (solid bars) in the upper Arkavathy basin over time [Source: 12]

### 1.4 Likely impact of climate change on Karnataka’s water resources

There is clear evidence that climate change (caused by the accumulation of greenhouse gases in the atmosphere at unprecedented levels) is already under way and that it will affect the Indian subcontinent significantly in many ways: changes in rainfall patterns, temperature, sea levels, etc. Of these, the changes in rainfall patterns (to a lesser extent in the temperature

<sup>2</sup> <https://www.thehindu.com/news/national/karnataka/groundwater-table-depleting-fast/article8512261.ece>

regime) are extremely relevant to the water sector. Analyses of historical trends carried out for Karnataka Climate Change Action Plan [13] indicate that:

- there is a decline of about six percent in rainfall of Karnataka between 1951 and 2004
- Most of this decrease in rainfall is in the coastal and north interior districts.
- A steady warming trend is observed in both the minimum and maximum temperature over Bijapur, Gulbarga and Raichur.

However, it must be noted that in the last decade or so, the frequency of droughts seems to have increased. During the 16-year period from 2001 to 2016, 12 years were drought years [14]. Such frequent and often sequential drought has seriously affected soil moisture and depleted the water resources in the state.

Another pattern that seems to be emerging, is changing intensities of rainfall (the intensity being the amount of rainfall falling during an hour or a day when it does rain). Our preliminary analysis of rainfall data from district rain gauge stations provided by WRDO is summarised in Table 2. It suggests that rainfall intensities are increasing in the drier districts while decreasing in the hilly districts.

**Table 2. Rain gauges with statistically significant trends in amount of rainfall per rainy day.**

District	Trend
Ramnagara	Decreasing trend
<i>Bellary</i>	<i>Increasing Trend</i>
Bidar	Decreasing trend
<i>Bagalkote</i>	<i>Increasing Trend</i>
Chickmagalur	Decreasing trend
Mandya	Decreasing trend
Chamarajnaragar	Decreasing trend
<i>Mysore</i>	<i>Increasing Trend</i>
Koppal	Decreasing trend
Uttara Kannada	Decreasing trend
<i>Tumkur</i>	<i>Increasing Trend</i>

If this suggested trend continues, then the major implication for the water sector would be increase in flooding and reduction in groundwater recharge (as infiltration will reduce). While this may appear to benefit surface structures like dams or irrigation tanks in the short run, the long term impact of reduced recharge is quite serious in a state that is already struggling with declining groundwater levels.

## **1.5 Current status of water quality**

The status of water quality in the state is also very precarious and the incidence of pollution is rising. The threat to water quality comes from several sources: geogenic, biological contamination and chemical contamination.

### **1.5.1 Geogenic contamination**

Geogenic chemicals such as fluoride and arsenic have emerged as significant threats to potability of water in many parts of Karnataka.

**Table 3. Fluoride, Nitrates and excess hardness/salts (high electrical conductivity) in groundwater samples**

District	Fluoride	Nitrates	EC
Bagalkote	Yes	Yes	Yes
Ramanagara	Yes	No	No
Bangalore Urban	Yes	Yes	No
Belgaum	Yes	Yes	No
Bellary	Yes	Yes	No
Bidar	No	Yes	No
Bijapur	Yes	Yes	Yes
Chamrajnagara	Yes	Yes	No
Chikmagalur	Yes	Yes	Yes
Chitradurga	Yes	Yes	Yes
Dakshin Kannada	No	No	No
Davangere	Yes	No	Yes
Dharwad	Yes	Yes	Yes
Gadag	Yes	No	Yes
Gulbarga	Yes	Yes	No
Hassan	Yes	Yes	No
Haveri	Yes	Yes	Yes
Kodagu	No	Yes	No
Chikballapur	Yes	Yes	No
Koppal	Yes	Yes	Yes
Mandya	Yes	Yes	No
Mysore	No	Yes	No
Raichur	Yes	Yes	Yes
Shimoga	Yes	Yes	No
Tumkur	Yes	Yes	No
Udupi	No	No	No
Uttar Kannada	Yes	No	No
Yadgir	Yes	Yes	Yes
Bangalore Rural	Yes	Yes	No
Kolar	Yes	Yes	No

(Source: National Water Quality Sub Mission, Ministry of Drinking Water and Sanitation, Government of India)

**Fluoride:**

High fluoride has been detected in 18 out of 30 districts (see Table 3), and 1038 habitations in all have been declared as fluoride affected. The number of suspected cases of fluorosis is more than 8,000, with the maximum numbers in Chikballapur, Kolar, Tumkur, Mandya and Raichur districts (source: same as Table 3). Although fluoride comes from natural sources



(hence geogenic), the mobilisation of fluoride is certainly related to the pumping of deep groundwater.

### Arsenic

Karnataka has the dubious distinction of being the only state outside the Gangetic basin which is showing signs of arsenic contamination in groundwater. As of now 21 habitations have been detected as being affected. They seem to show up near mining areas. Raichur district has half of these habitations. Again, the mobilization of arsenic is related to the pumping of deep groundwater.

### Iron and TDS

High iron and total dissolve solids (mostly salts) are also issues affecting groundwater quality. High TDS is something ubiquitous, while iron is present in pockets.

When geogenic contamination data are combined with groundwater over-exploitation data, we get an overall vulnerability map (quantity/quality) that shows much of the state as being vulnerable. All the districts in the state, but for two, show indications of either a groundwater

exploitation problem or a problem of contamination. Some districts show indications of both types of problems.

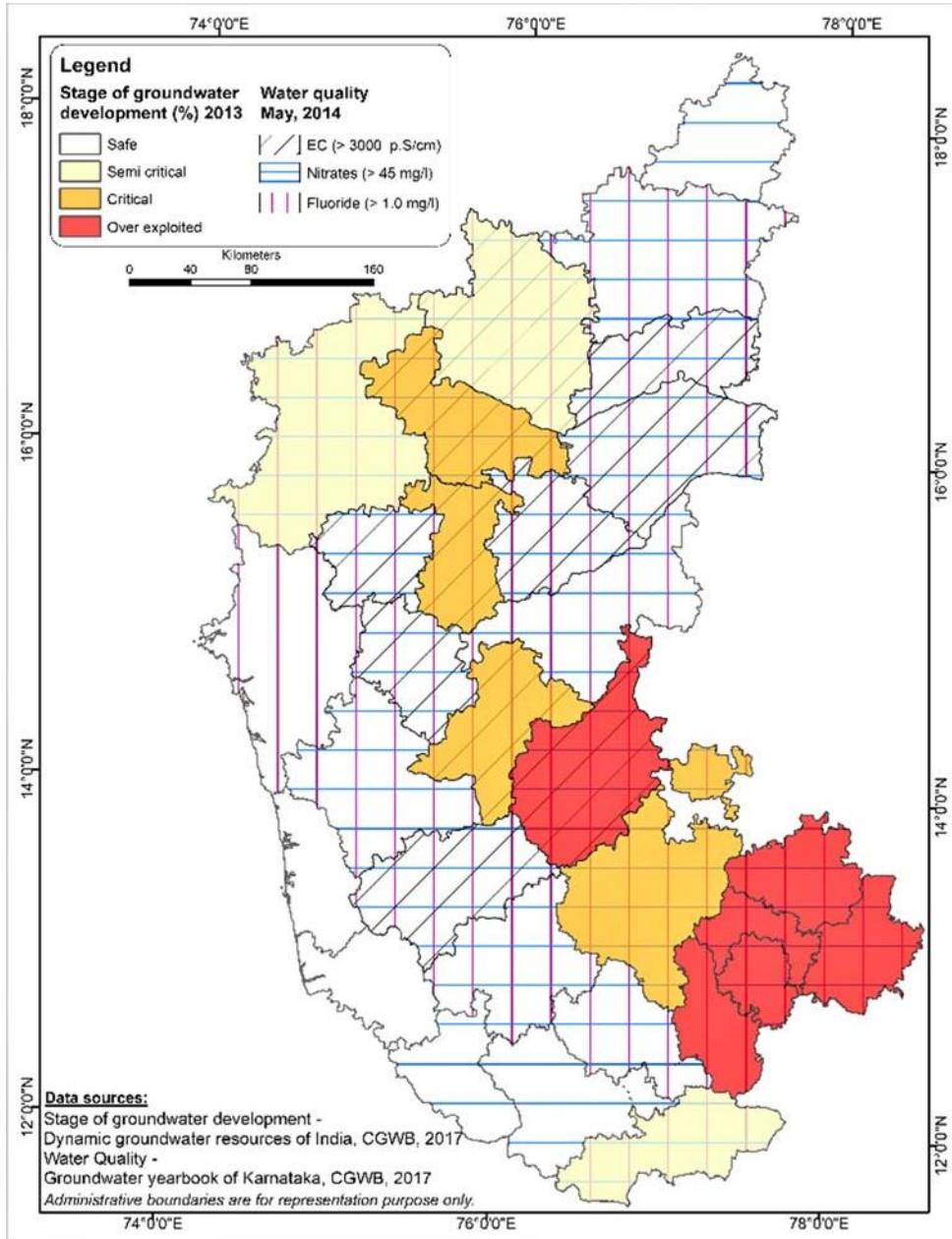


Figure 16. Overall groundwater vulnerability (quantity or quality)

### 1.5.2 Biological contamination

Biological contamination, primarily the result of domestic sewage, is ubiquitous in surface water bodies, especially in urban Karnataka. The Vrishabhavathy River in Bengaluru is an infamous example, and has been locally called a *mori* (sewer) for decades. Simply seeing and smelling it is enough to indicate the level of contamination: see Figure 17



**Figure 17. Vrishabhavathy river in Bengaluru (Photo: Priyanka Jamwal)**

The lakes in Bengaluru and many other towns and cities are equally contaminated. Again the extreme version is found in Bengaluru, where Bellandur lake receives 280 ML of raw (untreated) sewage every day as per official figures [15]. Such contamination has resulted in episodes of extreme frothing at the overflow weirs of Bellandur and Varthur lakes (see Figure 18).



Figure 18. Extreme frothing at Varthur Lake, Bengaluru

### 1.5.3 Chemical contamination

The major source of chemical contamination is industries. There is inadequate monitoring of water quality around industrial clusters in Karnataka, but for instance the Peenya Industrial area of Bengaluru has reported serious groundwater and surface water contamination for many years (CITE: The Hindu, 4 Sept 2018), including highly toxic hexavalent chromium in groundwater. A rigorous monitoring of that part of the Vrishabhavathy that flows through Peenya Industrial Area has revealed high levels of heavy metals, peaking at night.

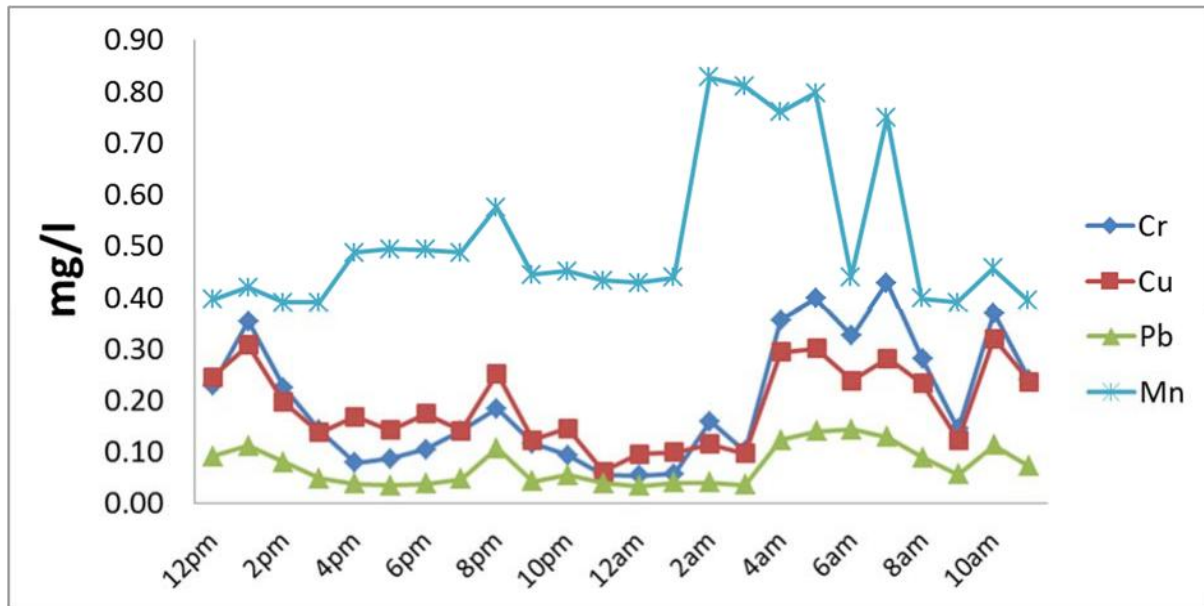


Figure 19. Heavy metal concentrations (especially at night) in Vrishabhavathy River passing through Peenya Industrial Area (Jamwal et al. 2018)





Data on other cities and industrial clusters are not readily available, but there is no reason to believe that they would fare any better.

Another set of pollutants about which scientists have warned are what are known as 'emerging contaminants', i.e., chemicals being used in houses for cleaning, painting, etc. which are entering sewage but do not get treated in customary sewage treatment plants and are now accumulating in water bodies and affecting ecosystems in yet unknown ways.

### **1.6 Summary**

In short, although occasional years of heavy rainfall such as 2017 and 2018 may provide an illusion of plenty, Karnataka is facing a major crisis in terms of surface flow declines, drastic declines in ground water levels, and deteriorating water quality. Hence, water resources in the state are coming under severe stress that has led to high vulnerability of the people to droughts, water scarcity and contamination, endangering water security in both rural and urban Karnataka. This, and the associated socio-economic as well as ecological impacts, demands that a new water policy be framed to address the core issues driving this crisis.



## CHAPTER 2. FOUNDATIONS, OVERALL GOALS AND OPERATIONAL PRINCIPLES<sup>3</sup>

### 2.1 *Socio-hydrological foundations of the water policy*

Water has certain key socio-hydrological features that make its management challenging. The Government of India's Draft National Water Framework Bill 2016 puts it succinctly:

“Water is the common heritage of the people; is essential for the sustenance of life in all its forms; an integral part of the ecological system, sustaining and being sustained by it; a basic requirement for livelihoods; a cleaning agent; a necessary input for economic activity such as agriculture, industry, and commerce; a means of transportation; a means of recreation; an inseparable part of a people's landscape, society, history and culture; and in many cultures, a sacred substance, being venerated in some as a divinity .. water in all its forms constitutes a hydrological unity, so that human interventions in any one form are likely to have effects on others; water is a finite substance in nature, circulating through the hydrological cycle for millennia; ground water and surface water interact throughout all landscapes from the mountains to the oceans”.

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<sup>3</sup> This chapter is based upon the note titled “Foundational Principles for Karnataka Water Policy” prepared by Dr.Sharachchandra Lele.

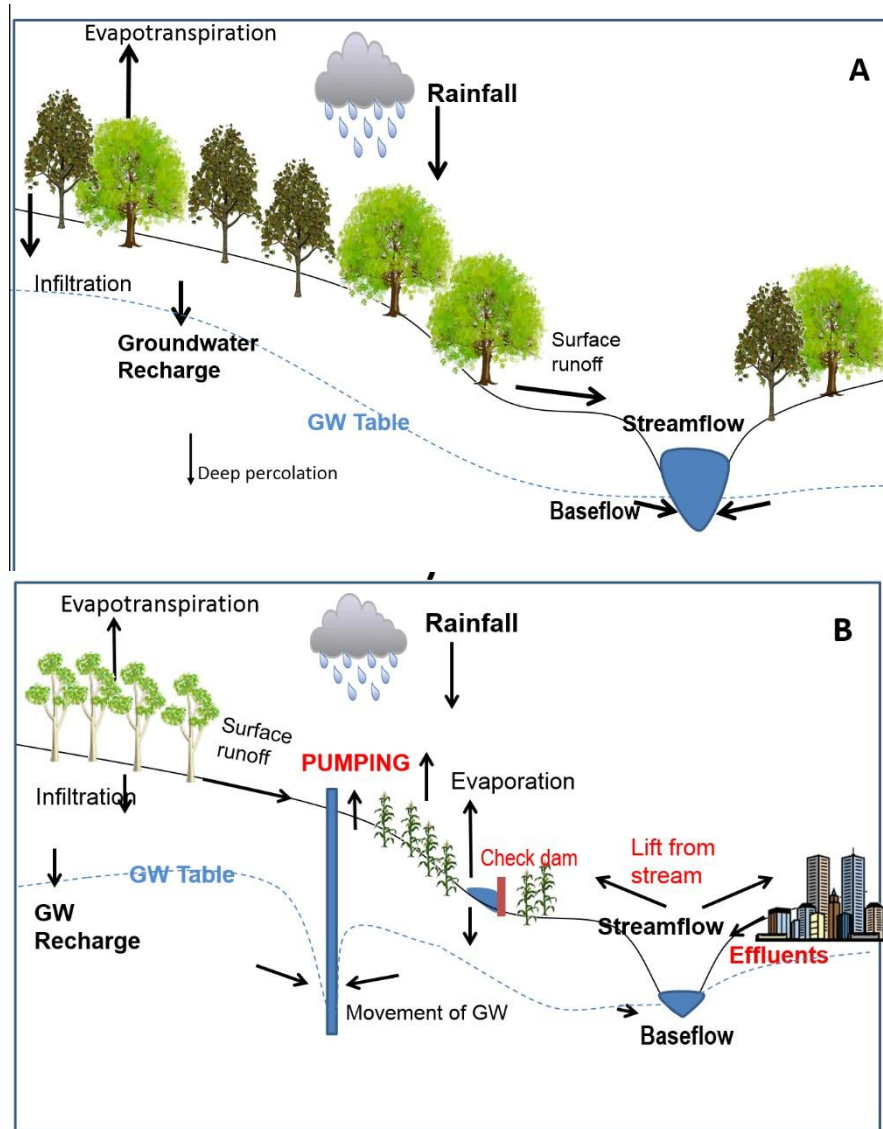


Figure 20. The natural hydrological cycle (A) shows how under pristine conditions, most of groundwater recharge will re-emerge as baseflow (or discharge) in streams. In (B), we see that interventions such as groundwater pumping lower the groundwater table and reduce baseflow or even reverse it. Other interventions (check dams) may increase recharge, but at the cost of surface flow. Changes in crops and urbanization change evapotranspiration and the quality of runoff (based on [16]).

To elaborate on this:

- Water is a bulky, limited, annually replenished, seasonal, uni-directionally flowing common-pool resource at basin scales. Its rate of renewal is not stock-dependent, but depends primarily upon precipitation and amount of recycling.
- Surface water and groundwater are highly interconnected, with the annually replenished (or dynamic) groundwater simply being a temporary phase of the cyclical movement of water i.e., the unified hydrological cycle. (This unified nature of the hydrological cycle is shown schematically in Figure 20)



- Deeper groundwater is water that escaped from the hydrological cycle over millennia. It is therefore non-renewable, limited in quantity and requires much more energy to extract.
- Water that flows in rivers and into estuaries and oceans is critical to the survival of aquatic organisms.
- Wastewater can be a threat to public health, but is also a potential resource.
- The amount of water available annually is thus fixed, and ‘new’ water can only be created through recycling, or by desalination of oceans, which is very energy-intensive.

Furthermore, in Karnataka:

- Seasonal and regional variation in availability: The availability of water is highly seasonal and with large variations between agro-climatic zones: Malnaad (with rainfall of ~4000mm per year), coastal (with rainfall of ~ 2500mm per year) and eastern plains regions (ranging from 900mm to 500mm per year). About 2/3rds of the state receives less than 750mm. Thus, the state has the second- or third-highest extent of area classified as “semi-arid” amongst all states in India.
- Regional variation in demand: The demand for water in Karnataka also varies significantly, and growing urban and industrial demand are being added on top of a pre-existing agricultural and livestock demand.
- Demographics: Karnataka’s population has increased from 4.5 crores in 1991 to 5.3 crores in 2001 to 6.1 crores on 2011 and to an estimated 6.8 crores in 2018—an increase of more than 50% since 1991. The urban share in the population has grown from 30% in 1991 to 39% in 2011, and to an estimated 42% in 2018, showing the rapid pace of urbanization.
- Economic growth: Karnataka has one of the fastest growing economies in India, with an estimated annual growth rate of 7% or more in its State Domestic Product for the last decade. This generates additional demand for water including major requirements for cooling water in thermal power plants.
- Socio-economic differences: There are significant socio-economic differences between communities in the ability to pay for water, to access water and to become involved in decision-making about water. The state has more than 30% families below the poverty line, and 16% of its population is in Scheduled Caste, and 6% is in Scheduled Tribe category. And although Karnataka ranks 7th in the Gender Vulnerability Index, women continue to be on the sidelines in most decisions related to water.
- Downstream commitments: Karnataka is located upstream in two major east-flowing river basins (Krishna and Cauvery), and in the west-flowing Mahadayi basin, and therefore has significant commitments to downstream states. Similarly, there are environmental commitments in other west-flowing rivers.
- Climate change is already under way. Current projections suggest that the Cauvery basin and north-eastern Karnataka may see reductions in total annual rainfall, the frequency of droughts will increase in the eastern plains region as a whole, and there will also be complex shifts in the rainfall patterns within the year.

## 2.2 Goals of Karnataka's water policy

All water management and governance in Karnataka must strive to ensure:

- **Water for life and livelihoods: Adequate, clean and affordable** water for domestic use (water for life) and for meeting livelihood needs of the people.
- **Water for birds, animals and other living beings, and for maintaining cultural values:** Adequate and appropriate provision will be made for **environmental flows**, culturally valuable flows, and consumption by livestock and wildlife.
- **Maintaining public and ecosystem health:** Water must be of a quality appropriate and safe for the use it is put to, and the wastewater resulting from its use must not result in further pollution of surface or groundwater or soils.
- **Equity and fairness:** Furthermore, Water must be shared fairly. Within any sector in a region, users must have equitable access to water, at similar cost for similar consumption. Every person has a right to sufficient quantity of safe water for life within easy reach of the household regardless of, among others, caste, creed, religion, community, class, gender, age, disability, economic status, land ownership and place of residence. Equity also includes social justice, which is the factoring in of the socio-economic position of resource users. Across sectors, the domestic sector must be prioritized, but other sectors (including conservation) must also get a fair share.
- **Sustainability and resilience:** Water must be used in such a way that our ability to continue to use it in the future is not compromised, nor should water management involve unsustainable use of other resources such as energy or land. Water management must also be able to accommodate and recover from extreme climatic events and fluctuations.
- **Democratic and participatory processes:** All decisions regarding water governance must meet high standards of democratic decision-making, including transparency, accountability and public participation in all major decisions.

These goals are based upon the commitments made in the Constitution of India, the National Water Policy, and the Sustainable Development Goals, and they also take inspiration from Draft National Water Framework Bill 2016 of the Government of India.

## 2.3 Meeting the goals: Approach and Operating Principles

### 2.3.1 Approach: Paradigm shift

In order to meet the multi-dimensional goals in the challenging situation outlined above, water governance must make undergo a **paradigm shift**:

- From supply-side to demand-side management, and from launching new projects to completing existing projects.
- From fragmented management (mainly of surface water) to integrated management includes surface water ground water and waste water.
- From depleted groundwater for a few to restored groundwater for all,

- From exclusively Engineering thinking to a holistic Ecosystem perspective,
- From a dichotomy of state property (surface water) and private property (groundwater) to all water as a commons held in public trust, and
- From top-down management to participatory, decentralised and democratic governance, following principles of environmental subsidiarity.

This policy document spells out how this paradigm shift can be achieved in every sector.

### **2.3.2 Operational principles**

In identifying strategies for this paradigm shift, the following operational principles will be kept in mind:

- Water will be treated as the common heritage of the people, held in public trust, for the use of all, subject to reasonable restrictions, to protect all water and associated ecosystems. In its natural state, such as river, stream, spring, natural surface water body, aquifer and wetland, water is a common pool resource, not amenable to ownership by the state, communities or persons. The state at all levels holds water in public trust for the people and is obliged to protect water as a trustee for the benefit of all.
- The responsibility of the state as public trustee shall remain even if some of the functions of the state in relation to water are entrusted to any public or private agency.
- Among the different uses of water: for life, livelihoods, ecosystems and cultural values, water for life will have highest priority, but the state will ensure a minimum availability for other biota and associated cultural values, and will ensure cost-effectiveness, environmental due diligence and region-specificity as outlined below.
- Evaluation of alternative strategies/projects for achieving particular outcomes will be mandatory, so that cost-effective and environment-friendly strategies are identified.
- Rigorous environmental impact analysis and scrutiny are a must for all strategies/projects and alternatives; precautionary principle must be the cornerstone.
- Norms & strategies will be region-specific. Specifically, for domestic supply, the norms will be 100 lpcd for all citizens in the eastern plains region, and 150 lpcd for citizens in the Western Ghats and coastal regions. Additional demand may be met at higher price if the resource is available and through recycled water.
- Pricing will be use-sensitive & user-sensitive, determined in an open, transparent and participatory manner, while meeting O&M costs in the aggregate.
- Use of local runoff, ground water & wastewater will be maximised before importing from outside the basin or sub-basin or over long distances; inter-basin transfers will be taken up only as a last resort, even for drinking water.
- Rivers, water bodies, aquifers and wetlands shall be recognised as ecological systems both in themselves and also as parts of larger ecological systems, and protected from over-use/depletion, abuse, pollution/contamination, and degradation. Wetlands, floodplains and riverbeds shall be recognised as integral parts of the rivers themselves. Rivers shall be protected from construction on their floodplains and from sand mining.



- Where water sources, catchments, drainage paths, river flows, water bodies, aquifers, wetlands, flood plains or riverbeds have already been encroached upon or interfered with, efforts shall be made to stop further encroachment or interference and reverse the adverse impact already made, to the utmost extent possible.
- Environmental flows adequate to preserve and protect a river basin as a hydrological and ecological system shall be maintained
- Environmental subsidiarity will be kept in mind, i.e., water will be allocated within basins to sub-basins and aquifer-scales and then within that day-to-day management will be at local scales as much as possible.
- Clear distinction will be maintained between drinking water, other domestic water, and commercial-industrial-institutional use of water, which otherwise gets subsumed under the label of 'drinking water'.
- Integrated management with transparency, open data, public participation and accountability will be the cornerstones of all decision-making.
- Separation of regulatory functions from provisioning functions of state organizations, and devolution of both responsibilities and concomitant authority as much as possible will be followed.

The sector-wise and cross-cutting policies and strategies that are required to achieve the goals in the water sector along the operational principles and using the approach as outlined above are spelt out in the remaining chapters.

## CHAPTER 3. TRANSFORMING AGRICULTURAL WATER USE<sup>4</sup>

Agriculture is the producer of food to sustain human life and also the source of livelihood for the majority of Karnataka's population today. At the same time, agriculture is also the biggest user of water in Karnataka. An estimated 85% of all water withdrawals (from streams, rivers or aquifers)<sup>5</sup> go for irrigating agriculture. And yet majority of the farmers do not have irrigation or are seeing their borewells run dry as groundwater declines<sup>6</sup>. Therefore, without a drastic reduction in the demand for water in this sector as a whole and better distribution *within* the sector, there will just not be enough water for the domestic needs of the people of the State, or for sustaining farming in the future, not to mention the needs of industry or the services sectors.

If water used in agriculture has to be reduced and distributed more equitably while ensuring sustainability of water resources and of farmer livelihoods, **combined policy shifts in both the agriculture sector, the water sector and the electricity sector will be required.** The new paradigm for agriculture and irrigation in Karnataka needs to have 6 main prongs:

1. Improve productivity and sustainability of farming while maintaining low water demand, by gradually moving away from chemical agriculture towards sustainable agriculture;
2. Reduce the demand for water by diversifying the cropping pattern away from water-intensive rice and sugarcane cultivation, towards millets and pulses, and other crops, and fruits and vegetables, based on what is appropriate for each agro-ecological region of the State;
3. Improve crop water use efficiency and overall irrigation efficiency in agriculture through changes in agricultural practices and technology, especially in paddy and sugarcane cultivation
4. Better utilizing the irrigation potential created in major and medium irrigation projects through improved participatory management of water in irrigation commands;
5. Integrate watershed development, irrigation tank revival, and groundwater management in the predominantly rainfed regions of the State.
6. Break the groundwater-energy nexus, while ensuring that policy changes in the electricity sector that are taken up to reduce the financial burden due to free electricity supply for pumping do not inadvertently result in increased groundwater draft.

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<sup>4</sup> This chapter draws significantly on the Summary Note titled "Draft Policy Recommendations: Agriculture & PIM" prepared by Dr. Mukund Joshi on behalf of Sub-Group 4 of the TGWP, led by Shri. S. V. Ranganath.

<sup>5</sup> Water withdrawn from streams, rivers and aquifers is called 'blue water'. In addition, agriculture and horticulture, along with forests, grasslands and other vegetation, use 'green water', that is water directly from rain. Given that agriculture occupies about 53% of Karnataka's total geographical area (as against 16% under forests) and further that 69% of the net cultivated area is rainfed, agriculture remains the major consumer of water even when all water (green+blue) use is considered.

<sup>6</sup> Groundwater was thought to provide more equitable access to water as compared surface irrigation structures. However, the depletion of groundwater resources means that in many parts of the eastern plains of Karnataka (the drier zones) only 5-10% of the farmers in a village have access to functioning borewells.



After discussing each of these prongs in detail, we end the chapter with a brief discussion of flood risk management, which is an emerging problem in the context of climate change and multiple dams on east-flowing rivers.

### **3.1 Addressing the farming crisis: Improving productivity and sustainability while reducing water use**

The State faces a deep crisis in agriculture. On suicides of farmers, Karnataka occupies the second highest position among Indian States, after Maharashtra. And the number of suicides is growing dramatically. From 2007 to 2012, as many as 1,077 farmers committed suicide in Karnataka, according to the Karnataka State Agriculture Department. Sadly, this number more than tripled to 3,515 farmers during 2013-2017. According to the National Crime Records Bureau, while farmer suicides increased marginally in the State between 2015 and 2016, farm labour suicides more than doubled in this period. Mandya district<sup>7</sup> has witnessed the highest rate of farmer suicides in the past 3 years.

This has become a matter of great concern for policy-makers in the State and attempts are being made to urgently redress the grievances of the farmers. However, the measures being taken by policy-makers and demanded by the farmers in many cases, are likely to only aggravate the vicious cycle farmers find themselves in. By merely waiving farm loans or providing higher Minimum Support Prices for the very same crops, the state may not be able to address the deeper roots of the problem, **which lie in the crisis of the entire paradigm of Green Revolution (GR) agriculture in India.**

#### **3.1.1 The Emerging Crisis in GR Agriculture**

Before the GR was initiated, India faced a major shortage of foodgrains, following severe droughts in the mid-1960s and was compelled to import grain from the United States on extremely humiliating terms under Public Law 480. The Government of India then resolved to move towards self-sufficiency in food, with the GR as its flagship initiative. The GR was a multi-pronged strategy with several components, including hybrid and high-yielding varieties of seeds, tubewell irrigation, intensive use of chemical fertilisers and pesticides, nationalization of banks to provide accessible credit to farmers and large-scale public procurement of rice and wheat. The GR is a historic success story in India's development journey since Independence, leading to national self-sufficiency in foodgrains.

At the same time, it needs to be recognised, that in the last two decades, the GR strategy has begun to reach its limits. The excessive withdrawal of water from aquifers has meant falling water tables and has jeopardised water quality, with fluoride, arsenic and even uranium, being found in groundwater. Farmer incomes have also suffered because crop outputs are no longer yielding the same response to application of inputs. Thus, to get the same increase in output, farmers are compelled to use much greater fertilisers and pesticides, whose prices have also been rising steadily. This is jeopardising net incomes of farmers, which have even turned negative in certain cases, leading at times to tragedies such as suicides by farmers.

What the GR paradigm, like many other development strategies of the 1950s to 1970s, failed to adequately recognise is that the economy must necessarily be seen as a subset of the larger eco-system, of which it is an integral part. No economy can achieve sustained growth if it jeopardises the health of this larger eco-system [see 17]. Today, the overuse and

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<sup>7</sup> "Sakkare nadu" (the land of sugar) inhabited by the "Sakkare nadina akkare janathe" (sweet and loving people) is sadly today suffering from severe water shortage, even though it has five important rivers (Kaveri and four tributaries Hemavathi, Shimsha, Lokapavani, Veeravaishnavi) and is fed by the iconic Krishna Raja Sagara dam, precisely because of the excessive amount of water consumed by the sugarcane crop in the district.

indiscriminate use of pesticides is destroying the very ecosystem in which agriculture is embedded. E.O. Wilson, one of the founders of modern ecology, warns us to “be careful with pesticides” [18] because destroying the insect world will have cascading effects of the health of agriculture as pollinators disappear and soil fertility declines. Simultaneously, pesticides are taking a heavy toll of human health. The effects of synthetic pesticides such as endosulfan, malathion, cypermethrin and lindane are depicted starkly in Figure 21.

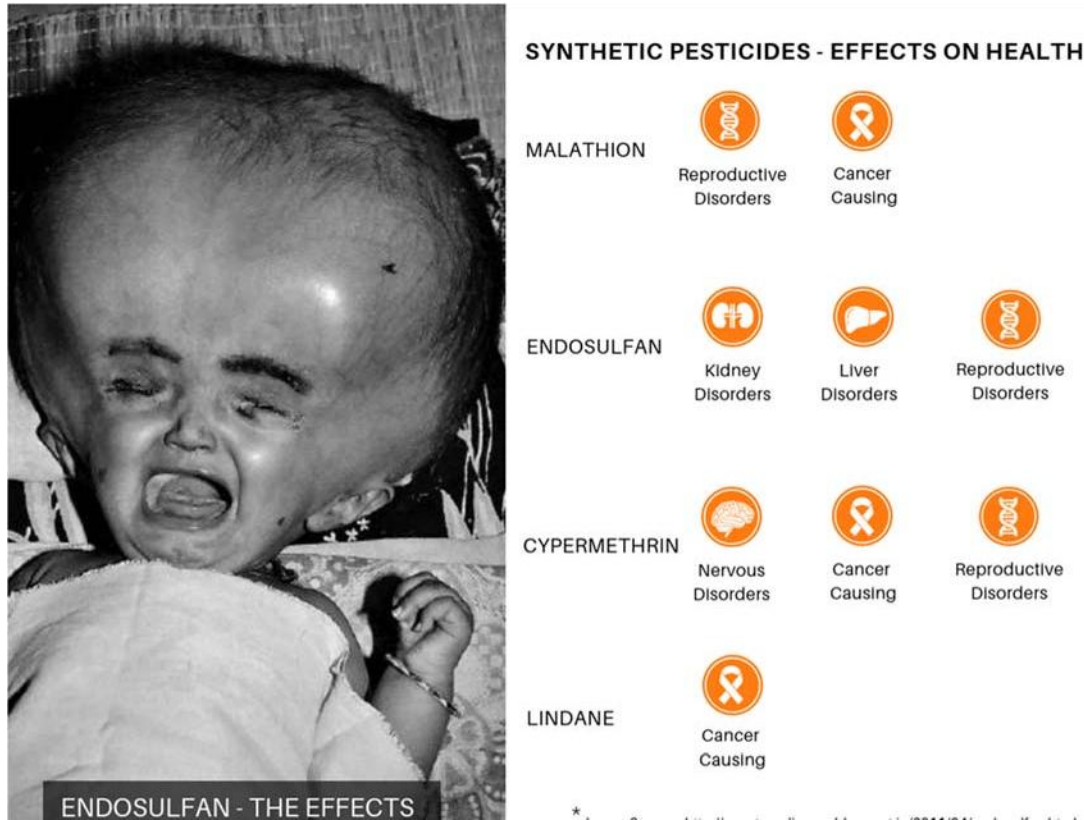


Figure 21. Effects of synthetic pesticides on human health (Source: <http://eventsandissues.blogspot.in/2011/04/endosulfan.html>)

Thus, the GR paradigm has turned out to have limitations on multiple dimensions: financial and economic unviability, ecological and public health costs, and unviable water demand.

### 3.1.2 The Search for Alternatives to GR: Global and National

Even those who may be persuaded of such a view, remain sceptical about whether workable alternatives to the GR paradigm exist: alternatives that would enable farmers to get the output and incomes they need to sustain livelihoods in agriculture. The good news is that over the last decade there is increasing evidence of this having been achieved at scale in a variety of diverse agro-ecological contexts. The United Nations Food and Agricultural Organization (FAO), which some decades ago was in the forefront of championing the GR paradigm, is now strongly advocating a move away from it towards “agro-ecology”. In the latest quadrennial review of its Strategic Framework and Preparation of the Organization’s Medium-Term Plan, 2018–21, the FAO states:

“High-input, resource-intensive farming systems, which have caused massive deforestation, water scarcities, soil depletion and high levels of greenhouse gas emissions, cannot deliver sustainable food and agricultural production. Needed are innovative systems that protect and enhance the natural resource



ZBNF draws upon a holistic is founded on the following key principles:

- a) Enhance soil biology by utilising animal dung- and urine-based formulations.
- b) Microbial coating of seeds for better germination and to enhance immunity. c) Mulching to improve soil fertility and reduce evaporation losses.
- d) Building up soil humus, leading to enhanced water vapour condensation on the soil surface, improving the soil moisture profile.
- e) Preference for indigenous seeds, which have co-evolved for thousands of years within the local eco-system and are therefore more resilient, more productive and respond better to ZBNF.
- f) Since the aim is not to eliminate pests, no pesticides are used. Rather, pest management practices seek to utilise the natural inter-dependencies of the food chain, through sound agronomy and where necessary, botanical extracts.

Already some fairly dramatic positive impact is becoming visible. Crop-cutting experiments by the State Agriculture Department in the kharif season of 2017 show higher average yields, reduced costs and higher net incomes for ZBNF farmers compared to non-ZBNF farmers, in all districts and for all crops. Encouraged by the results, the Government of Andhra Pradesh has now resolved to cover the entire cultivable area of 80 lakh hectares in the State by 2027, overcoming the objections of the powerful Green Revolution lobbies, both within and outside the State [20].

ZBNF is just one example of an alternative to the Green Revolution strategy. There are several others as well. The significance of ZBNF is that a large state like Andhra Pradesh has committed itself in this direction. The results of this approach will emerge over the years. But it is clear that if Karnataka has to solve its water problem, it has to seriously consider moving towards an alternative paradigm (ZBNF being one of them) that is economically more viable, ecologically more friendly and less water-intensive as well. In a welcome first step, the Government of Karnataka announced a pilot programme for ZBNF in June 2018. This programme needs to be upscaled and made location-specific at every stage.<sup>9</sup>

We therefore recommend that:

- a) In a very location-specific manner, based on a scientific assessment of requirements, farmers will be facilitated to shift to more diverse farming systems that are more sustainable, less risky, less input-intensive and more productive. As appropriate, these alternatives could include organic farming, zero-budget natural farming (ZBNF), low external-input sustainable agriculture (LEISA), conservation agriculture, and other similar alternative agricultural practices; but they will all emphasize organic manuring and mulching, limit use of chemical pesticides, and use indigenous seeds to the extent possible.
- b) There will be a transformation in the agricultural extension system in the state that develops far greater capacities within the state department to support farmers to move in the direction of sustainable, natural farming;

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<sup>9</sup> [www.thenewsminute.com/article/zero-budget-natural-farming-following-success-ap-ktaka-kick-pilot-project-83708](http://www.thenewsminute.com/article/zero-budget-natural-farming-following-success-ap-ktaka-kick-pilot-project-83708)



- c) Large-scale capacity building of farmers will be undertaken through Community Resource Persons or Extension Farmers who would have received prior training in the new approach (training of trainers).

### **3.2 Incentivising shifts in the Cropping Pattern in Karnataka**

In Karnataka, the Green Revolution was primarily a **rice and sugarcane** revolution. These are the crops that the government has incentivised farmers to grow, as they are virtually the only crops that the state procures or buys through institutionalized channels. Unfortunately, they are both highly water-intensive crops. As Table 4 and Figure 23 show, from the 1950s right up to the 1980s, sugarcane occupied only 1% of Karnataka's cropped area. In the 1990s, it grew to 2-3%. But in the 21st century, even as the water crisis grew worse, sugarcane area has expanded to an average of 6%. Meanwhile the fraction of cultivated area under paddy has also increased marginally from 10% to 11%, along with an increase in the absolute area (especially if one ignores the last two years that were drought years).



## Karnataka State Water Policy 2019



**Table 4. Crop-wise Area of Major Agricultural Crops in Karnataka 1955-56 to 2016-17 (Unit: '000 hectares)**

Year	Paddy		Jowar		Ragi		Tur		Bengal Gram		Groundnut		Cotton		Sugarcane		Other Crops		Total
	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%	
1955-60	958.20	10%	2732.80	28%	974.80	10%	291.00	3%	158.80	2%	932.60	10%	1107.40	11%	56.80	1%	2596.00	26%	9808.40
1960-65	1090.00	11%	2993.20	30%	1054.40	11%	298.40	3%	151.20	2%	899.00	9%	1003.60	10%	78.80	1%	2447.80	24%	10016.40
1965-70	1146.80	12%	2615.80	26%	1095.20	11%	297.80	3%	164.20	2%	937.20	9%	988.80	10%	96.60	1%	2562.20	26%	9904.60
1970-75	1142.40	11%	2299.60	23%	1038.60	10%	283.80	3%	157.80	2%	977.20	10%	1097.00	11%	109.80	1%	2887.40	29%	9993.60
1975-80	1098.40	11%	1936.40	20%	1094.40	11%	321.20	3%	165.20	2%	897.40	9%	1026.60	10%	145.60	1%	3170.40	32%	9855.60
1980-85	1158.80	11%	2190.60	22%	1087.60	11%	374.40	4%	159.80	2%	876.00	9%	944.60	9%	172.20	2%	3156.00	31%	10120.00
1985-90	1146.00	11%	2373.60	22%	1143.40	11%	461.40	4%	215.20	2%	1115.40	11%	583.00	5%	211.80	2%	3368.00	32%	10617.80
1990-95	1288.60	12%	2163.20	20%	1036.80	10%	416.40	4%	273.20	3%	1258.00	12%	603.80	6%	292.80	3%	3572.40	33%	10905.20
1995-2000	1371.00	13%	1949.20	18%	988.20	9%	454.80	4%	330.40	3%	1173.20	11%	604.40	6%	325.20	3%	3481.80	33%	10678.20
2000-05	1287.80	12%	1744.00	17%	926.80	9%	534.60	5%	451.40	4%	909.60	9%	478.40	5%	369.40	4%	3634.20	35%	10336.20
2005-10	1459.40	13%	1414.40	13%	796.40	7%	615.80	6%	674.40	6%	876.00	8%	411.60	4%	472.00	4%	4271.00	39%	10991.00
2010-15	1380.00	13%	1157.60	11%	701.00	7%	774.20	7%	919.20	9%	685.20	7%	630.40	6%	657.80	6%	3469.20	33%	10374.60
2015-17	1072.00	11%	1026.00	10%	651.50	7%	935.50	10%	1211.50	12%	618.00	6%	576.00	6%	545.00	6%	3204.50	33%	9840.00

Source: Directorate of Economics and Statistics, GoK.

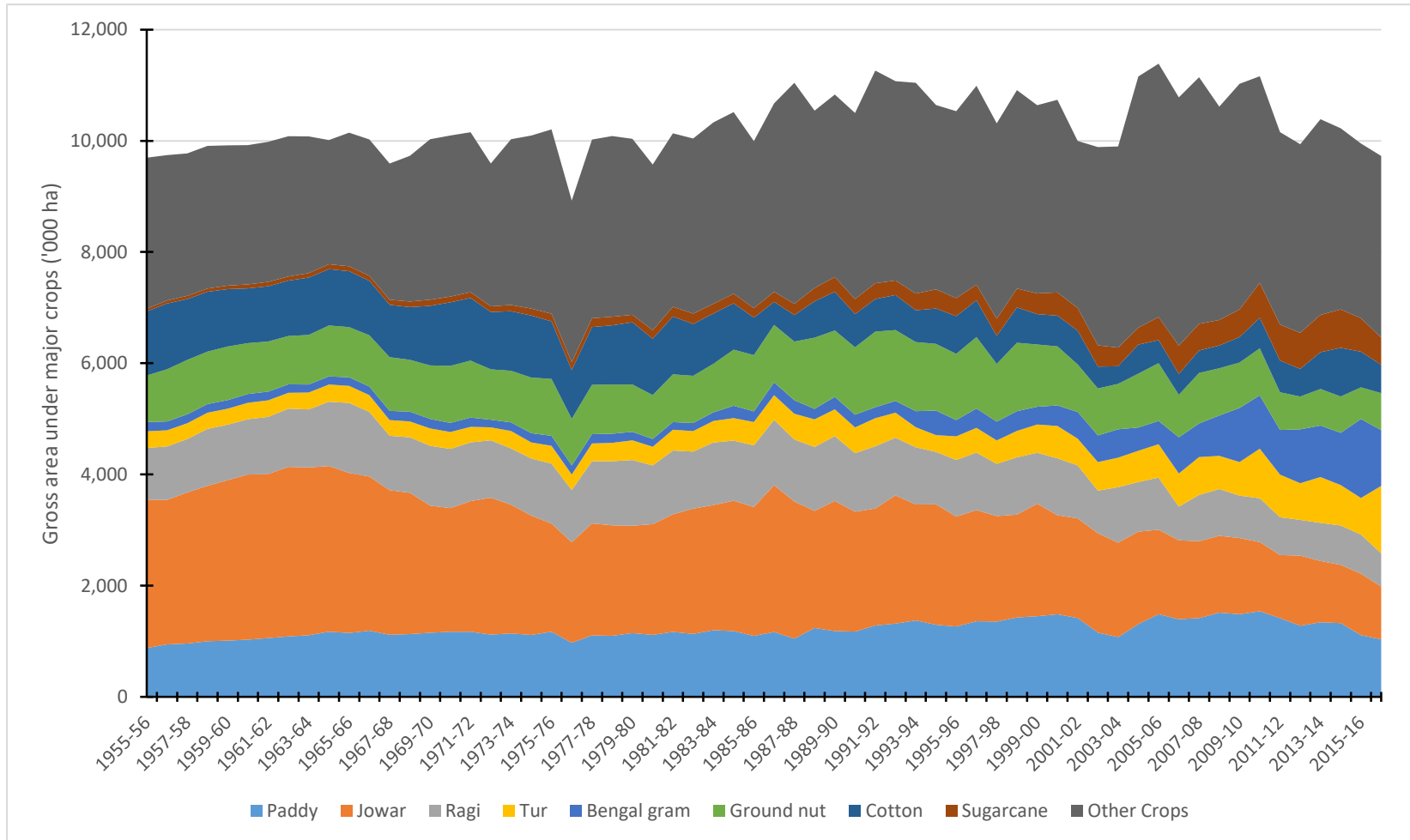


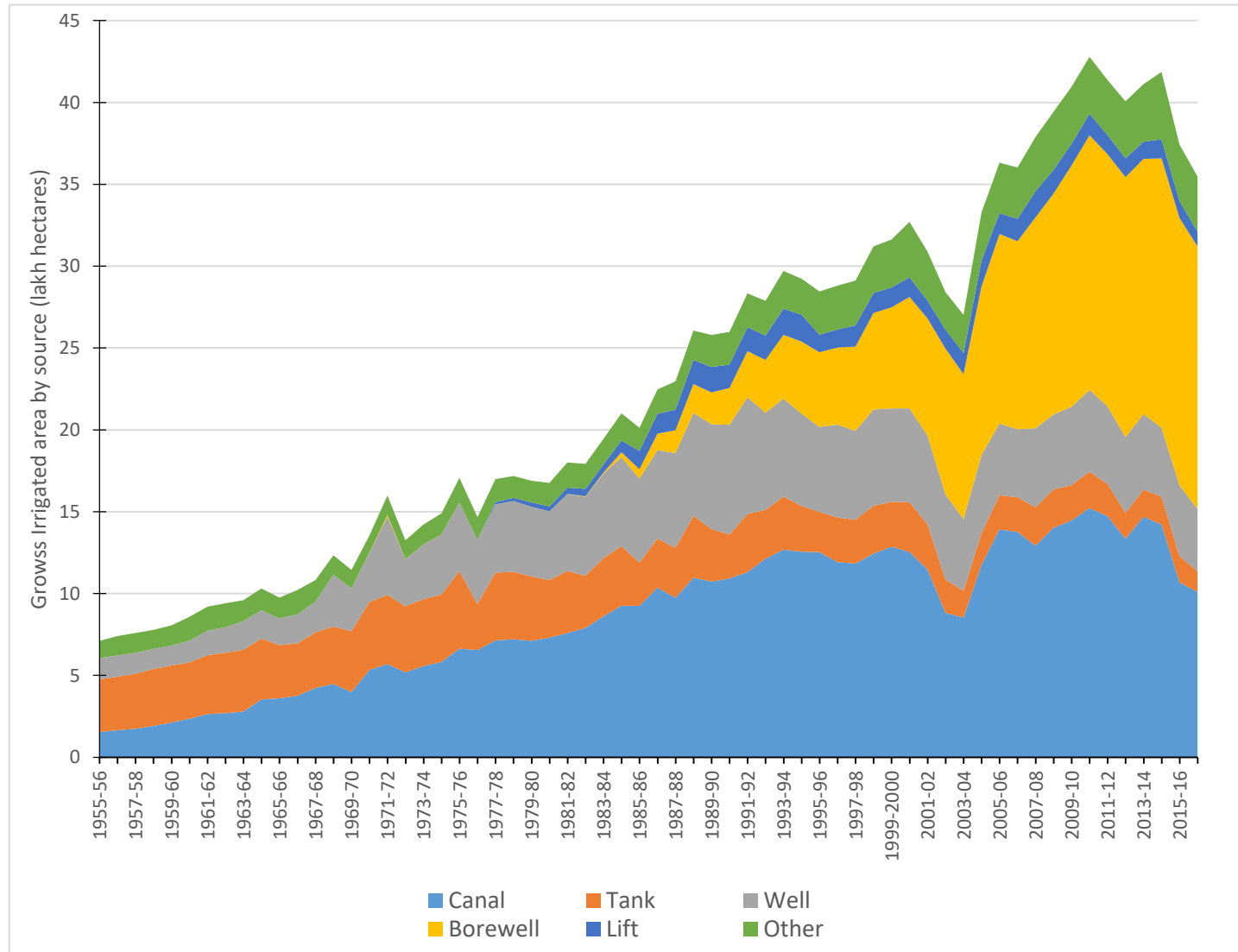
Figure 23. Trends in Crop-wise Area of Major Agricultural Crops in Karnataka (Source: Directorate of Economics & Statistics, GoK)

**Table 5. Source-wise Irrigated Area in Karnataka 1955-56 to 2016-17 (5-year averages) (Unit: lakh hectares)**

Year	Canals		Tanks		Wells		Borewells		Lift Irrig.		Other Sources		Total GIA	
	Value	%	Value	%	Value	%	Value	%	Value	%	Value	%	Value	%
1955-60	1.79	24%	3.36	44%	1.27	17%	0.00	0%	0.00	0%	1.17	15%	7.59	100%
1960-65	2.80	30%	3.64	39%	1.57	17%	0.00	0%	0.00	0%	1.40	15%	9.42	100%
1965-70	4.01	37%	3.41	31%	2.21	20%	0.00	0%	0.00	0%	1.28	12%	10.92	100%
1970-75	5.52	38%	4.13	29%	3.53	25%	0.03	0%	0.00	0%	1.18	8%	14.38	100%
1975-80	6.93	42%	3.95	24%	4.17	25%	0.00	0%	0.20	1%	1.39	8%	16.56	100%
1980-85	8.13	44%	3.54	19%	4.86	26%	0.09	0%	0.47	3%	1.54	8%	18.63	100%
1985-90	10.21	43%	3.13	13%	5.81	25%	1.33	6%	1.32	6%	1.67	7%	23.48	100%
1990-95	11.92	42%	3.05	11%	6.28	22%	3.32	12%	1.53	5%	2.14	8%	28.23	100%
1995-2000	12.32	41%	2.70	9%	5.58	19%	5.30	18%	1.18	4%	2.77	9%	29.84	100%
2000-05	10.62	35%	2.28	7%	5.11	17%	8.40	28%	1.27	4%	2.78	9%	30.46	100%
2005-10	13.82	36%	2.21	6%	4.55	12%	12.84	34%	1.40	4%	3.31	9%	38.12	100%
2010-15	14.44	35%	1.83	4%	4.64	11%	15.77	38%	1.17	3%	3.59	9%	41.44	100%
2015-17	10.39	29%	1.43	4%	4.07	11%	16.19	44%	0.97	3%	3.41	9%	36.45	100%

Source: Directorate of Economics and Statistics, GoK.





**Figure 24. Trends in Source-wise Irrigated Area in Karnataka 1955-56 to 2016-17 (Source: DES data)**

This expansion has contributed significantly to the water crisis in the State. Occupying less than 20% of Karnataka’s cropped area, sugarcane and paddy consume 71% of its irrigation water (see Table 6). This table also shows that the water requirement of jowar, ragi and tur is a mere 15% to 30% of the water requirement of paddy. Therefore what is required is a major shift in cropping from paddy and sugarcane to millets (ragi, jowar, other millets) and pulses (tur, chana, urad, moong).

**Table 6. Share in Irrigation Water by Crops, Karnataka 2013-14**

Crop	Area ('000 ha)	Depth of Irrigation (m)	Volume of Water (Million cum)	% of Irrigated Area	% of Irrigation Water
Rice	1006.60	1.05	10569.33	24%	47%
Jowar	110.44	0.14	154.62	3%	1%
Bajra	33.48	0.15	50.21	1%	0%
Maize	501.06	0.15	751.59	12%	3%
Ragi	41.99	0.35	146.96	1%	1%
Wheat	116.88	0.38	444.14	3%	2%
Gram	128.63	0.44	565.97	3%	3%
Tur or Thogari	54.57	0.15	81.85	1%	0%
Sugarcane	669.34	0.80	5354.68	16%	24%
Condiments & Spices	277.92	0.60	1667.50	7%	7%
Fruits & Vegetables	332.51	0.30	997.52	8%	4%
Groundnut	207.04	0.30	621.12	5%	3%
Sun-flower	93.36	0.10	93.36	2%	0%
Cotton	182.81	0.40	731.26	4%	3%
<b>Total</b>	<b>4111.48</b>		<b>22515.52</b>	<b>100%</b>	<b>100%</b>

**Sources**

1. Directorate of Statistics and Programme Implementation, Ministry of Agriculture: Indian Agricultural Statistics, 2017: <https://eands.dacnet.nic.in/>
2. Indian Council of Agricultural Research (1977): *Water Requirement and Irrigation Management of Crops in India*, New Delhi: Water Technology Centre.
3. Indian Council of Agricultural Research (1987): *Handbook of Agriculture*, New Delhi.
4. Prihar, S.S. and B.S. Sandhu (1994): *Irrigation of Field Crops: Principles and Practices*, New Delhi: Indian Council of Agricultural Research.

What is worse, the mono-cropping that accompanied the Green Revolution, has lowered resilience to both weather and market risk. Diversity of cropping pattern is the key to minimizing both these risks. What we need is a fine-tuning of cropping patterns as per the agro-ecological conditions found in different parts of the State

It should be noted that, even today, Karnataka is India’s largest producer of millets. Especially the northern, drought-prone regions of the State, need to move decisively towards millets and pulses. Unfortunately, public procurement is still restricted mainly to water-intensive crops, mainly rice. In the drought-prone, water-stressed regions of Karnataka, the state needs to begin **large-scale decentralised procurement of these crops at reasonable Minimum Support Prices (MSPs), so that the farmers who may prefer to cultivate them as compared to paddy and sugarcane, would have the requisite incentives to do so.**

The main objection to this suggestion usually is that there is no market demand for these crops, so procuring them will only create a huge fiscal burden for the state exchequer.



However, apart from existing consumption, a substantial increase in consumption of millets and pulses can be created by including them in the ICDS, MDMS and PDS programmes in the State. Karnataka has already made beginning in this direction in December 2017 by beginning procurement of ragi in some of the southern districts.<sup>10</sup> The amount procured under this programme has however been quite small: about 14 tonnes till March 2018. But by increasing the scale of this initiative, the state could decisively move towards solving the water problem of Karnataka.

A major shift in cropping pattern from paddy and sugarcane to millets and pulses following agro-ecological methods supported by adequate MSP would not only reduce water consumption, but also reduce chemical fertilizer and pesticide consumption (with the associated human and environmental health benefits) and also improve nutritional status, thereby creating a triple or quadruple win: water, environment, incomes and nutrition.

The health benefits of this shift will also be significant. The Government of India in 2018 renamed jowar, bajra, ragi and other millets as “Nutri Cereals”, dispensing with the nomenclature “coarse cereals”. The move is aimed at removing a lingering perception that these grains are inferior to rice and wheat. Compared to rice, foxtail millet (*navane*) has 81% more protein.<sup>11</sup> Millets also have higher fibre and iron content, and have a low Glycemic Index that reduces the postprandial blood glucose level and glycosylated haemoglobin. Millets also are climate resilient crops suited for the dry regions of Karnataka and traditionally grown there.

We therefore recommend that farmers be incentivized to shift away from irrigated paddy and sugarcane towards millets (ragi, jowar, other millets) and pulses (tur, chana, urad, moong) by:

- a) Increasing the Minimum Support Prices (MSPs) for Ragi, Jowar, Sajje and other millets and pulses;
- b) State procurement of millets and pulses at these attractive MSPs, especially in the water-scarce regions of the state;
- c) Encouraging Farmer Producer Organisations in the marketing of these crops;
- d) Supply of millets and pulses in a region-specific manner through the Public Distribution System (Ragi in the southern Maidan region, Jowar in the northern maidan region);
- e) Requesting the Centre to also replace 50% of the rice and wheat supplied in the PDS, with locally procured ragi and jowar;
- f) Supplying ragi and jowar and other millets-based meals through the Mid-day Meal Scheme (MDMS) and the Integrated Child Development Scheme (ICDS);
- g) Encouraging a shift in consumer diets by consciously promoting millets and pulses through mass media and people’s campaigns.

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<sup>10</sup> Food & Civil Supplies Department, GO dated 22 Dec 2017.

<sup>11</sup><http://vikaspedia.in/health/nutrition/nutritive-value-of-foods/nutritive-value-of-cereals-and-millets/small-millets-not-2018small2019-in-nutrition>

### **3.3 Improving Irrigation Efficiency**

The next issue is irrigation efficiencies. Water use efficiency in Indian command areas is among the lowest in the world. Karnataka (and several other states) are lagging far behind global standards in this regard. As a recent important nation-level analysis by NABARD-ICRIER [21] points out, “the sub-tropical belts of Tamil Nadu, Karnataka, Maharashtra and Andhra Pradesh have high land productivity but lower levels of Irrigation Water Productivity (IWP) values”. The study finds that the physical water productivity of rice (kg/m<sup>3</sup>) is lowest in Karnataka among 16 dominant rice growing states in India. It also finds that although, “Karnataka has the highest share among States in maize area (17.3 per cent) and maize production (20.7 per cent), ... in terms to productivity it lags behind, with yield of 2.9t/ha, physical water productivity (PWP) of 2.07 kg/m<sup>3</sup> of water consumed, and corresponding lower economic water productivity of just Rs.18.85 per cubic meter of water consumed.” Similarly, with 7.5 per cent of national area under chickpea, Karnataka has the lowest PWP among states at 0.27kg/m<sup>3</sup>. ...Economic Water Productivity of pigeon pea is [also] very low in the states of Andhra Pradesh, Madhya Pradesh and Karnataka where the crop is cultivated on marginal soils and allowed to suffer due to moisture deficit conditions.”

The study concludes that “at the present level of water stress existing in the country there is need to re-calibrate the cropping patterns in line with their PWP (particularly for water guzzler crops like rice and sugarcane), and not remain obsessed with only their land productivity. Else, country will be moving towards unsustainable agriculture from water availability point of view, raising risks for the farmers, and promoting extreme inequity in the use of scarce water resources.”

Key technological innovations that need to be introduced in farming include extensive use of the System of Crop Intensification (SRI as it known in the rice context), along with expansion of drip and sprinkler irrigation, which can help reduce water use even in the more water-intensive crops such as paddy and sugarcane.

While drip irrigation has not been traditionally practiced in rice cultivation, recent trials in Andhra Pradesh, Maharashtra, Rajasthan, Uttar Pradesh and Tamil Nadu have shown encouraging results.<sup>12</sup> Apart from significant reductions in water use, drip irrigation in rice reportedly also diminishes methane emissions and reduces arsenic uptake. To increase rice farmers’ incomes, Water Use Efficiency and conservation agriculture technologies and practices need to be promoted (water use efficiency potential in brackets):

- a. Alternate Wetting and Drying (~30%)
- b. Direct Seeded Rice (~50%)
- c. Land levelling (~20%)

In addition, incorporation of organic matter in the soil through green manuring and farm yard manure, as well as in-field bund management, can reduce irrigation water requirement in rice. Improved water management also enhances fertilizer use efficiency, thereby improving productivity and reducing greenhouse gases.

Government of Karnataka and 2030 Water Resources Group estimates suggest that 100% adoption of drip irrigation across 300,000 acres of command area in Karnataka can result in water use efficiency of up to 52 TMC of water. In addition to promoting sustainable water use, this will significantly lower the costs of freshwater supply to such areas. For example, creating a reservoir of 52 TMC for freshwater supply was estimated to cost Rs. 7,800 crores, including

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<sup>12</sup> <https://k-learn.adb.org/system/files/materials/2012/04/201204-drip-irrigation-and-fertigation-technology-rice-cultivation.pdf>



land acquisition. As such, micro irrigation and farm level water use efficiency are more cost-effective measures for demand-side water resources management.

In addition to micro irrigation, a package of practices for water-efficiency can be encouraged in sugarcane cultivation, such as trash mulching and skip furrow. Combined practices of trash mulching and skip furrow are estimated to result in water use efficiency of up to 50%.

A micro-irrigation policy has already been approved by the cabinet in March 2018. We need towards large scale adoption of micro-irrigation by incentivisation through technology based interventions and streamlining the policy of planning and implementation by robust institutional frame work and well-designed software. At present, different departments follow different norms to consider the micro irrigation proposals. Time bound consideration for technically backed proposals is rarely practiced. Training, R & D are ignored. An encouraging experiment is the Ramthal Drip Irrigation Project launched recently with Israeli technology, which includes mandatory drip irrigation along with fertigation and weather-data controlled water releases.<sup>13</sup> The outcomes of this project must be closely monitored and learnings incorporated into the process of wider dissemination of this model.

To improve the implementation of the micro-irrigation policy, an exclusive autonomous corporation called Karnataka Antharagange Micro Irrigation Corporation (KAMIC) for the time bound consideration and disposal of all micro irrigation proposals in the state was proposed[22], and has indeed been set up in 2018. The Corporation is to be responsible for all the strategies to promote micro irrigation, including third party inspection, R & D and training.

In addition to roles already indicated, the KAMIC must also give a thrust to adoption of sub-surface drip irrigation method to all sugarcane areas, which not only saves 45% water but increases the cane yield by 55% as a result of reduced nutrient losses and ease to adopt fertigation techniques. Sub-surface drip sugarcane may be incentivized through the concerned sugar factories, which should be keen to promote the technology in their own enlightened self-interest. Since sub surface drip method requires wide row planting, there would be need for massive education of farmers in adopting wide row planting by sugar factories.

Finally, the possibility of pipe-based irrigation supply (replacing the Field Irrigation Channel) may also be explored further in terms of costs and water savings.

We therefore recommend that the efficiency of water use in agriculture be promoted through:

- a) Facilitating adoption of drip, sub-surface drip and sprinkler irrigation by farmers, with weather-data input where possible,
- b) Facilitating adoption of System of Rice Intensification (SRI), Alternative Wetting and Drying (AWD) and Direct Seeded Rice (DSR) technologies in farming,
- c) Incorporation of organic matter in the soil through green manuring and farm yard manure, as well as in-field bund management,
- d) Trash mulching and skip furrowing for sugarcane,
- e) Pipe-based irrigation supply and lining of canals to reduce conveyance losses,

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<sup>13</sup> <https://www.thehindubusinessline.com/economy/agri-business/karnataka-gets-asias-largest-drip-irrigation-project-with-israeli-tech/article22592938.ece>.



- f) Ensure volumetric charging for water supplied in all major and medium irrigation commands, including charging for conjunctive use of groundwater.
- g) Helping farmers integrate rainwater into irrigation planning

Successful implementation of all these water use efficiency measures in water-intensive crops requires active convergence and coordination of several state government departments and agencies, including Water Resources, Agriculture, Horticulture, Rural Development, and Food Processing. Leveraging existing schemes (e.g. subsidy schemes for micro irrigation, seeds, fertilizers, and mechanization), strengthened extension support, and coordinated implementation are crucial for tackling inefficiencies in agricultural water use.

### **3.4 Better Utilizing Existing Surface Irrigation Potential in Major and Medium projects through PIM**

There have also been dramatic changes in the irrigation scenario in the State in recent decades, which have aggravated the water situation. Irrigated area as a percentage of cropped area in Karnataka is still only around 36%. The national average is 48%. Karnataka remains one of the largest rainfed States of India. Indeed, after peaking at 42.79 lakh ha in 2010-11, gross irrigated area in the State has been falling in the last few years, plummeting to 35.48 lakh ha in 2016-17, which is even lower than what it was in 2005-06, when it was 36.32 lakh ha (see Table 5 for 5 year averages and Figure 24). Furthermore, the data show that this decline in gross irrigated area is entirely due to a drop in canal irrigated area. In other words the surface irrigation projects in the State are falling short of their targets.

Can this problem be solved by building more dams? Unfortunately, the scope for further dam building across major rivers is both increasingly limited (hydrologically) and prohibitively expensive (economically). Hydrologically speaking, of an ultimate irrigation potential through major and medium dams of 1695 TMC, the State has already created 1690.30 TMC. The situation is epitomized in the Krishna basin, where it is estimated that, during a drought year, no water reaches the ocean and even otherwise the all the available water is fully allocated (if not over-allocated) and the basin is said to be nearly “closed” [23]. The Cauvery basin is also now completely allocated. Indeed, the lack of minimum environmental flows in these basins has not only destroyed aquatic ecosystems (see 6.9) but also means there is no dilution of the pollution outflows from towns on the river banks. So there little physical scope for more surface water provisioning, and expanding groundwater irrigation is only coming at the cost of surface water availability as shown in Chapter 1. .

Economically speaking, the cost of adding new irrigated area has become prohibitive. For 2017-18, the State proposed an expenditure of Rs. 15,853.31 crore on major and medium dams to create an irrigation potential of 67868 ha. This means the cost of an additional hectare to irrigated area through this route is a whopping Rs. 23.36 lakh! Not to mention the added problems of human displacement, submergence of fertile land and environmental destruction. A recent study also brings out that the capital costs of canal irrigation per hectare calculated at 2017-18 prices are the fourth highest among States in Karnataka [24].

So what is the way forward for Karnataka to achieve increase in irrigated area? The good news is that there is low-hanging fruit available that the State can go for. The low hanging fruit lies in making sure that the surface irrigation potential already created is actually utilized.

**Table 7. IPC-IPU Gap in Major and Medium Irrigation Projects In Karnataka (lakh ha)**

1. Tungabhadra	3.54
2. Malaprabha	2.15
3. Hemavathy	2.08
4. Hippargi	0.51
5. Singatalur	0.44
6. Ghataprabha	0.16
7. Markandeya	0.16
8. Varahi	0.11
9. Amarja	0.05
<b>Total</b>	<b>9.2</b>

Source: Niti Aayog [25]

Karnataka has already invested huge amounts of capital in building several big dam projects. Sadly, the water stored in these dams at such huge financial, social and environmental cost, has not always reached the farmers for whom it is meant. There is a huge gap between the Irrigation Potential Created (IPC) and the Irrigation Potential Utilised (IPU) in Karnataka. The gap is currently estimated by the Niti Aayog, Government of India [25] to be around 9.20 lakh hectares (Table 7) (see also [26]). While this IPC-IPU gap certainly represents a failure of the way irrigation projects have been implemented, it can also be seen as a great opportunity to quickly add to irrigated area in Karnataka, at very low cost. According to the Niti Aayog, the cost per hectare of irrigation in this case would be a mere Rs. 50,000 compared to the enormous Rs. 23.36 lakh per hectare involved in building new dams in the State (See Table 8).

**Table 8. Costs and Potential for Alternative Pathways to Expanding Irrigated Area**

<b>PATHWAY</b>	<b>COST</b>	<b>POTENTIAL</b>
Bridge IPC-IPU Gap through PIM	50, 000 Rs/ha	9 lakh ha
100, 000 farm ponds through MGNREGA	30, 000 Rs/ha	2 lakh ha
Enhance Storage Capacity of 33,000 tanks	50, 000 Rs/ha	1 lakh ha
Micro-irrigation in M&M Projects	1 lakh Rs/ha	1 lakh ha
Groundwater development	1 lakh Rs/ha	1 lakh ha
Construction/Completion of M&M irrigation projects	23 lakh Rs/ha	1 lakh ha
<b>Total</b>		<b>15 lakh ha</b>

Source: Niti Aayog [25]

The IPC-IPU gap is not just a matter of capital investments being under-utilized, but it represents a serious equity issue, as water and investments in water systems made from public funds do not reach some of the intended beneficiaries, typically the tail-end farmers.<sup>14</sup> The extent of tail-end deprivation is not fully known. One study in 2003 indicated 40% to 91% tail-end deprivation across three major irrigation projects [27, also see 28]. The reasons for this are multiple: poor maintenance or breaching of canals, and over-appropriation of water by head-end farmers.

<sup>14</sup> This also distorts the cost-benefit calculation that is used to sanction large irrigation projects, which are justified on the basis of assumptions that their water will flow to the most deprived regions.



How is this gap to be bridged? How is equity, efficiency and accountability to be promoted in surface irrigation projects? The first two steps are fairly clear:

- a) Before considering new dam projects, which have suffered from major time-lags and severe cost escalation, the state must first focus investment primarily on completing existing projects and bridging the IPC-IPU gap,. This must include the 'last-mile connectivity', i.e., the completion of field irrigation channels or equivalent distribution systems.
- b) Given that the water available for irrigation from the reservoir is fixed or even declining (due to abstractions for urban or industrial needs), the state must make drip or sub-surface drip irrigation mandatory in command areas of all major and medium irrigation projects.
- c) Simultaneously, the NNLs must ensure measured release of canal water reflecting crop water budgets to encourage more efficient water management. Measurement of water supplied must be made at every level up to the farmers' fields.
- d) The NNL must replace system of flowing surface irrigation from field to field by independent outlets for all the fields covered by each field channel.
- e) Compulsory adoption of 'on and off' system of distribution for the entire irrigation command so as to ensure equitable distribution.
- f) Improving drainage in command areas to reduce waterlogging and associated salinity-induced productivity losses.

However, experience shows that a dependence on conventional institutional arrangements such as the CADA to address tail-ender deprivation will not be sufficient. The only way to do this is to (better) implement Participatory Irrigation Management (PIM). The idea of PIM is that the irrigation departments (or in Karnataka's case the Neeravari Nigams) only concentrate on technically and financially complex structures, such as the dam, and the main systems up to secondary canals and structures at that level. Tertiary level canals and below, minor structures and field channels are handed over to Water Users Associations of farmers, which enables the transformation of last-mile connectivity through innovative command area development. When successfully implemented, this leads to:

- More equitable access to water by all farmers in the command (*har khet ko paani*)
- Sustainable operation and maintenance of the irrigation systems
- At least 20% saving in water use
- Creating a healthier link between farmers and irrigation department
- Producing more crop per drop
- Farmers actively participating to:
  - contribute towards the physical rehabilitation of the system
  - undertake crop planning, and
  - resolve conflicts amicably.



Interest in PIM in India began as far as back 1985, when the Command Area Development programme asked states to involve farmers in irrigation management. Experiments with PIM began seriously in the 1990s, and the PIM approach has been shown to be feasible and successful in many locations in India, such as Dharoi and Hathuka in Gujarat, Waghad in Maharashtra, Satak, Man and Jobat in Madhya Pradesh, Paliganj in Bihar and Shri Ram Sagar in Andhra Pradesh (see Box 1).

### Box 1 Success Story of PIM

One of the most successful examples of PIM in India is being implemented jointly by the Government of Gujarat and Development Support Centre, Ahmedabad since 1994 on the right bank canal of the Dharoi project on the Sabarmati river covering about 48,000 hectares. 175 WUAs and two Branch Level Federations have been formed. Each WUA services a command area of about 300 to 500 hectares and has about 200 to 350 members. The Branch Level Federations service an area of 7,000-14,000 hectares. The WUAs in Dharoi are registered as co-operatives. Each farmer within the command area has purchased a share to become a member. There are about 35,000 members. They have carried out canal rehabilitation works worth Rs.55 million wherein the members have contributed about Rs.10 million. They have appointed their own President, Secretary and Canal Operators who ensure that the WUA financial and administrative systems as well as the physical system are in shape before the irrigation season. These operators and the secretary are paid by the WUA itself without any grants from the Government. They have installed gates at the outlet level with their own funds and devised a system of water distribution wherein no member is given water without a pass. They prepare an annual budget and decide the water charges which are often over and above the Government rate. The office bearers collect the water charges in advance from the farmers and pay them to the Irrigation Department. The WUAs charge penalties to members in case they break the rules finalized at the Annual General Body meeting and this penalty is double for office bearers. Some of them have also carried out pilots on volumetric supply of water and water use efficiency. They have built up reserve funds that serve as a contingency during scanty rainfall years.

Source: Planning Commission (2010): *Mid-term Appraisal of 11<sup>th</sup> Five Year Plan*

Inspired by some of these experiments, the Government of Karnataka adopted PIM formally in 2000 by amending the Irrigation Act, initially by an ordinance and then by amendment. While the initial model was voluntary formation of WUAs, it is now mandatory to have WUAs in all command areas, and the formation of WUAs is done by the Command Area Development Authority. On paper 3145 WUAs have been registered (as compared to a target of 4237). Unfortunately, the record of PIM in Karnataka has not been very positive. Only 1795 can be said to be functioning [29]. Even more important, the functioning of the WUAs is far from the role they are supposed to play. While a detailed assessment of the institutional structure of PIM in Karnataka and the reasons for failure is given in Chapter 7, suffice to say here that the major reforms required include:

- a) clear and statutory water rights to WUAs,
- b) WUAs authorised to retain upfront a fraction of irrigation service fees collected,
- c) renovation of the canal network *before* the WUA signs an MOU with the NNL, d)
- strict definition of the responsibilities of the NNLs,
- e) gradual elimination of the CADAs, while strengthening the WALMI to play a major supportive role,

- f) factoring in groundwater use in the irrigation service fee and in water allocation in general, and
- g) increasing the involvement of women, and overall capacity building of WUAs.

### ***3.5 Integrated Management of Groundwater, Watersheds and Minor Irrigation Tanks outside the Major/Medium Command Areas***

The water scarce landscape of the eastern plains of Karnataka can be broadly divided into those lands that are served by major / medium irrigation projects, and the lands outside these major/medium commands. The latter landscape was, in the past, either rainfed or partly irrigated by minor irrigation tanks. But this landscape has now evolved in complex ways.

First is the dramatic rise of groundwater irrigation in the state. As Table 6 and Figure 24 show, the contribution of groundwater to irrigation in Karnataka has increased enormously from 17% to more than 50% of the gross irrigated area. Most of this groundwater based irrigation happens outside the command area of major and medium surface irrigation projects. This boom in groundwater irrigation was a boon to farmers whose lands were not irrigated by surface irrigation systems, thus making irrigation somewhat more equitable. Groundwater is the major source of irrigation for small and marginalized farmers in Karnataka (and elsewhere in India), as the latest Minor Irrigation Census shows.

Unfortunately, today, the solution to the problem of water access has precipitated the problem of groundwater depletion, jeopardizing its future availability. The crisis depleting groundwater tables in Karnataka has been presented in detail in Chapter 1. The reason for this is that groundwater is (in physical terms) a common pool resource but the legal regime for accessing groundwater is that of unregulated individual access (i.e. virtually open access). The policy of free electricity for pumping has only aggravated the unsustainable and inequitable use of groundwater.

This crisis not only jeopardizes future availability to all, but also has serious equity implications, since marginal and small farmers will be most affected by this depletion (apart from the effect on drinking water wells/borewells). Better off farmers can afford to drill repeatedly for groundwater that has now gone to 1000ft or deeper in many parts, but others cannot.

Second, even though this landscape boasts of over 25,000 minor irrigation tanks<sup>15</sup>, in reality today most of these tanks have fallen into disuse. Efforts to rejuvenate these tanks through desilting, tank bund repairs, and also clearing of inflow channels have met with limited or short-lived success, even where major investments were made (such as in the World Bank-funded JSYS Programme). A major reason is the lack of a holistic understanding of the link between catchment area health, groundwater use/depletion and tanks. Many farmers in the tank commands have invested in borewells and thereby lost interest in the traditional system of tank based irrigation via surface channels. They prefer to operate the irrigation tanks as percolation ponds, but this leads to a loss of interest in collective action. Simultaneously, groundwater pumping and depletion in the tank catchments has significantly reduced the inflows into the tanks (as described in chapter 2). Thus the management of these tanks is now intertwined with the management of groundwater.

Third, the idea of watershed development was originally proposed as a solution to the precarious nature of rainfed farming in drought-prone or semi-arid areas. Karnataka has a

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<sup>15</sup> [http://waterresources.kar.nic.in/irri\\_in\\_kar.htm](http://waterresources.kar.nic.in/irri_in_kar.htm)



large area that falls in this category (as mentioned in Chapter 1). Hence the government has pursued watershed development programmes vigorously for the past 20 years through its Watershed Development Department with funding from various agencies. By 2007, watershed development programmes had been implemented in 39 lakh hectares, which amounts to 20% of Karnataka's geographical area.<sup>16</sup> The programmes primarily involve soil and water conservation measures such as check dams, gully plugs, field bunds, and revegetation of upland commons.

However, watershed development faces several challenges or creates unintended adverse outcomes. To begin with, not all of these programmes have been equally effective or long-lasting in their impacts: a post-facto assessment in 2009 of a large sample of watersheds treated under 11 different programmes showed that only 46% of check dams constructed were in good condition [30]. But more importantly, where the increased recharge provided by such structures leads to greater groundwater exploitation, in the absence of any regulation on this exploitation, the benefits of these investments dissipate quickly. Finally, the intensive (often indiscriminate) construction of recharge structures in a catchment (coupled with local pumping and use) naturally leads to reduced inflows in irrigation tanks downstream [31, 32].

Hence it is clear that all ongoing efforts to rejuvenate/repair tanks<sup>17</sup>, treat watersheds or enhance local water harvesting in other ways (e.g., using farm ponds) need to be linked with groundwater regulation in an overall integrated water management framework, if they are to be effective and provide long-term benefits. This would require understanding the links between surface and groundwater, upstream and downstream, and the distributional effects of the different technologies such as wells, check dams, farm ponds, and irrigation tanks. Key to this is understanding and strengthening groundwater management in a bottom up manner.<sup>18</sup>

Similarly, in the Western Ghats region which has an abundant number of springs, understanding the nature of springsheds (which may lie outside the surface stream catchments) and managing these springsheds becomes vital.

The challenge of groundwater management arises from the fact that a fugitive, common pool resource is being extracted by many individuals under an open access regime. Over the last few years, innovative approaches across the country have blazed a new trail on how to address this challenge. (See Box 2 for details).

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<sup>16</sup> <http://www.watershed.kar.nic.in/Intro.htm>

<sup>17</sup> Including using treated wastewater to fill the tanks, as being attempted under the KC Valley Diversion project, without asking why the irrigation tanks were empty or why groundwater in Kolar had declined in the first place.

<sup>18</sup> Top down attempts such as a single state level groundwater regulatory authority to regulate more than 13 lakh wells have failed miserably.

### Box 2. Success Stories of Participatory Groundwater Management in India

- The FAO-supported APFAMGS programme in Andhra Pradesh aimed at involving farmers in hydrologic data generation, analysis and decision-making, particularly around crop-water budgeting.
- Social regulation in groundwater sharing under the AP Drought Adaptation Initiative (APDAI) involving Watershed Support Services and Activities Network (WASSAN), in parts of AP.
- Experiences from Barefoot College, Tilonia, with a water budgeting tool known as JalChitra.
- Foundation for Ecological Security taking a micro-watershed unit for water balance and planning groundwater use along with communities in Rajasthan, MP and AP.
- Experiences of Advanced Centre for Water Resources Development and Management (ACWADAM) with Samaj Pragati Sahayog in MP and with the Pani Panchayats in Maharashtra on knowledge-based, typology-driven aquifer-management strategies.
- Training programmes and drinking water initiatives by ACT in Kutch training local youth as para-professionals in their quest for improved groundwater management.
- Research on documenting local groundwater knowledge in Saurashtra and Bihar by INREM Foundation.
- The Hivre Bazar model of watershed development and social regulation to manage water resources in Maharashtra.

*Source: Planning Commission (2012): Twelfth Five Year Plan*

The experiences from these trail-blazing efforts enable us to distil the key elements for successful (sustainable and equitable) management of this Common Pool Resource:

1. Understanding the relationship between surface hydrologic units (watersheds and river basins) and hydrogeological units, i.e. aquifers;
2. Understanding the broad lithological setup constituting the aquifer with some idea about the geometry of the aquifer – extent and thickness; and the storage and transmission characteristics.
3. Identifying groundwater recharge areas, and necessary recharge structures, keeping in mind downstream commitments;
4. Carrying out a water balance (surface + ground) and crop-water budgeting at the scale of a village or watershed.
5. Identifying regulatory options at community level, including drilling depth (or whether to drill tube wells or bore wells at all), distances between wells (especially with regard to drinking water sources), cropping pattern that ensures sustainability of the resource (aquifer) and not just the source (well/tubewell).
6. Regulatory Institutions at the community level having the authority to implement these options through participatory decision making.

The Government of India had taken a significant step to enable the scaling up of these ideas by launching the National Project on Aquifer Management (NAQUIM) in the 12<sup>th</sup> Five Year Plan. However, this focuses primarily on elements 2 and 3 above and in the absence of adequate capacities within government groundwater boards at both the central and state levels, the programme floundered. Groundwater and catchment scale water being a state subject, a major push is required at the state level which also encompasses the other elements above. Fortunately, the Government of Karnataka, along with several other states, is about to begin the implementation of the Atal Bhujal Yojana (ABHY). This programme



funded by the World Bank seeks to implement most of the ideas mentioned above in thirty overexploited and critically exploited talukas of Karnataka. This ABHY is the largest such exercise attempted in India at the scale of Gram Panchayats.

Effective implementation of this programme depends critically on several complementary changes including:

- A revamped groundwater regulation act that makes groundwater part of all water as a common pool resource held in public trust (see Chapter 8).
- A much more micro-level aquifer mapping exercise than carried out so far in NAQUIM, preferably at the individual village level.
- The aquifer mapping activity must not be reduced an academic exercise and must seamlessly flow into a participatory groundwater management endeavour. This demands strong partnerships among government departments, research institutes, gram panchayats/urban local bodies, industrial units, civil society organizations and the local community. The interface of civil society and research institutes with government needs to be encouraged across all aspects of the programme.
- Substantial strengthening of the capacities of the Ground Water Directorate including enhanced manpower and diversification of skill in order to provide long-term technical support for such a micro-level groundwater planning and regulation system
- Scrutinising more carefully the ongoing 'tank filling' programmes where irrigation water is transferred to fill dried tanks without any analysis of cost-effectiveness or reasons for tanks drying up.
- Integration of groundwater regulation with the management of micro water sheds and minor irrigation tanks.
- Encouraging micro-irrigation and fertigation in tank- and well-irrigated areas through KAMIC as suggested in section 3.3.

This last step is perhaps the most challenging and requires not just technical understanding or engineering but most importantly institution building. Fortunately, the state of Karnataka has already taken the first step by creating an integrated Minor Irrigation and Ground Water Development Department. What is required now is to create a nested and participatory institutional structure from the bottom up, i.e., the Gram Panchayat or preferably the village Gram Sabha itself. A possible 3-tier structure of institutions would look like the following:

- a) Water Management Committees (WMC) at the Gram Sabha level, which would plan and participate in the development of water budgets and integrated planning and implementation of watershed development, tank renovation and groundwater (and all water use) regulation and distribution. The WMC would be the recipient of all government grants for these activities. It would also raise funds for operation and maintenance through appropriate water charges.
- b) Milli-Watershed Association (MWA), covering multiple Gram Sabhas and their water bodies within a single catchment. The MWAs will be responsible for renovation, cleaning and excavation of feeder channels and repairs to diversion weirs/ regulators on feeder channels. They will also help resolve conflicts across WMCs within the cascade on water sharing and maintenance responsibilities.



- c) Technical Support Teams within Taluka Panchayats or Zilla Panchayats for providing monitoring and training programmes for WMCs and MWAs.
- d) This process of participatory integrated water planning and groundwater regulation will be initiated through the Atal Bhujal Yojana and expanded to the rest of the state, including ULBs. Partnerships with knowledge institutions and civil society organizations will be an integral part of implementing this Yojana. A cadre of trained resource persons at local level will be created to support this process.
- e) Merge the Watershed Development Department with the Minor Irrigation Department and Groundwater Directorate, and making Integrated Water Management in Rainfed Areas the mandate of this combined department, with its role focused on providing funding and technical support to WMCs and MWAs, while leaving implementation and day-to-day management/water allocations decisions to the latter.
- f) In the Western Ghats region, following a comprehensive inventory of springs, a dedicated participatory springshed management programme to be taken up.

Only with this kind of multi-pronged approach to radically transforming water management and farming in Karnataka, can a lasting, cost-effective, and fair solution to the Karnataka water crisis be found.

### **3.6 Addressing Electricity Sector concerns while Protecting Groundwater Resources**

It has been repeatedly pointed out that the policy of providing free electricity for irrigation pumpsets has aggravated the groundwater depletion problem. At the same time, farmers complain that electricity supply is so unreliable that they are forced to over-irrigate whenever it is available. And electricity suppliers are reluctant to invest in improving supply quality because as of now they are already operating with a huge deficit because of the zero tariff charged. Consequently, several measures are being proposed and experimented with to alleviate the dual problem of the (electrical and) financial losses of power producers/distributors, and the unreliable supply faced by farmers. The question is whether these measures will also ameliorate or might inadvertently aggravate the problem of groundwater overdraft.

One measure that has been experimented with is the idea of Demand Side Management (DSM) in agriculture by improving pumpset efficiencies and feeder separation. The WENEXA project in Doddaballapura<sup>19</sup> sought to do this by replacing 280 out of 600-odd pumpsets across 34 villages, and separating the feeders from domestic supply feeders to ensure predictable supply. The results have been encouraging vis-à-vis electricity savings and therefore reduced losses to the power utility, but unclear vis-à-vis groundwater pumping.

A more recent effort is the Surya Raitha Scheme,<sup>20</sup> which involves providing capital subsidies to farmers to set up solar PV systems for their pumpsets, with net metering that will enable them to sell electricity to the grid also. The farmers get more predictable supply for their pumpsets and also earn additional revenues by sale of electricity [33]. Again, it is not clear that this will reduce groundwater overdraft.

While free electricity does undoubtedly contribute to groundwater depletion, two complications may be noted. First, electricity costs are only part of the cost of borewell-based irrigation (the

<sup>19</sup> <http://bescom.org/wp-content/uploads/2012/11/WENEXA-corrected.ppt>

<sup>20</sup> [www.kredinfo.in/Solaroffgrid/Surya%20raitha%20eng.pdf](http://www.kredinfo.in/Solaroffgrid/Surya%20raitha%20eng.pdf)

capital cost of borewell drilling being equally significant in most hard-rock contexts) [34]. So once the farmer drills for water, s/he may not stop pumping even if electricity is moderately priced, if the marginal value of water is high (which would be true in a dry zone). Second, free electricity leads to groundwater depletion in the presence of an open-access groundwater regime (a free-for-all in terms of how much groundwater is permitted to be pumped). If free electricity is replaced by highly subsidized solar PV-based pumpsets, the situation will not change. The farmer will now have a reliable and almost free source of electricity for pumping groundwater. The claim that farmers will sell electricity to the grid instead of using it for pumping if a high enough price is offered for their solar-PV electricity [33] is yet to be tested. The subsidy required to provide a high enough electricity price could be huge, and in any case it is unlikely to affect pumping as long as there are no restraints on total quantum of groundwater pumped—farmers may sell with one hand and pump with another.

Thus, while these schemes may address the challenges faced by electricity suppliers and also make supply more predictable for farmers (reducing their temptation to over-irrigate and improving productivity, reducing pumpset burnout), for them to result in any groundwater savings would require them to be overlaid on top of some form of groundwater regulatory system. Such a regulatory system in the form of Participatory Groundwater or Integrated Water Management, as described in the previous section, must, therefore, become an integral element in any attempt to break the groundwater-energy nexus. Without PGWM, it is not clear if these well-intentioned programs will really reduce groundwater over-extraction.

At the same time, it would be useful to integrate energy monitoring in the PGWM model. Since PGWM also looks into improving efficiencies in recharge and water supplies (including application of water for agriculture), bringing in the energy dimension through a careful monitoring of energy – whether conventional grid based electricity or in-situ solar power – might provide further both an opportunity and impetus to an improved WENEXA.

In summary, we recommend that the state:

- a) Implement feeder separation with farmer involvement to improve the reliability of rural electricity supply;
- b) Implement electricity metering and charges at low rates to farmers after feeder separation, and in tandem with pump improvement subsidies, to reduce electricity losses and incentivise water conservation;
- c) Ensure that in any solar-PV based irrigation scheme, total water pumped for irrigation is kept unchanged or reduced by simultaneous monitoring of water use, and making micro-irrigation and fertigation mandatory in such schemes;
- d) Make Gram Panchayat level groundwater budgeting and Participatory Integrated Groundwater-Tank-Watershed Management, a pre-requisite for initiating solar-PV based pumping.

### **3.7 Flood management downstream of major irrigation projects**

Unlike states in the Gangetic flood plain or Assam, Karnataka is blessed with a generally low flood risk, because almost all the rivers in the state originate in the state, and the state is therefore located in the higher reaches of each major river basin. However, the construction of large dams for irrigation on east-flowing rivers has increased the responsibility on the state, and the changing intensities of rainfall (highlighted in Chapter 1) have increased the chances of high inflows that can aggravate the risk of flooding.

For instance, the October 2009 flood in the Krishna river basin is one of the worst disasters witnessed in the recent past in the Karnataka-Andhra-Telangana region. Fifteen districts in Karnataka and thirteen districts in erstwhile Andhra Pradesh were severely affected by the flood, which took the toll of 319 lives, flattened more than a million houses, and destroyed vast areas of standing crops. There was severe damage to public infrastructure including roads, culverts, bridges and embankments leaving several villages stranded and hindering rescue operations [35]. There have also been instances of high rainfall in Maharashtra leading to flooding in the parts of northeast Karnataka that receive inflows from the Maharashtra portion of the Krishna basin.

There is of course an inherent tension between irrigation dam management and flood management. Irrigation managers would like to capture as much of the monsoon rainfall as possible for use during the non-monsoon period. But a full dam is then ineffective in flood control when (if) additional storms come, as it happened in 2009 [35, 36]. And it can be potentially even hazardous, because dam managers may release water suddenly to safeguard the dam structure. There is reason to believe that the Krishna basin floods mentioned above could have resulted in lower damages to life and property with more judicious releases from upstream reservoirs and better communication between dam operators and flood plain administration [35].

Indeed, reacting to the Kerala floods of 2018 and the controversy over management of inter-state dams in the Western Ghats of some of the rivers that flooded, the Secretary, Ministry of Earth Sciences, Government of India expressed the concern that there is “no scientific dam water management across India. As per my understanding, no big reservoir has a decision support system. So we don’t know when to open them, how to open them.”<sup>21</sup> It has been further pointed out that “World Bank analysis while preparing the National Hydrology Project (NHP) in 2015 showed that although weather forecasts are more accurate now, dam managers are reluctant to authorise advance controlled releases. This is partly because operating schedules are not based on predicted rainfall. These usually specify that dams must be filled up as soon as possible (because rain is not guaranteed later in the season) and must be full by the end of the monsoon (for the summer). But the world has moved to dynamic reservoir operations based on weather forecasts. The NHP is improving hydro-meteorological and weather forecasting systems across India but unless dam managers feel free to take credible risks, these will not be used for dynamic reservoir operations.”<sup>22</sup>

Recommendation: While flooding cannot be fully prevented and the changing nature of climate is making weather patterns even more unpredictable, steps are required to mitigate the excess risk created by dam operations. A combination of better use of real-time monitoring and forecasting technologies and support provided by the National Disaster Management Agency and improved communication between dam managers and flood plain administration, including inter-state administration can address this issue.

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<sup>21</sup> <https://indianexpress.com/article/india/not-just-kerala-no-scientific-dam-water-management-across-india-madhavan-nair-rajeevan-secy-earth-sciences-5322003/>.

<sup>22</sup> <https://www.thehindu.com/opinion/op-ed/preparing-for-the-floods/article24988789.ece>.



## CHAPTER 4. RURAL DOMESTIC WATER NEEDS<sup>23</sup>

Domestic water use in rural areas generally receives less attention because of the dispersed nature of the rural population, the use of rivers, streams and irrigation water (tanks, canals and irrigation borewells for meeting some of these needs), and the small quantum of this use as compared to other uses. Nevertheless, with 60% of its current population still living in rural areas, the provision of safe and adequate drinking water and water for other domestic uses, must rank as the single most important duty of the Government of Karnataka.

### 4.1 Status

As per the MIS of the Ministry of Drinking Water and Sanitation, Government of India, as on 4<sup>th</sup> December, 2018, of the 59,774 rural habitations in Karnataka, 23,120 habitations are fully covered with 40 lpcd water supply, leaving as many as 35,862 or 60% habitations as partially covered, with less than 40 lpcd water supply.

### 4.2 Existing policies and programmes

There have been several rural drinking water supply schemes and programmes taken up by the Government of Karnataka (GoK) in the past that include World Bank assisted IRWS & ESP-I, IRWS & ESP-II, Jal Nirmal, DANIDA-funded water supply, Netherlands funded water project etc. Currently, the GoK is in the progress of designing a universal piped drinking water scheme for the state with an estimated budget of Rs. 50,000 crores.<sup>24</sup>

The State Water Policy 2002 set a goal of providing 55 lpcd in rural areas, and many schemes had set this target. However, since 2017, all new scheme are being designed for a service level of 85 LPCD.

Potable drinking water is being supplied to rural areas through the following schemes:

1. Borewells fitted with Hand pump
2. Mini Water Supply Scheme (MWS)
3. Piped Water Supply Scheme (PWS)
4. Multi Village Water Supply Scheme (MVWS)

All Rural Water Supply Programmes are supposed to be implemented through Panchayati Raj Institutions (PRIs). Borewells fitted with hand pumps are the major source of potable drinking water in rural areas. Since inception of the programme 2,25,640 borewells have been drilled in the State. An amount of Rs.1,000/- per borewell is being provided for the annual maintenance of borewells to Gram Panchayats (GPs) by the Rural Development and Panchayath Raj Department (RDPRD). In MWS, water is pumped to one or more small tanks (cisterns) fitted with 3-4 taps, from where water can be collected by households. Since inception of this programme, 51,582 MWS schemes have been completed. Rs.5,000/- per annum is provided for each MWS scheme to GPs by the RDPRD. 39,081 PWS schemes have been completed and commissioned under both State and Central Sectors. Rs.10,000/- per PWS is being provided to GPs per annum towards O & M of these systems. 555 MVS

<sup>23</sup> We gratefully acknowledge inputs received from Dr.Himanshu Kulkarni for this chapter.

<sup>24</sup> <https://www.deccanherald.com/state/top-karnataka-stories/karnataka-plans-mega-universal-678791.html>



schemes costing Rs.11,287 crore have been given administrative approval, out of which, 427 have been completed at an expenditure of Rs. 3966 crore.<sup>25</sup>

In a submission to this Task Group, the Department of Rural Development and Panchayath Raj (RDPRD) has stated that

“The aspiration (goal) of the department is to provide piped water supply to all rural habitations with all households getting individual connections. Mini-water supply schemes and hand-pumps supported by bore-wells are transitory arrangements that need to be phased out as we universalise piped water supply with individual home connections. Bore-well as a source is not sustainable and contributes to water quality problems. In the short run the department is promoting source sustainability through spot bore-well recharge structures, ground water recharge and water harvesting structures located in the villages through a watershed based treatment.

In the long run, the department has a policy of relying on surface water sources like perennial rivers and reservoirs. In regions where there is sustainable water source and it is techno-economically feasible to convey water to the habitations around the source, schemes will be designed to build multi-village drinking water schemes (MVS) which provide treated water to the villages at their door step. The internal distribution of water in the village will be done through the existing PWS and it will be the responsibility of the Grama Panchayat to maintain the same. Currently out of the rural population of 3.75 crores, a population of 1.04 crores is being served by MVS. When the ongoing MVS are completed the coverage will increase to serve 1.60 crore rural population. To cover the remaining rural population, as far as possible through MVS, an ambitious program called “Jaladhare” is being launched. The Department’s vision is to run about 1000 large MVSs that can supply treated water at service level of 85 LPCD to most of the rural habitations. In the Western Ghats (covering about 7 districts, viz., Uttara Kannada, Udupi, Dakshina Kannada, Shivamogga, Chikmagalur, Hassan and Kodagu) perennial streams in upper reaches of mountains will be tapped to provide piped water through gravity to habitations. In the three coastal districts, viz., Uttara Kannada, Udupi and Dakshina Kannada, due to lateritic soils, the abundant rainfall does not get stored and it runs off into the sea. There too MVS will be taken up by tapping the west flowing rivers, well before they reach the sea.”

According to a submission by the RDPRD to this Task Group, “In the Southern Karnataka region, districts like Tumkur, Kolar, Chikballapur, some parts of Mandya, in Mumbai Karnataka Bijapura, Gadag and in Hyderabad Karnataka districts of Bellary, Koppal, Raichur, Gulbarga, some of the villages are Fluoride affected. In the Western Ghats region, where lateritic soil is prevalent, the districts of Mangalore, Karwar, Kodagu, Udupi, and in some parts of Shivamogga and Chikkamagaluru, they are affected by iron Concentration. Some parts of Davanagere, Kolar, Bijapur, Chitradurga, Mandya, Ballary, Raichur and Tumkur districts are Nitrate affected due to chemical contamination. In some villages of Raichur and Yadgir, i.e., (gold Mining area) some traces of Arsenic are also present in drinking water sources.

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<sup>25</sup> Annual Report 2017-18 of Department of Rural Development and Panchayati Raj (RDPRD).

### **4.3 Issues in Rural Water Supply and Looming Challenges**

#### **4.3.1 Slip-back habitations – challenges in quantities and quality**

According to the NRDWP statistics, as on April 2017, only 33% of the total habitations were covered under the drinking water supply. The recent CAG report [37] highlighted the gaps in the implementation of the NRDW programme in the state. The report largely highlighted that habitations covered under the programme has actually decreased from 42% in April 2013 to 33% in April 2017. There has been a very marginal increase from 9% to 11% (from April 2013 to April 2017) in percentage of habitations fully covered under the scheme. The report explicitly highlights that the lack of water security plan and the lack of a comprehensive state water policy also contributed to the failure of the programme along with issues relating to land acquisition, convergence between departments for permissions, lack of a detailed action plan and governance mechanisms.

Many habitations in the state are also affected by water quality issues such as arsenic, fluoride, nitrate and other contaminants. The Ministry of Drinking Water & Sanitation has identified 745 habitations affected by fluoride, 4 by arsenic and 378 affected by nitrate, even though there are many more districts affected that are not represented in the data.

In the recent past, Reverse Osmosis (RO) has become the preferred solution for ensuring safe drinking water to communities. However, this system of installing RO plants is also faced with varied challenges such as slipbacks, differential pricing, lack of wastewater treatment and its usage guidelines, lack of needs based assessment before installing a plant, and weak regulatory systems etc. In July 2018, GoK admitted to 2,498 RO plants lying defunct, and civil society estimates peg this at close to 50% of total 8000 installed. Borewells going dry has been the most common reason for this.

One widespread problem is that since 87% of drinking water supply schemes are dependent on groundwater, there is a tendency for the aquifer supplying this water to get depleted over time because the same aquifer is used for the much greater consumer of water, viz., irrigation. As explained in Chapter 1, the major type of aquifer in Karnataka, prevailing in the eastern part of the state, is hard rock aquifers (granite, basalt, gneisses, schists and charnockites). These hard-rock aquifers not only have poor storativity but have highly variable transmissivities leading to a high degree of heterogeneity. Recharge rates in these regions are also quite limited. Indeed, Karnataka has the largest area of hard-rock aquifers within the country. On the other hand, the area underlain by potentially high storage aquifers is much smaller and is constituted by sedimentary rock formations such as sandstones and limestones, mostly in the northern parts of the state. Hence, there is a repeated phenomenon of “slip-back habitations” that refers to those habitations which at one time had access to safe drinking water but which over time had run out of water. This reflects a general “hydro-schizophrenia”, where the left hand of drinking water does not know what the right hand of irrigation is doing. There are also major water quality issues that have emerged in the state. These are covered at length in Chapter 6. Of the last 15 years, 13 have been drought years in Karnataka. Compounded by the problem of unsustainable groundwater extraction, more than 1,134 habitations are getting water through transportation<sup>26</sup> as a consequence of a combination of these two factors.

#### **4.3.2 Non-integration of Swachh Bharat Abhiyan with Drinking Water Supply Schemes**

A similar issue of non-integration arises from the fact that the Swachh Baharat Abhiyan (SBA) has not been implemented in sync with the drinking water supply schemes. This has been a

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<sup>26</sup> Ministry of Drinking Water and Sanitation. *Supplementary Note on the Contingent Action Plan of Rural Water Supply in Karnataka 2014-15.* [https://mdws.gov.in/sites/default/files/karnataka\\_0.pdf](https://mdws.gov.in/sites/default/files/karnataka_0.pdf)

problem all over the country. This has given rise to serious water quality issues, especially due to nitrate contamination. It is well-known that there is a high likelihood of nitrate pollution of groundwater reaching levels exceeding the World Health Organization guideline value for nitrate in drinking water of 50 mg/L after as short a period as two years for the aquifer situated 5m below toilet pits [38]. Consumption of high concentrations of nitrate in drinking water is known to cause methemoglobinemia, and associations with cancer in humans have been observed. Human faeces also harbour a large number of microbes, including bacteria, archaea, microbial eukarya, viruses, and potentially protozoa and helminthes [39]. At a study site in India characterized by a shallow water table and fractured rock aquifer, high concentrations of faecal coliforms were found in domestic wells located near pit latrines and septic tanks [40]. In a geo-referenced spatial study of viral contamination [41], the scientists sampled 287 drinking-water sources (247 water wells, 25 pumps, and 15 surface water samples) proximate to 220 latrines. Adenoviral DNA was repeatedly detected in 26 water sources, and rotaviral RNA was detected in 1 source. In multiple rounds of sampling, 40 of the 287 drinking-water sources were positive for viral contamination at least once. These authors hypothesized that during the wet season, viruses were transported by groundwater flow in the upper part of the soil, whereas viral transport in the dry season was more likely a result of virus contaminated surface water.

These are dangerous possibilities with serious consequences for human health. A recent study from Bihar confirms these dangers. The study sampled a total of 150 water supplies for “thermotolerant (faecal) coliforms (TTC) and tryptophan-like fluorescence (TLF): an emerging real-time indicator of faecal contamination. Overall, 18% of water supplies contained TTCs, 91% of which were located within 10 m of a toilet, 58% had TLF above detection limit, and sanitary risk scores were high. Analysis also indicated proximity to a toilet was the only significant sanitary risk factor predicting TTC presence-absence and the most significant predictor of TLF. Therefore, increasing faecal contamination of groundwater-derived potable supplies is inevitable across the country as uptake of onsite sanitation intensifies.” [42]. A study of microbial movement near onsite sanitation in West Bengal found increased concentration of total and faecal coli form during monsoon period [43].

At least two studies from Karnataka, provide confirmation of the dangers of not integrating sanitation and drinking water supply programmes. A study of Mulbagal town found nitrate concentration of 30-140 mg/l in surrounding bore wells near the onsite sanitation system [44]. A very interesting recent study was carried out in different geological settings in Doddaballapura in Bangalore Rural district and Kanakapura in Ramanagara district [45]. The study reveals: “Bore well water samples collected near the onsite sanitation systems contain high values of chloride, Total Dissolved Solids, and nitrate, which indicates the contamination of groundwater by onsite sanitation systems. 75% of the samples exceed the WHO guideline. The bore well water is not suitable for drinking purposes. The high concentration of chloride and nitrate shows that the groundwater is contaminated from the Leachate from the onsite sanitation systems. Chloride and nitrate are found in bore wells up to 50m from the onsite sanitation system.”

### **4.3.3 Poor Operation and Maintenance**

Poor operation and maintenance of drinking water infrastructure has resulted in high rates of attrition and dilapidated facilities. This has happened especially where primary stakeholders do not feel a sense of ownership over the facility created and in the absence of sufficient support structures and professional capacities, upkeep suffers. On the other hand, where people have been centrally involved, they have both paid for the service provided and felt a stake in maintaining the assets, garnering adequate support for the same through the revenues generated.

## 4.4 Recommendations

In order to ensure safe drinking and domestic water to rural Karnataka, the following principles form the fundamentals of developing a set of specific recommendations.

1. Principles of equity (of access) and sustainability (of the resource)
2. Participatory and community engagement in planning, implementation and governance.
3. Access to safe drinking water for all, as a fundamental Right to Life as enshrined under Art. 21 of the Indian Constitution.
4. Entrusting the community with the responsibility to govern, make decisions on and manage their resources through the established decentralised governance system. Such an approach will help build community ownership for the resource and the initiatives.
5. Due consideration to ecological and socio-economic aspects must also be inclusive of the decentralised governance on water.

### 4.4.1 Aquifer Management Plans as part of a District Water Vision

Adopt a holistic aquifer and surface water management approach with active community and PRI participation that converges in a District Water Vision, including monitoring and recording of groundwater levels and rainfall at sub-block level and Aquifer Management Plans to protect and recharge drinking water sources. In doing so, a mandate could be developed at each village panchayat/ gram panchayat to design Water Security Plans annually to estimate the demand and supply requirements for the village in which domestic water including drinking water gains top priority. All of this will be part of the integrated and participatory groundwater-tank-watershed management system proposed in section 3.5, in which the first priority is drinking water and domestic water security.

This should become an integral part of *Jalamrutha*, the programme that is just about to be launched by the RDPRD, as a comprehensive community mobilisation effort to harvest, conserve, and judiciously use water, with a priority for rural domestic use. This program aims to bring together all stakeholders on a single platform to trigger community action to revive existing water bodies and conserve them, to treat the land on watershed basis, create water and soil conservation structures like nala-bunds, check dams, etc., to promote water literacy among stakeholders at all levels, and to promote greening of the villages through strategic planting of trees. Sustainable and equitable aquifer management must become an integral part of *Jalamrutha*.

### 4.4.2 Integrate Sanitation and Water Supply Initiatives

All sanitation and water supply efforts must be carried out in an integrated manner. Of course, the extent to which microbes from pit latrine wastes may be transported and contaminate groundwater largely depends on the environmental context of the area, particularly hydrological and soil conditions. But careful siting of sanitation infrastructure away from high water table areas, more frequent pit emptying, or switching to urine diversion toilets is highly recommended. A minimum vertical distance of 5-10m between the bottom of the pit and the water table would maintain safe groundwater quality. Improper sanitation also has serious implications on water quality. Bacteriological contamination of groundwater is a serious issue which could undermine the gains through SBM. Containment technologies for toilets and structural design should therefore be informed by a more systematic hydrogeological understanding.



#### **4.4.3 Wastewater Treatment and Recycling to be integrated into Water Supply Schemes**

Wastewater treatment and recycling must be an integral part of every water supply plan or project. Management of liquid and solid waste must be promoted together with recycling and reuse of adequately treated grey water for agriculture .

#### **4.4.4 Safe distance between Mining Activity and Water Supply Initiatives**

Mining activity should be at a safe distance from major drinking water sources as it can threaten both the quality and sustainability of the source.

#### **4.4.5 Active Involvement of Primary Stakeholders**

Participation of the primary stakeholders, especially the leadership of women, in water supply schemes must be ensured right from the conceptualisation and planning stage, spanning construction and post-scheme completion management stages. Capacity building of members of the Village Water and Sanitation Committees is of critical importance here.

#### **4.4.6 The Subsidiarity Principle**

The subsidiarity principle must be followed and decisions made at the appropriate level possible especially on issues like location, implementation, sustainability, O&M and management of water supply schemes, while retaining an umbrella role for the Gram Panchayats for effective implementation.

#### **4.4.7 Participatory, Progressive Water Tariffs**

A progressive water tariff with different pricing tiers for different uses and different classes of consumers must be arrived at in an open, transparent and participatory manner and implemented at various administrative levels i.e. the Gram Panchayat, District and State as appropriate. Incentives may be provided to the GPs for collecting user charges from the beneficiaries. A minimum collection of 50% of O&M cost (including electricity charges) through user charges should be the target. The capital contribution and O&M costs for any water supply scheme should consider the earlier revenues generated and forecasted revenue projections for the GP to accordingly ensure financial support provision from State and Central Govt. for rural drinking water.

#### **4.4.8 People's Participation should be ensured in large MVS under Jaladhare**

With *Jaladhare* wherein large MVS are being built, the planning and construction of the large systems will have to be at the district or state levels. These systems also demand high level of skill and expertise for their maintenance. Therefore maintenance through of the MVS common facilities will have to be done through the use of professional agencies deployed by the ZP or the state government (in case the scheme cuts across districts.) However, these systems supply bulk water to the GPs. The GPs will therefore have to be engaged in managing the systems in their village and interacting with the agency that maintains the MVS common systems. GP capacities need to be adequately built for this purpose.

#### **4.4.9 Special Focus needed on Emerging Water Quality Issues**

In areas with high contamination levels, safe water must be provided through piped water systems, community RO systems and water grid based network schemes. Focus on systematic groundwater recharge keeping in mind the consequences for contamination. In places where such contaminants continue to exist, RO plants can be installed at minimal prices based on data and surveys.



Water quality improvement is about improving health and nutrition. Linking nutrition improvement through mid-day meals and local public health centres for children affected by fluoride is one such example that has encouraging results in other regions of India. The status of many water quality testing labs is questionable or ranges from being dysfunctional to being sub-optimal in terms of access to data, inadequate instruments and staff in labs. Since water quality testing is the foundation for subsequent actions for mitigation, GoK can make standards for water quality testing transparent and encourage multiple agencies/ entrepreneurs to get into the WQ testing space, based on a system of certification and accreditation. The data generated by these players will be made accessible to the government as well as end users through an open data system.

#### **4.4.10 Clear Policy required on RO Plants**

An inventory of existing and potential plants will be made and mapped to vulnerable areas to understand the criticality of water levels before commissioning RO plants. The GoK can cap the price at which the RO water is being sold in a participatory manner, to ensure equity and affordability in rural areas. The water charges would be determined by the GP in consultation with the Rural Water Supply / Public Health Engineering Department, community and VWSC subject to cap on the charges, if any, fixed by the State. The pricing limits along with operation, maintenance and insurance, related aspects can be adopted or guided by the MDWS guidelines and other State pricing mechanisms. In case of breach in pricing, O & M, insurance related works; the RO plants can be fined, punished, license revoked or all of the above. A real time monitoring network can be established to assess the installation of new plants, the standards of quality maintained, and the area covered through the services.

## CHAPTER 5. URBAN AND INDUSTRIAL WATER NEEDS<sup>27</sup>

### 5.1 Context: an urbanizing and industrializing state

Like the rest of India, Karnataka is rapidly urbanizing: The urban fraction in the population has risen from 29% in 1981 to more than 40% by 2018. This, coupled with an overall growing population, means that the urban population in Karnataka increased from 1.35 crores in 1991 to about 2.86 crores by 2018, an increase of 111% in 17 years.

Urbanization in general and at this rapid rate in particular poses a special challenge, because urban areas are characterized by

- a concentrated year-round demand for water,
- domestic demand that is always coupled with commercial, industrial and institutional (CII) water demand;
- the concentrated generation of polluted return flows, since consumptive use is by and large low;
- a higher per capita consumption because urban settlements currently depend upon conventional water-intensive sewerage systems to get rid of their sewage return flow.
- a higher per capita consumption as compared to rural areas also because of affluences and urban lifestyles.

Thus, although the urban landscape has a lower consumptive use fraction as compared to a rural/agricultural landscape, at the state-level a shifting in the population from rural to urban areas often does not 'free up' water from the agricultural sector, because the urban population requires agricultural products and has its own (higher) water needs. This is also because the shifting of population has not meant and a reduction in the absolute rural population or dependence on agriculture.<sup>28</sup>

In Karnataka, as of the 2011 census, there were 355 urban settlements including 275 administrative recognized urban local bodies (ULBs) and other Census Towns.<sup>29</sup> But a huge fraction of the urban population of Karnataka—about 40%—is concentrated in the city of Bengaluru (the fraction is larger if one includes the surrounding peri-urban areas). Moreover, it is predicted that this lopsided pattern of urbanization in Karnataka will continue over the next few decades, with some projections suggesting that the population of the Bengaluru Metropolitan Region (essentially the districts of Bengaluru Urban, Bengaluru Rural and Ramanagara) will cross 2 crores (as compared to the current 1.1 crores). Thus managing Bengaluru's water becomes almost a separate problem in itself within urban water management in Karnataka.

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<sup>27</sup> This chapter is based upon the report of Sub-Group 6 on Urban and Industrial Water, led by Prof. M. S. Mohan Kumar and prepared with inputs from Dr. Sharachandra Lele. The term 'urban and industrial' is used in the title as short-hand for 'urban domestic, commercial, industrial and institutional' water use. Elsewhere, we use the term domestic and CII water use.

<sup>28</sup> In fact, it may be noted that as per UN population projections, even in 2050, as many as 800 million Indians will continue to live in rural areas.

<sup>29</sup> This includes 11 municipal corporations, 58 city municipal councils, 114 town municipal councils and 92 town panchayats (Source: Department of Urban Development, Government of Karnataka: spreadsheet data).



## 5.2 Current status of the urban water sector

The status of water service to the urban domestic and allied (CII) sector is quite precarious, to say the least. We present a quick assessment of this sector in terms of the goals outlined earlier (chapter 3), viz., adequacy, affordability, quality, equity, sustainability and democratic governance.

### 5.2.1 Adequacy

The norms for adequate water supply to urban domestic users have been laid down in the Karnataka Urban Water Supply and Sanitation Policy 2003 as follows: 150 litres per capita per day (lpcd) for metropolises (essentially Bengaluru), 135 lpcd for other cities and towns with sewerage systems, and 70 lpcd for towns without sewerage systems. The official data in terms of quantum of water actually supplied to individual households are rather unreliable, as they ignore distributional losses (through leakages), do not segregate domestic supply from CII supply, use outdated population figures, use guesstimates for amounts pumped from public wells/borewells, and ignore private groundwater pumping by households and tankers. Nevertheless, even as per official figures, summarized in the histogram below, there are many ULBs that do not meet these norms. (The ones which do, tend to be from the coastal (high rainfall) region).

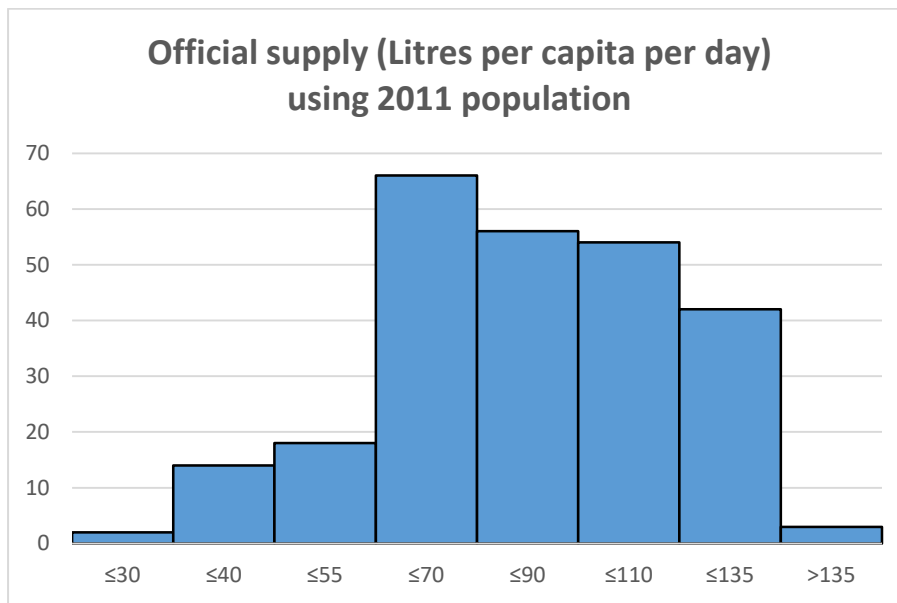
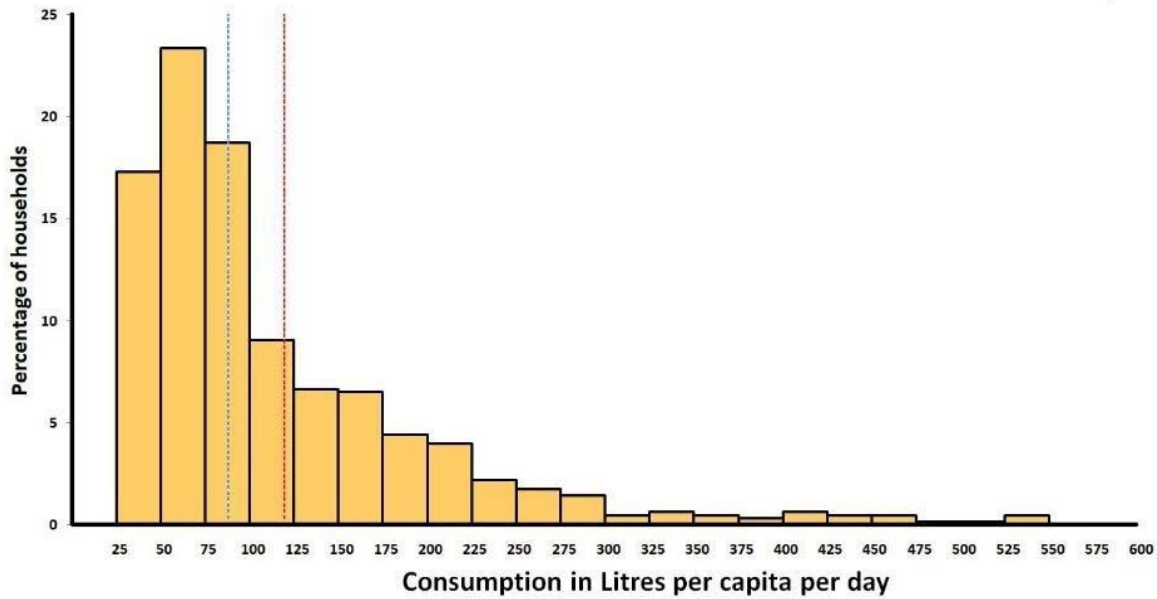


Figure 25. Histogram summarising status of water supply in all Karnataka ULBs (excluding Bengaluru) as per official data (Source: Urban Development Department, GoK).



**Figure 26. Histogram of actual water consumption by households in Bengaluru: the green line represents median consumption of 85 lpcd and the red line represents mean consumption of 120 lpcd (Source: [46]).**

Apart from the limitations mentioned above, these figures based on the average for a whole town do not reflect the actual picture of water supply within those towns and cities for individual households. For instance, a recent survey of household consumption in Bengaluru [46] that includes all sources of water showed that the median consumption was 85 lpcd, which means that 50% of the population of Bengaluru consumes less than 85lpcd (see Figure 26). Similarly, a study of Nelamangala and Ramanagara towns (near Bengaluru) which again used primary survey data coupled with some field monitoring showed that actual water supply is far below the official norms (see Figure 26). The Bengaluru study also shows the problem at the higher end: the top 10% of consumers were above 200 lpcd and averaged 340 lpcd, which is an unjustifiably high level of consumption in a water scarce region!

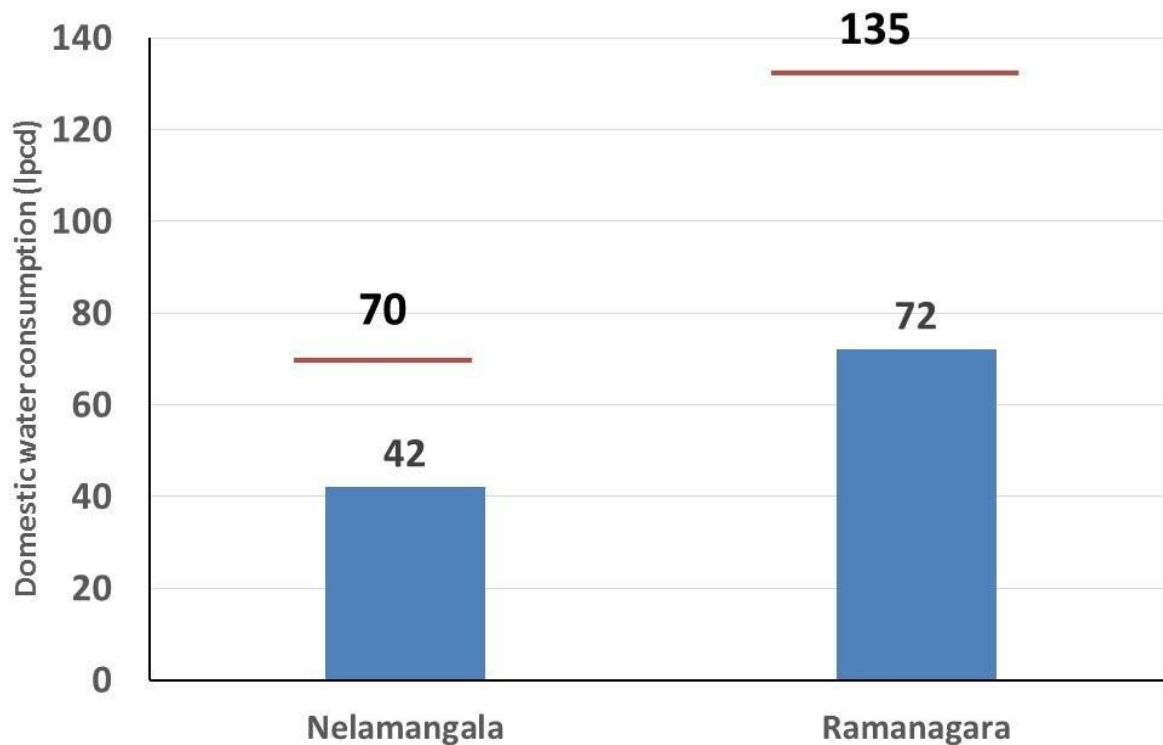


Figure 27. Average actual domestic water consumption (bars) in two small towns as compared to the official norm (brown line). (Source: [12])

Similarly, studies from Hubli-Dharwad (which is seen as the flagship of water sector reform) show that households in the 24x7 supply area were able to cross 100lpcd (at least initially)[47], but areas without the heavily funded 24x7 project had only 50% households crossing 50lpcd [48].

Moreover, intermittent supply imposes a lop-sided cost: those who have adequate storage capacity (such as in-house sumps) do not even see the intermittency, but the poorer sections who do not have such storage (or have limited storage) suffer more. Hence, the extent of intermittency also matters, and the fact that official figures show 54 out of 275 ULBs receiving water with frequency less than once in 4 days<sup>30</sup> is therefore a matter of concern.

It should also be borne in mind that availability of water fluctuates significantly across seasons. For instance, in Nelamangala town, 34% of the households reported purchasing water from tankers during the dry season [12]. The frequency of water supply during summer may drop down to as low as once in a fortnight in some towns.

When it comes to commercial, industrial or institutional (CII) users, there cannot be any specific adequacy norms. But from the information available from various surveys of industrial consumers it is clear that they meet their water needs from multiple sources, and that water from own borewells or purchased water from tankers is the major fraction of their supply [see 49]. This suggest inadequate or unaffordable supply for these users.

<sup>30</sup> Data provided by the Urban Development Department.

Thus the problem of inadequate water supply is ubiquitous in urban areas of Karnataka.

### **5.2.2 Affordability**

The price and affordability of water consumed in ULBs in Karnataka varies dramatically from one extreme to another, depending upon the source of water, and on whether one is considering only at monthly expenses or at the capital costs of either getting a connection or of setting up one's own supply (typically a borewell).

At one end, water supplied in public taps is free, although of course households using/collecting this water pay for it in kind—in the form of the significant extra labour involved in standing in line and collecting the water or using at the public tap. In the case of household connections, most of the ULBs charge very nominal amounts in the form of a fixed monthly charge of about Rs.60-90 (which may work out to 3-9 Rs/kL depending upon the amount of water actually received).

In the city of Bengaluru, where BWSSB has volumetric pricing, the charge for 100 lpcd consumption by a household could work out to more than 120 Rs/month (ranging from 8 Rs/kL to 12 Rs/kL). At the other extreme, when households are forced to buy tanker water (because they do not have supply from the ULB or BWSSB), they pay Rs60-130/kL, and when slum dwellers (who do not have the means to store a tankerful of water) buy it in pots, they often end up paying Rs. 100-200/kL (depending upon the going rate per pot)!<sup>31</sup> A study by the Institute for Social and Economic Change found that slum dwellers actually paid more per month for a lower quantity consumed than middle class households that had piped water supply, because the slum dwellers often had to purchase tanker water.

The affordability for commercial and industrial consumers is unclear. The price charged by BWSSB to smaller CII water users in Bengaluru is 50-87 Rs/kL.<sup>32</sup> In other ULBs, CII users are often charged flat rates that are double the domestic flat rates, but in the absence of metering it is not possible to estimate what this means in per kL terms. For larger (bulk) industrial consumers, BWSSB charges Rs.90/kL. On the other hand, for large consumers in rural areas, such as thermal power plants or major industries, that lift water directly from reservoirs, the water tariffs set by the state government for bulk industrial consumers appear to be very low (0.1 Rs/kL), nevertheless, a recent attempt to raise this tariff to 10 Rs/kL has met with stiff resistance.<sup>33</sup> The high tariffs for CII users also often results in their switching to groundwater use, thereby reducing the financial viability of the municipal supply and increasing the possibility of groundwater over-exploitation.

Affordability is not just determined by the monthly charges, but also by the so-called 'pro-rata' charges for providing the connection, and here householders struggle to meet the stiff charges imposed by agencies such as BWSSB or KUWSSB. Again, there is a lot of variation in these charges across towns, over time and within towns by type of property and there have been concerns about the affordability and consistency in these charges.<sup>34</sup>

### **5.2.3 Quality of water supplied**

If one measures the quality of water supplied against the standard of potability, then it is possible that most municipal supply systems do not meet this standard. But over time, it has

<sup>31</sup> <http://bengaluru.citizenmatters.in/should-bengalureans-be-grateful-for-bwssb-s-water-rates-6907>

<sup>32</sup> <https://bwssb.gov.in/images/upload/pdfs/201712071853460679592001512653026.docx>

<sup>33</sup> <https://www.thehindu.com/news/national/karnataka/departments-to-relook-at-water-tariff-hike-for-industry/article24535516.ece>

<sup>34</sup> <https://www.deccanherald.com/content/543137/hc-notice-bwssb-state-over.html>

been recognized that aiming for all domestic supply to meet the potability standard may be overkill, since less than 5% of domestic use is for drinking purposes. As such, most ULBs are probably able to meet a bathing water quality standard. The drinking water quality need is then met from either private investments in filters, UV treatment or RO treatment, or public RO plants that have emerged in recent years.

### **5.2.4 Equity and fairness**

There is a high level of inequity in water service access and affordability within the urban domestic sector. In Bengaluru, as the histogram in Figure 26 shows, while half the population consumes less than 90 lpcd, the top 10% of consumers consume an average of 340 lpcd! (Which is more than double the norm, and almost 4 times the median consumption). There is very limited information available regarding the variation in water consumption across socio-economic classes in other cities, but where available it reveals significant differences between poorer households (public tap dependent) and the better off (with in-house connections).

Across the state, 40% of urban households use public taps only or supplement other sources with public tap water. As mentioned above, while public tap water is free, the household (typically women) spends lot of labour in accessing this water. And when public taps fail to supply timely or adequate water, the households that do not have individual connections have to purchase water from tankers at steep rates, as mentioned above. BWSSB has a special programme for slums which sought to replace public taps with individual connections, but it has not been successful in ensuring adequate and affordable access to water for slum dwellers as a whole.

Across ULBs, again there is significant variation in water supply. While some of this variation is no doubt related to their hydrological endowment (being located in the water rich coastal region versus in a water-scarce semi-arid region), other variations are the result of state policy. For instances, towns within 20-40km of the edge of Bengaluru (Nelamangala, Doddaballapur Malur, Hoskote) do not get access to Cauvery water even as BWSSB supplied this precious water to industries in and outside Bengaluru (e.g., to Electronic City).

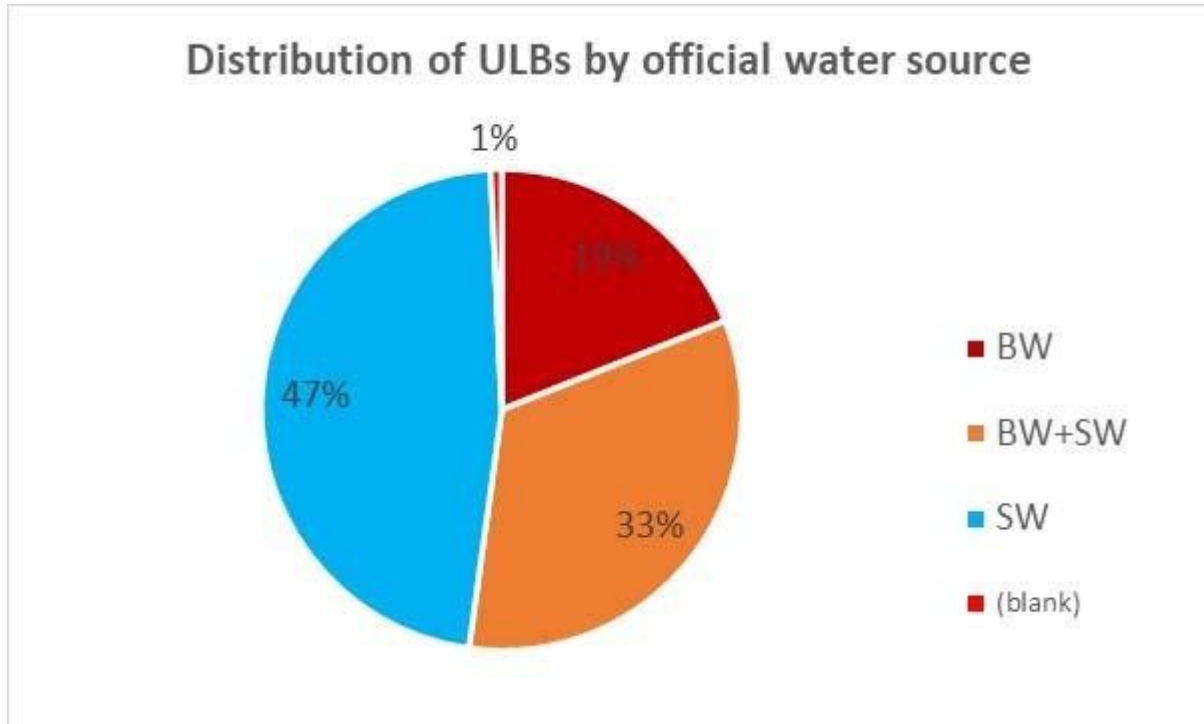
As mentioned above, the tariffs set for bulk consumers like power plants lifting from reservoirs/rivers appear to be very low compared to the tariffs set for urban industrial consumers, although in the former case the consumers probably bear the pumping costs. Attempts are being made to increase these tariffs.

The fairness dimension requires due consideration of downstream users and users in source catchments. Unfortunately, the principle of prioritizing 'drinking water' has been blindly applied, leading to increasing diversion of water from rivers and irrigation reservoirs to urban areas, with no environmental or social impact assessments. Similarly, cross-basin transfers have been proposed (such as Yettinahole diversion) without any such assessments.

### **5.2.5 Sustainability**

An often overlooked fact about urban water supply in India in general, and peninsular India in particular, is that groundwater forms a crucial, if not dominant, component of water supply. The biggest challenge to water resource sustainability in urban areas comes from the fact that a significant fraction of urban water supply still comes from groundwater, which is an open-access resource that is subject to over-exploitation and low recharge rates. In Karnataka, more than 50% the ULBs are partially or fully dependent on groundwater for their supply--see Figure 28. Note that the pie-chart in this figure does not tell us the magnitude of the contribution—it simply recognizes where pumping from groundwater is part of the public water supply system. This is further augmented by private borewells. Private pumping has played a crucial role by filling the gaps in public water supply schemes. The extreme example is Bengaluru where an

estimated 45-50% of total water consumed comes from groundwater. However, such heavy dependence has also led to problems of co-terminal depletion and contamination of aquifers. Thus, groundwater remains a blind spot in civic water supply planning.



**Figure 28. Share of borewells and surface water (or both) in household water use across all ULBs of Karnataka**

As mentioned in Chapter 2, given the hard-rock nature of most of Karnataka’s aquifers, they cannot support this level of groundwater extraction and so the groundwater resource is declining in almost all cases, or at least faces summer shortages. Within Bengaluru, the periphery (areas such as Whitefield) is facing serious declines (see Figure 29).

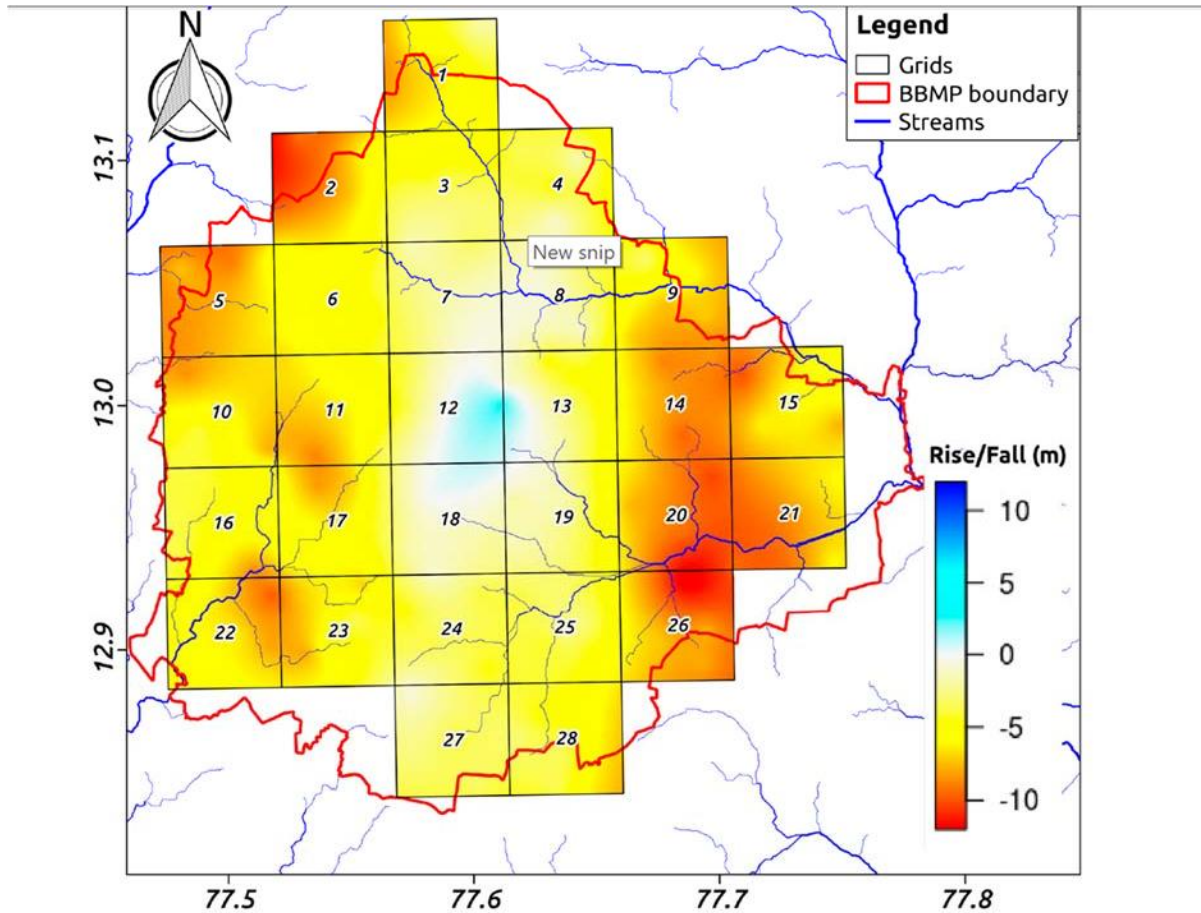


Figure 29. Change in groundwater level between Jan 2016 and Jan 2017 across Bengaluru city [50]

Across Karnataka, several towns such as Kolar and Nelamangala are facing even higher declines in groundwater tables.

Simultaneously, local surface water bodies in all urban areas of Karnataka have been made unusable for water storage and supply, either through conversion to real estate, dumping of solid waste or release of sewage into the water bodies. For instance, in Bengaluru city originally lauded as a city of a thousand lakes, 54% of the urban lakes (erstwhile irrigation tanks) had been converted to other uses by 2011 [51]. The blockage of storm water drains had led to severe flooding episodes in south Bengaluru.

Sustainability of the urban water sector also has other dimensions. The energy cost of pumping water to cities is always high, but in the case of Bengaluru, which pumps water from the Cauvery river from a 100km distance and 300m uphill, the energy (and hence carbon emission) cost is the highest of any major town in the country. And the consequent financial burden of the electricity bill of BWSSB (Rs 370 crores per year) makes the water supply system financially unsustainable unless constantly subsidized by the state. Financial unsustainability dogs virtually every ULB in Karnataka [see, e.g., 12].

Finally, there is the matter of resilience to climate change. When cities become dependent only upon imported river water, they become vulnerable to climate change-driven changes in rainfall in that river's catchment. At present, there is no conscious planning for climate

resilience. But it is clear that diversification of sources, and having a fully recharged groundwater table as a buffer, are appropriate strategies for improving climate resilience.

### **5.2.6 Wastewater disposal and sewage-worker health**

How well is the wastewater generated in Karnataka's ULBs disposed off? And who bears the health risk of its disposal? As the later chapter on water pollution describes in detail, all the ULBs of Karnataka fall far short of the required sewage treatment capacity. First, 40% of the ULBs have no sewage treatment plants (Data from UDD). Second, even where they do, in many cases the installed capacity is inadequate as compared to the sewage generated. Bengaluru, for instance, generates more than 1100 MLD of wastewater (given a total water consumption of more than 1700 MLD), but has an installed sewage treatment capacity of only 900 MLD as of date, and the actual capacity utilization is even lower. Thus, about half of the dry season inflow of 550 MLD into Bellandur lake in Bengaluru was untreated sewage [52]. Third, the STPs function poorly and often do not meet effluent discharge standards [53]. Finally, urban areas not only generate domestic sewage but also industrial effluents. Here again, a large fraction of these effluents are ending up in urban rivers and lakes. (See Chapter 6 for more details).

Moreover, there is a severe social problem associated with sewage disposal: the manual work associated with cleaning of septic tanks and sewers is being carried out without adequate safety measures or remuneration, and often by the same social/caste groups that were earlier forced to do manual scavenging.<sup>35</sup> Consequently, in Bengaluru-Mysuru alone, in 2017-18, 7 workers died in sewage management related incidents.

### **5.2.7 Urban flooding**

A recently emerging risk or natural hazard is urban flooding. In general, coastal cities like Mangalore and Karwar (which are located in heavier rainfall zones) have been blessed with undulating terrain enabling easy drainage of heavy rainfall. And the mega-city of Bengaluru is located on a ridge, with drainages in three directions, which should again make for easy removal of flood waters. However, in recent years significant urban flooding has been witnessed in Bengaluru.<sup>36</sup> And the Kerala floods of 2018 suggest the possibility of similar hazards in coastal Karnataka.

## **5.3 *Current policies and strategies***

The state of Karnataka has the goal of providing 70 to 150 lpcd of water to urban domestic consumers. While groundwater based supply continues to be a major component, the long-term strategy has been to build infrastructure for pumping surface water from rivers and reservoirs outside the ULBs. And the state has invested a substantial amount of public funds, human resources and expertise in striving towards that goal. To a lesser extent, it has also invested in sewerage and wastewater treatment. It has set up a dedicated water engineering agency just for serving Bengaluru (BWSSB) and subsequently set up KUWSDB as a state-wide counterpart. Through KUWSDB for other ULBs and BWSSB for Bengaluru, it is investing thousands of crores in new schemes funded by grants from JNNURM or AMRUT and loans from the World Bank, ADB and JICA.<sup>37</sup> The large water supply and sewerage infrastructure is operated by staff of BWSSB, KUWSDB or the ULB at various levels. Under the World Bank funded KUWASIP programme, the state also launched a 24x7 pilot project in Hubli-Dharwad

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<sup>35</sup> <https://ruralindiaonline.org/articles/pavagadas-social-hierarchies-of-sorrow>

<sup>36</sup> <https://indianexpress.com/article/india/heavy-rains-cause-flooding-in-parts-of-bengaluru-4825442/>;  
<https://timesofindia.indiatimes.com/city/bengaluru/record-rain-floods-bengaluru-toll-hits-16/articleshow/61095641.cms>

<sup>37</sup> E.g., <https://www.jica.go.jp/india/english/activities/activity17.html> (BWSSP Phase 2 and 3).





Municipal Corporation, which was accompanied by handing over distribution to a private company under a public-private-partnership (PPP). The approach was then extended to some other cities as well, but with mixed success (see also Box 1). Bengaluru is the first city in the country to introduce metered supply and volumetric pricing, and its rising block tariff is one of the highest in the country. Though volumetric supply and charges are missing in most ULBs till date, it is being tried under the new PPPs and also under the ADB-funded 'Jalasiri' project being implemented by KUIDFC.<sup>38</sup>

Urban wastewater reuse is at a very nascent stage and the approach to it has been somewhat contradictory. [54]Dual piping (for using treated water for flushing) is now mandatory for large apartment complexes and is also slowly being incorporated into BDA layout design, such as the new Kempe Gowda Layout.<sup>39</sup> But BWSSB is able to sell hardly 15 MLD out of the more than 750MLD it generates, whereas large (>50 unit) apartment complexes are required to treat and reuse 100% of their wastewater, which is an impossible task [54]. In recent policy changes, apartments with sewer line connections are also being asked to treat their own sewage, imposing severe costs with little gain.<sup>40</sup>

The policy regarding urban lakes has also been in constant flux for last decade or so. The phenomenon of urban 'lakes' itself is a recent one, as these man-made water bodies have lost their traditional function of irrigation, and have become important as green spaces and urban biodiversity repositories. While the attempt to hand over lakes to private players to manage as recreation spaces was struck down by the Karnataka High Court, the state has continued to invest in the 'rejuvenation of urban lakes' through a standard template of de-silting, walkway creation, diversion drains, bird island, etc. While this template provides some of the desired functions, it does not address the question of why polluted water is entering the lake or why clean storm water runoff has dried up. The recent move to dissolve the KLCDA (dedicated to urban lakes) and consolidate all control under the KTCDA (which is effectively the Minor Irrigation Department) appears to be misguided and anti-democratic. Moreover, it does not address the problem of overlapping jurisdictions between ULBs (who manage storm water drains in the catchment), Forest Department (that sometimes controls lakes or lake foreshore plantations), Fisheries Department (that auctions the fishing rights in the lake) and other agencies such as the BDA. Urban lake governance needs to focus on the issues of decentralized democratic control, single agency management, and interconnected hydrologies [55].

Urban flood management has not been a clear focus in water policy thus far. Notwithstanding periodical efforts to clear stormwater drains of debris or solid waste, and court orders for removal of encroachments on stormwater drains, there has been limited progress. Increases in rainfall intensities have compounded the problem. There is no policy on the extent of concretization of private or public spaces, or monitoring of actual recharge happening under rooftop rainwater harvesting structures.

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<sup>38</sup> [http://www.kuidfc.com/project\\_jalasiri.htm](http://www.kuidfc.com/project_jalasiri.htm)

<sup>39</sup> <https://www.deccanchronicle.com/nation/current-affairs/200717/kempegowda-layout-to-get-treated-water.html>

<sup>40</sup> [www.deccanherald.com/content/585028/bwssbs-wrong-approach.html](http://www.deccanherald.com/content/585028/bwssbs-wrong-approach.html)

**Box 1: Unpacking “24x7” in concept and implementation**

The term “24x7” water supply suggests that it is about converting intermittent supply to continuous supply. However, in the Indian context, this term is a banner that actually involves 4 distinct measures:

- a) Moving from intermittent to continuous supply
- b) Upgrading the infrastructure of water service delivery to reduce leakage and improve delivery
- c) Shifting from fixed monthly charges to volumetric metering and rising block tariffs
- d) Privatizing the functions of service delivery, operation & maintenance, billing and bill collection.

The arguments for continuous supply are two-fold: i) maintaining a constant high pressure reduces the bacterial contamination prevalent in the intermittent water supply system, and ii) the poorer households that are unable to store enough water under intermittent supply will get better service. The infrastructure upgradation is linked to leakage reduction, making more water available; volumetric metering and billing will obviously encourage conservation; and privatization is supposed to bring about efficiency, reduce corruption and improve water bill collection.

This package of measures is often treated as inseparable. But in fact even the famous Hubli-Dharwad experiment in 24x7 shows that all the elements need not go together. When KUWSDB was first asked to take over distribution from the Hubli-Dharwad Municipal Corporation, it carried out measures b (infrastructure upgradation) and c (volumetric billing) and thereby made a major improvement in service delivery as well as cost recovery [2]. Even the subsequent implementation of privatization and 24x7 in subset of wards was built upon the infrastructure upgradation that was carried out at public cost (a loan taken from the World Bank under the KUWASIP project). And in most private service contracts, the task of enforcing disconnection for non-payment and removing illegal connections is put back on the ULB anyway. Results from Hubli-Dharwad also show that the poor do end up paying significantly more, and that the improvement in water quality due to continuous supply is marginal, often compromised by in-house contamination anyway. The vast majority of the population in cities already have ‘24x7’ because they have built sumps and overhead tanks. Finally, 24x7 takes the water source availability as a given, but in fact that is going to be the big challenge in the future.

In other words, there is a need to unpack 24x7, and judiciously focus on those measures that are really essential to a particular context. If infrastructure is to be upgraded at public cost anyway, one may as well then avoid the political contentious issue of privatization and instead upgrade the capacity of the ULBs—which are democratically accountable—to carry on with distribution and O&M, and to move towards integrated urban water management.

*[Based on 3]*

**5.4 Causes of shortfalls**

In spite of the efforts of the state through various agencies and methods as described above, there is significant shortfall in achieving the multiple goals in the urban water sector. The reasons for this may be understood in terms of proximate and deeper causes.



### 5.4.1 Proximate causes

There are many proximate reasons for the current state of urban water service delivery, governance and its source conditions.

1. First and foremost, one has to acknowledge that the combination of population growth in generation and rate of urbanization presents a major challenge, and the rate of growth of Bengaluru in particular is simply unprecedented. E.g., the population of Bengaluru urban district grew by 46% in just the 2001-2011 decade. Not surprisingly then, public infrastructure (water & sewerage, as well as other) has lagged behind the needs. The urban population elsewhere is also showing substantial growth.
2. There is a high percentage of Unaccounted For Water (UFW) (i.e., leakages and theft), especially in Bengaluru. The UFW fraction was 50% for many years, and recently has been reduced to 40%, which is still unacceptably high. More than half of this is estimated to be in the form of leakages. The extent of UFW in other ULBs is not fully known, simply because they do not have volumetric supply, but is estimated to be high also.<sup>41</sup>
3. Most towns and cities provide unmetered water supply, and charge consumers a fixed monthly charge. As a result, consumers (domestic and non-domestic) have no information on their consumption nor any price incentive to make their consumption more efficient. Even in Bengaluru, where connections are metered, households consuming high quantities of water have little information on how their per capita consumption compares with the norm.
4. Groundwater is not part of official water supply planning, or is treated as last resort, with no attention to its sustainability even when it is pumped by ULBs themselves. Inadequate reach of the public supply system or inadequate supply from the public system also triggers private drilling and pumping. Since private groundwater pumping is also not regulated, this leads to indiscriminate individual drilling and pumping (especially by CII users). Hydrogeological conditions in Karnataka vary tremendously, requiring customized management solutions (see Table 9), but current understanding is poor.
5. Rooftop rainwater harvesting was made mandatory in Bengaluru to improve groundwater recharge, but this rule has not been successfully implemented: only 10% of the 9.5 lakh customers (domestic and non-domestic) connected to BWSSB's network have implemented rainwater harvesting.<sup>42</sup>
6. Local surface water resources—primarily erstwhile irrigation tanks—are polluted or dried up, and in any case are not part of the water supply system. For instance, KSPCB data show that of the 53 lakes monitored by them for water quality, the water in 51 lakes did not even meet bathing quality standards. And 11 of these lakes had dried up during the monitoring period.
7. Tariffs are lagging behind inflation and ability-to-pay of most of the consumers, contributing to financial unsustainability, and poor recovery of even these water charges further compounds financial unsustainability [see, e.g., 12].
8. Weaker sections of society have limited voice in how water is supplied to them; in Bengaluru, elected representatives have no voice in BWSSB's decision making, whereas

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<sup>41</sup> E.g., a study in Mulbagal town estimated UFW to be more than 30% 56. Nadhamuni, S., 2012, *An Approach to Integrated Urban Water Management (IUWM) :The Mulbagal Experience*, Arghyam, Bengaluru..

<sup>42</sup> [https://economictimes.indiatimes.com/news/politics-and-nation/harvesting-rainwater-is-half-  
hearted/articleshow/60253588.cms](https://economictimes.indiatimes.com/news/politics-and-nation/harvesting-rainwater-is-half-hearted/articleshow/60253588.cms) and [https://timesofindia.indiatimes.com/city/bengaluru/has-water-harvesting-cut-  
dependence-on-cauvery-bwssb-hasnt-got-a-clue/articleshow/66507198.cms](https://timesofindia.indiatimes.com/city/bengaluru/has-water-harvesting-cut-dependence-on-cauvery-bwssb-hasnt-got-a-clue/articleshow/66507198.cms)

in ULBs, where municipalities themselves engage in water distribution, there is significant voice but it leads to looking for short-term solutions (such as supplying water by tankers or digging new borewells) [12].

9. Not enough attention is being paid to sewage management. International funding has focused on 24x7 or water supply in general, and less on sewerage infrastructure or STPs. Urban citizens are also less interested in STP functioning because it is an externality they impose on some unknown downstream community/aquatic ecosystem. Where investments have been made, they have used conventional western technologies and concepts of moving all wastewater (black and grey) long distances using a lot of water [57] rather than coming up with technologies and designs appropriate for Indian conditions of dense populations in water scarce regions and high temperatures.
10. Source catchments or downstream users have little say in decisions regarding inter-basin transfers or diversion of irrigation water to cities. Decisions are taken at state level with little transparency or clear criteria.
11. The causes of urban flooding are a combination of changing climate, especially the increasing rainfall intensities (as mentioned in Chapter 1) and unplanned urbanization that is leading to concretization of the land surface and choking of natural drainage channels. The choking of stormwater drains is related to poor solid waste management and encroachment of the drains themselves by builders. While periodic attempts have been made to remove these encroachments, none have really succeeded; moreover, clearing of existing drains on a timely basis is also not happening.

### 5.4.2 Deeper causes

A complex set of processes underlie the above immediate causes.

1. Urban policy: While the rate of urbanization in Bengaluru is outside the scope of the water resources agencies, there is also the problem that water and sewerage availability are not factored into sanctioning of building plans by BBMP. This is true for all ULBs as well. Even urban master plans pay little attention to water constraints and wastewater impacts, focusing primarily on landuse planning and non-water infrastructure development.
2. Engineering-based supply paradigm: Water supply and sewerage are seen as civil engineering problems, and further reduced to importing of river water through pipelines. Even ULBs that supply mostly or entirely groundwater, recruit engineers, but no groundwater hydrologists who can grapple with the complexities mentioned in Table 9. The focus of all projects is on phasing out groundwater-based supply and replacing it with surface water, even if drawn from large distances and prone to much leakage. This paradigm leads to the neglect of local sources (rooftop RWH, lakes, groundwater or treated wastewater) and their lack of integration into water supply planning. The Integrated urban water resource management (IUWRM) paradigm has not been adopted as yet, or where formally adopted it is far from being truly integrative (see also #5 below).
3. Conventional approach to sewerage: The European paradigm of transport of sewage over long distances using extra water for flushing, and its treatment in STPs hidden from public view dominates thinking, increasing capital costs and reducing compliance. New approaches to decentralized wastewater management, in-stream treatment, and citizen involvement in monitoring are not internalized. Grand plans of imitating Singapore's reuse of blending treated water into the drinking water system ignore the possibilities of localized treatment and reuse.

4. Misdirected focus on “24x7”: The label “24x7” is actually a bundle of 4 distinct strategies: renovation of the water supply network, moving from intermittent to uninterrupted water supply (actual 24x7), privatization of distribution, and metering and volumetric pricing of all water supply. Uninterrupted supply is only relevant to those households which do not have their own storage (sumps and overhead tanks) and for reducing chances of in-pipe contamination. Whereas renovation of water supply networks is relevant to the entire urban population and metering is relevant to better financial recovery. These three elements enable privatization but privatization is not essential to them, nor is uninterrupted supply relevant to the other two (renovation and metering). Bundling these strategies has produced limited results (the Hubli-Dharwad experiment has not even been expanded to the whole city), results in cross-subsidising the private sector (because renovation is done at public cost) and raises opposition (as citizens see lifeline water as a human right). (For details, see box 1, which is based on [3].
5. Lack of capacity and capacity-building in ULBs for IUWRM: ULB staff are so overburdened with day-to-day operations and trained in narrow engineering perspectives that they cannot think in terms of multiple sources, participatory planning, or water balance calculations.[56]. And even though major new urban water projects, such as the ADB-funded 9-ULB project administered by KUIDFC (“Jalasiri”), come with the banner of IUWRM (integrated urban water resource management), they do not actually promote it significantly. The focus seems to be on providing piped river water supply and metering, but not on understanding who is using groundwater and how to build ULB capacity for integrating multiple sources of water or make water management more participatory.
6. Confusion of roles between bulk-supply and distribution: The state-wide para-statal (KUWSDB) was originally supposed to focus on providing bulk supply to ULBs. But in some ULBs, it has also been saddled with distribution. This may work in the short-term (as in Hubli-Dharwad) [see 2]. But it does not work everywhere and is inimical to democratic control of water distribution in a ULB [as has been documented in Ramangara: see 12]. KUWSDB itself has now realized the challenges posed in combining the primarily engineering-oriented task of providing bulk water supply from a source to a town and the more complex and socially-embedded task of distributing that water within the town, and is seeking separation of roles [58].
7. Confusion of roles between management, regulation and rejuvenation of lakes: In spite of the experience with JSYS in the case of rural tanks, and the regulatory experience of KLCDA in the case of urban lakes, the formation of a single authority (KTCDA) for all tanks (urban and rural) for all functions and that too with a top-heavy structure (Chief Minister as Chair of the KTCDA) leads to the concentration of all roles—day to day management, upstream-downstream negotiation, and regulation—in one state-wide body that simply cannot carry out this task.
8. Governance structure: The two key agencies involved in urban water, BWSSB and KUWSDB, are not governed in a manner that is conducive to efficiency, transparency & accountability to users. First, there are no service benchmarks for these agencies or for the ULBs. Internally, performance is measured in terms of revenues and costs, not service provided or population reached. Second, very limited details about agency performance (vis-à-vis goals), financial performance, and ongoing or future plans are available to the public.<sup>43</sup> The governing bodies of these agencies are filled with representatives of different government departments, and in the case of BWSSB chaired by an IAS officer (who may change every year and/or may hold additional charge of other departments). Missing is

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<sup>43</sup> E.g., even after a revamped website, neither its annual administrative report nor its annual audited financial statements are available on the website. And when it comes to provide information on ongoing projects, all that BWSSB provides on its website is the list of projects, the contractor, and the budget. No details on the content of the project are available.

representation from the public they serve (in the case of BWSSB, the citizens of Bengaluru) and engineering, hydrological and social science expertise in the governing body. The question of participatory planning, which should be essential for an agency such as BWSSB that distributes water, simply does not arise. In the case of other ULBs where distribution is with the ULB, there is more downward accountability, but limited staff strength and capacity hamper planning and support for any new ventures, as the Mulbagal experience showed [56]. Moreover, too much flexibility in funding (ability to deduct from state finance commission grants) means there is no attention to cost recovery or cost-effectiveness. (More details on the institutional shortcomings of urban water management are given in Chapter 7).

9. **Inensitivity to gender issues:** While water collection is often a highly gendered task, especially in low-income/slum areas, urban water service delivery is not sensitive to women's needs at all [59]. This is particularly true for women living in slums or low-income areas, where delivery is often through public taps and is seen by the utility as a 'sink' of revenues. E.g., grievance redressal forums by ULBs or BWSSB are held at times and in locations that most women cannot attend, and focus on billing issues rather than overall quality of service.
10. **Lack of process and criteria in inter-basin or inter-sectoral allocations:** The term 'drinking water' hides the fact that 'drinking' constitutes only 5% of domestic water use and even drinking, cooking and bathing constitute less than half the typical domestic water need (the rest being washing, flushing, etc.). Moreover, 'urban water supply' includes more than just domestic water supply. For instance, in Bengaluru, up to 30% of total water use is by CII users. Thus, exempting 'drinking water supply projects' from all environmental clearances and other forms of public scrutiny amounts to inadvertently prioritizing these other uses (non-drinking domestic and CII uses) over agriculture or over in-stream or downstream water requirements. The treatment of 'drinking water' projects as sacrosanct and therefore above detailed public scrutiny results in rewarding inefficiency in the management of existing resources, as comparisons with alternative options (demand side management, reduction of UFW, or use of local water) are simply not made.
11. **Flooding is nobody's baby:** In theory, urban concretization, stormwater drain encroachment and solid waste pollution are all issues to be addressed by the ULB. But in practice, ULBs have failed to address these issues, and encroachment in particular is a highly challenging issue. But not enough attention has been paid to the possibility of reducing the impact of intense rain by reducing concrete around houses, increasing rooftop rainwater harvesting, and also using lakes for flood management (which would require lakes to be partially emptied at the start of the monsoon). Lakes are currently in mixed jurisdictions, as mentioned above. And the ULB is completely understaffed and inattentive to the question of reducing concretization in public and private spaces.

## **5.5 Policy shifts recommended in urban water sector as a whole**

A leading global scholar on urban water systems David Sedlak has argued that it is possible and appropriate for us to leap-frog to the 21<sup>st</sup> century because "water systems built in the nineteenth century and later retrofit with twentieth-century technologies may not be up to the challenges of the 21<sup>st</sup> century" [60]. This opens up great opportunities for the state of Karnataka to adopt more cost-effective and sustainable solutions to urban water problems, as outlined below.

### **5.5.1 Set region-specific and use-specific quantity norms and quality standards**

- a) For domestic users, lpcd norms must reflect the agro-climatic or hydro-climatic zone they are living in. So the minimum domestic lpcd norm in the eastern plains should be



100 lpcd, whereas the norms in the Western Ghats and the coastal zone can be higher (150 lpcd).

- b) For commercial, industrial and institutional users, co-define in collaboration with industry associations the best practice water use standards for each type of establishment, and set a 5-year period for existing establishments to achieve those efficiency standards. Set up regular water audits of all industries and big commercial and institutional users.
- c) Standards for quality of water supplied should also be realistic. Instead of insisting that all water supplied to domestic users be potable, the water may be bathing quality provided additional sources of affordable drinking quality water are made available (such as RO-based water ATMs).
- d) Use awareness building on consumption norms and information on individual bills to 'nudge' high-end consumers towards lower consumption.

**5.5.2 Integrate groundwater into urban water supply planning and management**

- a) Groundwater will be treated on an equal footing with imported river water, and will be seen as valuable local resource that provides inter-seasonal storage, to be used sustainably by the ULB/BWSSB in the public interest.
- b) Groundwater may be supplied in separate lines or blended with river water and/or stormwater, depending upon the quality.
- c) Private groundwater pumping will be metered, and its use for commercial purposes (both in-house and for sale in the form of water tankers) will be charged at CII rates.
- d) Mapping of aquifers and identification and protection of recharge zones will be part of the ULB/BWSSB's mandate
- e) Groundwater management strategies will vary depending on the nature of the aquifer, as explained in **Table 9**.

**Table 9. Aquifer types and possible management strategies for Karnataka's Top 27 Cities**  
(Source: Himanshu Kulkarni, Note prepared for TG)

<b>Aquifer Type</b>	<b>City</b>	<b>Broad strategies of groundwater management</b>
<i>Crystalline rock aquifers – complex and heterogeneous but mostly over-exploited</i>	Bengaluru UA, Mysuru, Hubballi-Dharwad, Shivamogga, Chikkamagaluru, Bhadravati, Mandya, Hassan, Kolar, Robertson Pet, Gangawati, Hosapete, Ballari, Gadag-Betigeri, Raichur, Ranibennur, Davangere, Chitradurg, Tumakuru	Given that this aquifer setting is the largest in the State with a maximum number of urban habitations, a strategy for implementation managed aquifer recharge (MAR) must be developed for the growing urban centres here.
<i>Basalt aquifers belonging to the Deccan Volcanic Formation, layered systems</i>	Kalaburagi and Vijapura	Will require urban watershed management that includes strategic recharge at different contours in watersheds both in the cities and in the peri-urban neighbourhoods. Regulating drilling depths could prove most effective.
<i>Sedimentary rock formations, aquifers likely to be regional and with larger storage</i>	Bagalkot	Focus on protection zones for the recharge areas of such aquifers. Managed Aquifer Recharge at scale can be attempted.
<i>Transition zones at the interface of two or more of the above formations</i>	Belagavi and Bidar (Laterite and basalt), and Udupi and Mangaluru (Laterite and Crystalline with alluvial cover)	Customized strategies required for each location based on detailed investigations. Regulate distances between private and public sources. Encourage rainwater capture in sumps to alleviate summer scarcity. Springs likely to be present at the base of laterites, so it is important to bring into focus urban spring management.

**5.5.3 Maximise local water use and wastewater reuse under IUWRM before external water imports**

- a) Encourage rainwater harvesting (not penalise) at individual user level: Mandate at commercial, industrial and institutional (CII) level
- b) Encourage wastewater reuse (not penalise) at individual user level, and mandate it for CII consumers.
- c) ULBs to get external river water only after they meet minimum rainwater harvesting, tank rehabilitation and wastewater reuse norms (rainwater harvesting target: 25% by 2030; wastewater reuse 25% by 2025, and 50% by 2030 as laid down in Urban Wastewater Policy).
- d) Link building plan sanction to availability of water and wastewater facilities.
- e) Reduce Unaccounted For Water (UFW: leakages and thefts) to below 15% by 2025 in all ULBs.
- f) Initiate flood management by mandating adequate infiltration zones in new construction, encouraging increased infiltration in existing construction, and construction of recharge structures in public lands and public buildings. Provide support to ULBs for removal of encroachments on stormwater drains.





- g) Promote innovation in technologies and planning for alternative approaches to wastewater treatment that are neighbourhood scale, separating grey and black water, linked to markets for sludge, and passive technologies where possible.
- h) Mandate use of recycled water for all public parks/gardens/green spaces and all corporate gardens.
- i) Urban flood management, especially storm water management, will be included in the Integrated Urban Water Management programmes in all cities.
- j) The state will provide special support to all ULBs to remove encroachments from storm water drains, reduce concretization, and improve solid waste management.

#### **5.5.4 Ensure equitable access and charging**

- a) Set service benchmarks and evaluate ULB/BWSSB water supply performance at ward and sub-ward level w.r.t. universal coverage, water quality, fair pricing, sewage treatment and reuse, efficiency (leakage reduction), and minimized costs.
- b) Introduce volumetric charges in tandem with lifeline rates for weaker sections in all ULBs.
- c) Instead of 24x7, focus on storage needs of the weaker sections; initiate community storage for slums; retain stand-posts for groundwater supply; involve women in the design and monitoring of these programmes.
- d) Meter and charge groundwater use by CII users and tanker companies at commercial rates.
- e) Provide to the public detailed calculations and justifications of tariff components such as “sanitary cess” or capital expense recovery (“betterment charges”).

#### **5.5.5 Protect and use urban lakes as multi-functional entities**

- a) Integrate of urban lakes or tanks into urban water management, and use them for both aesthetic/recreation/conservation purposes and storing stormwater, floodwater, and/or treated wastewater for reuse locally.
- b) Establish lakeside sewage treatment, storage and reuse via lakes.
- c) Prioritize improving of sewage collection and treatment in lake catchments over desilting and civil works in the lake bed.

#### **5.5.6 Mitigating urban flooding**

- a) Urban flood management, especially storm water management, will be included in the Integrated Urban Water Management programmes in all cities, and
- b) The state will provide special support to all ULBs to remove encroachments from storm water drains, reduce concretization, and improve solid waste management.

### **5.5.7 Institutional changes required**

The above policies will not get implemented unless there are changes in the governance of the water sector and the urban water sector in particular. These changes are elaborated in Chapter 7. Key recommendations are:

- a) Do not exempt so-called drinking water projects from environmental impact assessment and public hearings, since they are basically domestic water projects and often domestic-cum-commercial water supply projects. Increase the scrutiny by demanding comparison with alternatives such as demand-side management or local resource utilization (rainwater or stormwater harvesting) and wastewater recycling.
- b) Separation of roles: KUWSDB to focus only on bulk water supply. ULBs to take responsibility for distribution.
- c) Increasing democratic governance, transparency & accountability of all para-statal. d)

Explicit mandate, staffing and training for Participatory Integrated Urban Water Management for all ULBs, which emphasizes a OneWater perspective, i.e., including local and imported water, surface and groundwater and recycled wastewater, as well as lake and flood management, at the .

- e) Performance benchmarks publicly monitored, including adequacy and equity, affordability, quality, reliability, source sustainability, financial sustainability
- f) Transfer all urban lakes into the custody of the respective ULB, route all funding (for rejuvenation) through the lake wings of ULBs, transfer all other lake-related functions (such as fishery auction) to the ULBs, form a dedicated regulatory-cum-technical support authority for urban lakes, promote grassroots (ward-level or below) citizen participation in all lake management.
- g) Initiate Participatory Integrated Urban Water Management at the ward-level (or ULB level in case of Town Panchayats) in all towns, that includes surface, ground, storm, waste and imported river water and urban lakes and flood management in its mandate.
- h) Involve knowledge institutions and civil society organizations in this participatory planning exercise and in a wider effort at public awareness building and citizen science.

## **5.6 *Special challenge of Bengaluru Metropolitan Region*<sup>44</sup>**

Bengaluru (BBMP boundary) currently contains 40% of Karnataka's urban population, and if one includes the peri-urban portions of Bengaluru rural and Ramangara districts, this share is even higher. Bengaluru's rate of growth has been higher than that of any other urban centre, and there is no sign of this growth abating. Therefore special attention may be needed to address the water needs of this urban megalopolis.

### **5.6.1 BBMP Area: BWSSB's Jurisdiction**

Given Bengaluru's location in a relatively dry zone (900mm rainfall) and on a ridge away from any major perennial river, managing Bengaluru's water supply has always been a challenge. The Government of Karnataka responded early to this challenge by creating the first dedicated para-statal agency for urban water supply and sewerage in the country, viz., the BWSSB. The

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<sup>44</sup> This section is based partly on [61].

BWSSB managed the existing pipeline from the TGHalli reservoir but focused on constructing supply lines from the Cauvery. Currently, four “stages” of Cauvery supply have been commissioned, providing a total of 1350 MLD to the city (while TGHalli has ceased to be a source due to the drying of the Arkavathy river). A 5<sup>th</sup> stage has been sanctioned and is being constructed with JICA funds. BWSSB has many firsts to its name, including implementing metering and rising slab rates (the highest in the country) and setting up a social development unit to address the problems of slums. Nevertheless, for a variety of reasons mentioned above, BWSSB is struggling to meet Bengaluru’s water and sewerage needs. To summarise in brief the final outcomes vis-à-vis the stated goals in Chapter 3:

- Median LPCD supplied (including a significant amount of self-supply) is 85, with large disparities (see Figure 26).
- Pollution from sewage outflows is very high, leading to extreme pollution in the Vrishabhavathy river (see chapter 1) and in Bellandur and Varthur lakes, and most of the remaining 200 lakes as well (see also chapter 6).
- CII consumers complain of high prices and switch to unregulated groundwater pumping [see 49].
- Excessive groundwater use is leading to declining groundwater tables in the peripheral areas of Bengaluru [see 50].
- The cost of water supply is high and BWSSB cannot make ends meet<sup>45</sup> (see [https://bwssb.gov.in/com\\_content?page=3&info\\_for=4](https://bwssb.gov.in/com_content?page=3&info_for=4) ).

The main proximate reasons for this state of affairs are:

- High UFW: In Bengaluru, the fraction of unaccounted for water stood at an incredible 50% in 2014. This includes water supplied for free, but also leakages and thefts in the distribution process. Since 2014, with intense efforts involving multiple projects, the fraction has reduced so that latest reports from BWSSB indicate UFW at about 38%-40%. Nevertheless, this fraction is extremely high and represents not just a revenue loss to BWSSB, but (especially in the leakages) a loss of a resource pumped from 100km distance and 300m uphill at heavy cost.<sup>46</sup>
- No attention to local water sources: Although groundwater use constitutes as much as 40% of the water use in Bengaluru [62], and although BWSSB itself has inherited about 6,000 borewells from the erstwhile ULBs and 110 villages that were merged with Bengaluru Municipal Corporation to form BBMP, the agency does not have any plans to maintain groundwater-based water supply. Consequently, even though rainwater harvesting (RWH) was made mandatory for all houses in Bengaluru, although BWSSB claims that 50% of the buildings that were supposed to install RWH have done so (and it earned Rs.15 crores as fines between mid-2016 and end-2017 from the others),<sup>47</sup> it

<sup>45</sup> The BWSSB’s website ([https://bwssb.gov.in/com\\_content?page=3&info\\_for=4](https://bwssb.gov.in/com_content?page=3&info_for=4)) indicates an annual revenue gap of Rs.436 crores (when loan repayments are taken into account).

<sup>46</sup> It has been argued that leaked water recharges the groundwater table and since groundwater is used significantly, this leaked water is not a loss as such. However, it may be noted that the areas with high density of old BWSSB distribution network are also the area of least groundwater use. Groundwater is used heavily in the periphery, especially where there is no BWSSB supply, and so this does not get recharged by leaked Cauvery water.

<sup>47</sup> <https://timesofindia.indiatimes.com/city/bengaluru/rainwater-harvesting-board-slaps-rs-15-crore-fine-on-offenders/articleshow/62077063.cms>

is not clear how effective the RWH systems are, whether they are recharging groundwater or storing and reusing the harvested rainwater, etc. The focus has not been on *promoting* and *facilitating*, but penalizing.

- Insufficient focus on universal coverage and economic disparities: BWSSB was perhaps the first utility in the country to set up a Social Development Unit to address the needs of slum dwellers [63]. Nevertheless, efforts to reach the underprivileged population have been insufficient to address the problem. The sudden expansion of Bengaluru city's administrative boundaries to greater BBMP area also meant that BWSSB has played 'catch up' with the peripheral parts of Bengaluru even as these have been the fastest growing wards, creating major inter-ward disparities as well. The idea of supply only Cauvery water has meant that BWSSB can only meet needs where they have a Cauvery water network, rather than focusing on water supply by all possible means to the entire population.
- Skewed tariff structure: BWSSB's operating costs are high, only partly due to the cost of pumping Cauvery water from 100 km distance and 300m uphill. Estimated electricity cost itself is 7 Rs/kL, while the total O&M cost appears to be Rs..65/kL.<sup>48</sup> But the base tariff is Rs.8/kL for domestic consumers. Thus, the average domestic tariff is too low. On the other hand, while volumetric pricing with rising block tariffs is basically a sound policy (BWSSB being one of the first utilities to do so in India), the charges are per connection and not per family or individual. Since the major portion of Bengaluru's population lives in multi-family dwellings (2-3 families in each building) that share a connection, and since these are typically lower income families as compared to those living in single family dwellings, this amounts to charging poorer families a higher tariff than richer families. Similarly, BWSSB charges apartment dwellers at bulk rates (Rs.24/kL) while bungalow owners of similar (or better) socio-economic class are charged much lower rates (Rs.8-12/kL). And of course, if certain areas are simply not serviced by the municipality, households there have to invest in own borewells or tanker purchases to meet their needs. At the other end, BWSSB's tariff for industrial consumers is Rs.90/kL, which only incentivizes them to switch to groundwater. Similarly, by asking apartments to set up their own STPs and operate them at their own cost, the state has selectively transferred the burden of BWSSB onto citizens. Capital costs charged for getting a connection also vary dramatically.
- Insufficient investment, rigour and innovation in sewage management: The first sewage treatment plant in Bengaluru came up many decades after water supply systems were set up and at least one decade after the creation of BWSSB. Sewage treatment capacity and utilization present a paradox. Installed capacity recently reached 900 MLD, while sewage generated is estimated to be 1100 MLD. Yet, its oldest STP at V-Valley in south-west Bengaluru operates at 2/3rds of its installed capacity and even that only by picking up wastewater from the river, rather than getting raw sewage directly from the sewer lines [53]. On the other side of the city, an estimated 280 MLD of untreated sewage flows directly into Bellandur lake [52], some of which comes from central Bengaluru (old) that is still unconnected to STPs. Moreover, there is evidence that the STPs function poorly and often do not meet effluent discharge standards [53]. And with some areas discharging untreated sewage into the same river, lake or stormwater drain into which treated sewage is released, the purpose of sewage treatment is defeated. Perhaps the bigger concern is that all the ongoing investments in setting up sewerage networks and STPs continue to follow

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<sup>48</sup> S.Vishwanath, pers.comm.

conventional models of transporting all wastewater (grey and black) over long distances instead of exploring other options.

The deeper causes of this state of affairs are several, including:

- The absence of a “One-Water” mandate for BWSSB: BWSSB has defined its mandate as supply of river water pumped from long distances, instead of supply of appropriate quality water from all combinations of sources.
- As elaborated in Chapter 7, BWSSB also lacks the multi-disciplinary capacity that would be required to deliver on such a mandate.
- BWSSB is not held accountable to service quality benchmarks such as universal coverage or minimum lpcd supplied to all households.
- Behind all of this is the fact that there is a singular lack of transparency and accountability to the citizens of Bengaluru vis-à-vis such multi-dimensional performance benchmarks. BWSSB’s governance body consists mostly of representatives of from various government departments, while lacking in multi-disciplinary experts and most importantly representation of the citizens it is supposed to serve.
- At the same time, lack of regulation on groundwater pumping has led to a proliferation of borewells for domestic use as well as the emergence of tanker markets. At the very least, 4 lakh domestic borewells represent an enormous investment of capital that could certainly have been reduced if BWSSB had itself supplied groundwater with street-wise public borewells. And all attempts to promote wastewater use will flounder as long as borewell water is far cheaper than all other sources. Tankers may meet a need of a growing population that BWSSB is unable to service, but there are concerns about quality and exorbitant pricing also.
- The inability to build citizen awareness and a sense of ownership of the water problem of Bengaluru that would be an essential precursor to rationalizing tariffs, promoting rooftop rainwater harvesting and reduced theft in the long run.

### 5.6.2 **The Challenge beyond BBMP**

While BWSSB moves on with Cauvery 5<sup>th</sup> stage and other projects targeted at the BBMP area, urbanization is happening not just within BBMP limits (710 sqkm) but equally in the peripheral area. From an urban planning perspective, there exists a Bangalore Metropolitan Area (BMA) region of about 1200 sqkm (see Figure 30), and a BMRDA region of 8,000 sqkm that essentially covers all 3 districts—Bengaluru urban, Bengaluru rural and Ramangara. It is likely that all of the BMA and some fraction of the remaining BMRDA area would be urbanized by 2030, and may reach a population of 2.3 crores by 2031. How will the water and sewerage issues in this larger area be dealt with?

Even in a conventional ‘state planning’ model, the state would have to invest substantial resources to plan for the water and sewerage in this larger area. But unfortunately, the experience so far shows the failure of planned development. Thus, much depends upon the model of governance adopted for this larger region, and the scope for ex-ante planning and infrastructure development.<sup>49</sup> Since the process of water supply needs to begin with local

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<sup>49</sup> The Kasturirangan Committee 64. Kasturirangan, K., A. Ravindra, and K.C. Sivaramakrishnan, 2008, "Report of the Expert Committee on Governance in the Bangalore Metropolitan Region and Bruhat Bangalore Mahanagara Palike", Government of

water sources, including water being collected in lakes today, agencies at a catchment level must be created in the upper Arkavathy catchment, the Suvarnamukhi and lower Arkavathy catchment, and the Dakshina Pinakini catchment, and develop integrated water management plans for each (that include some imported water), with the participation of existing and proposed civic bodies in those catchments. The state will have to prioritize and invest substantial resources in this process.

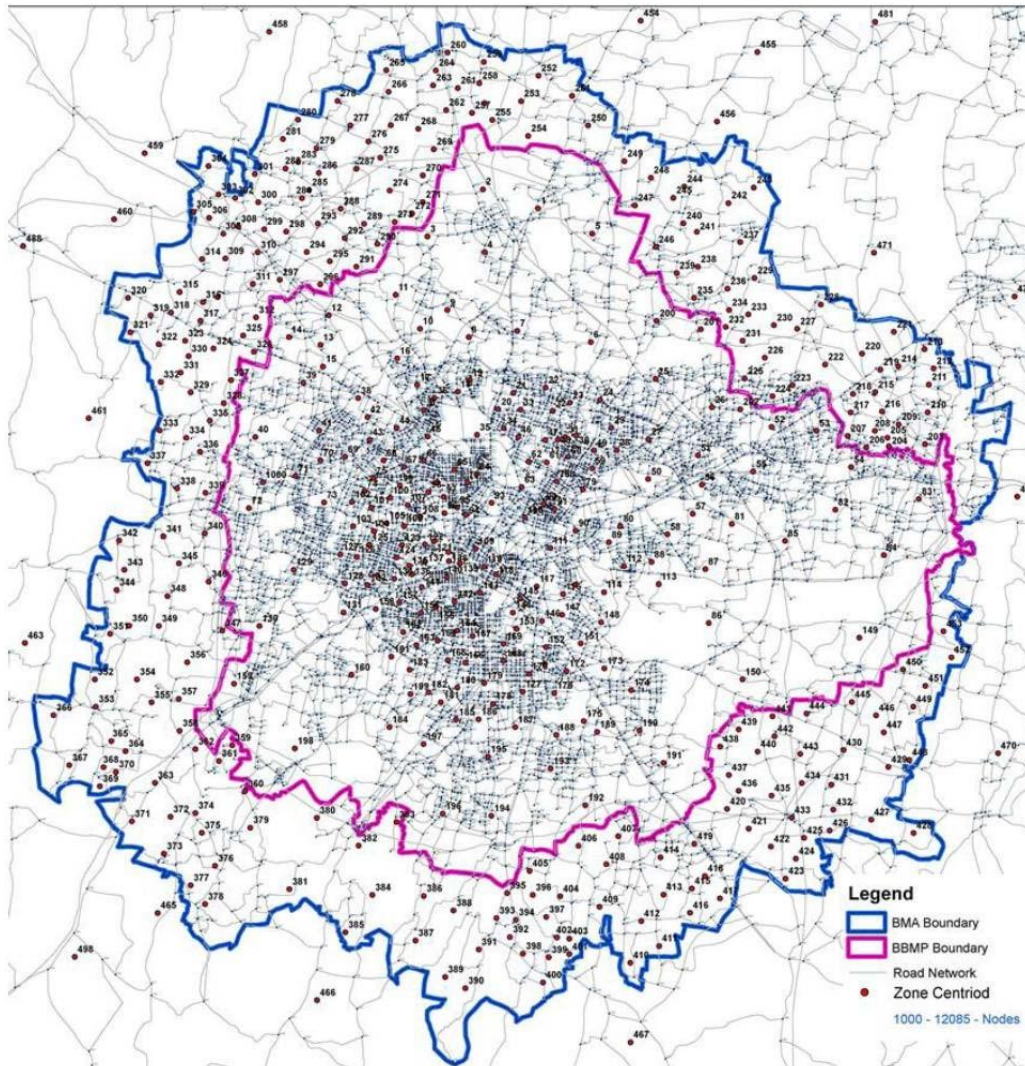


Figure 30. BBMP boundary and the larger BMA area (Source: Revised Master Plan 2031, BDA)

### 5.6.3 Special recommendations for Bengaluru city and the growing Bengaluru Metropolitan Region

Bengaluru city is not only hugely important in the State, it also has a massive impact on the hinterland through both the water it draws, as also the pollution outflows from the city. Keeping

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Karnataka, Bengaluru. has proposed creation of a Special Purpose Vehicle involving BWSSB and BBMP to cater to these new areas. But with trifurcation of BBMP around the corner and given that both agencies are struggling to deliver services within the 710 sqkm area itself, a different approach may be required.



this in mind, the recommendations specifically applicable to BBMP area and the surrounding, rapidly growing, Bengaluru Metropolitan Region are summarised here.

### BBMP Area

- a) BWSSB mandate to be revised to a OneWater mandate that includes local and imported water, surface and groundwater, rooftop and wastewater. Performance to be measured against goal of providing adequate water (100 lpcd) of necessary quality (or qualities) to *all* Bengaluru citizens, and other users where possible, while limiting imports to Cauvery stage V and reducing polluted outflows to standards set by the CPCB.
- b) Reduce leakages and thefts to under 15%. (Separately estimate and report water that is supplied free of cost.)
- c) Initiate integrated Ward-level water management planning at ward-level in collaboration with BBMP (which is responsible for lakes and stormwater drains). The measures should include:
  - i. Integrating groundwater with planning and supply of surface water. Lay parallel supply lines for groundwater, surface water and treated wastewater (or partially treated stormwater) where possible.
  - ii. Incentivising (not penalising) rooftop rainwater harvesting in all buildings, starting with government buildings.
  - iii. Exploring ways of using lakes as multi-function water bodies, including aesthetic/spiritual functions, biodiversity habitat, groundwater recharge, stormwater or treated wastewater repositories.
  - iv. Decentralise wastewater treatment as much as possible to lakeside STPs wherever possible. Enable reuse of treated wastewater from apartment complexes and buildings.<sup>50</sup>
  - v. As far as possible, move towards biological methods of wastewater treatment, with lower financial and energy costs
  - vi. Mandate the use of treated wastewater for all public irrigation purposes.
- d) Prioritise under-served areas and low-income areas, address needs of slums through community storage tanks linked to metered supply (with low tariffs).
- e) Rationalise water charges, sanitary charges, and betterment charges such that water charges meet annual average O&M costs for all except the poorest customers, and to the extent possible rising water tariffs slab rates apply uniformly based on per capita consumption, not per building consumption.
- f) BWSSB should takeover O&M of STPs (instead of privatising them) and make them transparent and visible to the public as a matter of principle. Invite independent monitoring of effluent quality.

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<sup>50</sup> Newer decentralized wastewater management systems can address multiple problems: catering to the un-served areas and minimize the pressure of transporting to a single location, reducing the cost of treatment and O&M costs (if sewer lines infrastructure costs are factored in), and minimizing land requirement for treatment.



- g) BBMP should strictly link building permits to water availability in a ward or sub-ward.
- h) Increase infiltration and remove encroachments on stormwater drains on a priority basis.
- i) Restructure BWSSB as follows:
  - i. Restructure the Governing Board of BWSSB to ensure BBMP representation, representation of Bengaluru's civil society, and representation of independent multi-disciplinary water experts, while drastically reducing the number of ex-officio members.
  - ii. Require public consultation for all major projects, following full disclosure of DPRs. Ensure consistent criteria of cost-effectiveness and comparison of alternatives, including demand-side management and dual or triple-sourcing of water.
  - iii. Separate the operations, staffing and accounting of the Cauvery (or bulk) water supply division from the water distribution and sewage management functions, splitting 'new projects' also along similar lines.
  - iv. Reorganize/decentralise planning and operations to carry out planning of imported water, stormwater and wastewater at the ward level, including lakes.
  - v. Set performance benchmarks for staff at the smallest unit (ward) that include adequacy, affordability and access to all citizens, quality, reliability, source sustainability and financial sustainability.
- j) Introduce latest technologies for supply and quality monitoring, ensure rigorous monitoring of groundwater tables, and use best possible reporting technologies to make all data publicly accessible and understandable in English and in Kannada.
- k) Use various media tools to provide end-users with information on how they are performing in terms of water use efficiency and vis-à-vis adequacy norms.
- l) Over a 5-year period ensure that all CII users are monitored for groundwater consumption and charged for total water use. Work with KSPCB to link the Consent to Operate (issued by KSPCB) to metering of groundwater, use latest technology to install tamperproof meters.
- m) Carry out ward-level planning and management for flood-control using multiple complementary measures (rainwater harvesting in rooftops and public spaces, reduction of concrete to enable more infiltration, removal of solid waste, and lake management to absorb some of the floods).

### Larger BMR area

- n) Revise RMP 2031 to include infrastructure plan and location for water supply, treatment and reuse that combines local groundwater and stormwater use (via lakes and rooftops), recycling, and sharing of Cauvery water with BBMP, along with rejuvenation of TGHalli (as its catchment urbanises), for the RMP's area outside BBMP boundaries.
- o) Set up special OneWater Boards—one for each of the 3 catchments surrounding /overlapping with Bengaluru—for such integrated planning and development of water infrastructure and water plans. The governance of these Boards should be jointly between KUWSDB, BMRDA and the existing local civic bodies (ULBs and Gram Panchayats), and





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subsequently to whatever new urban governance structures that emerge for these areas. The staffing should be multi-disciplinary.

- p) The water infrastructure plans must be integrated with the rest of the urban planning, especially zoning, building rules and building plan sanctioning processes.
- q) The state government to commit adequate funds for both the planning and the implementation of key infrastructure *before* the region gets heavily urbanized.



## CHAPTER 6. WATER QUALITY, POLLUTION CONTROL AND ECOSYSTEM HEALTH<sup>51</sup>

Water quality is an important dimension of the water health of a region. Quality of water consumed, especially for drinking but also in other uses, affects human health as well as ecosystem health. Water quality (or its converse: pollution or contamination) is determined by both geogenic (naturally occurring) and to a much greater extent from anthropogenic contamination. The latter includes biological and industrial contamination and new emerging contaminants as well. Geogenic contaminants pose threats to human health in certain areas and hampers functioning in other ways, while biological and industrial contamination not only poses health hazards but also destroys aquatic life and wider ecosystem health.

As reported in Chapter 2, the surface and groundwater in Karnataka state faces significant threats from geogenic pollutants (that have been mobilized by deep borewell drilling), from coastal salinity and from nitrates in agricultural runoff. But the biggest threats are the biological contamination (and emerging contaminants) from domestic sewage and the heavy metal contamination from industrial effluents. This chapter contains a detailed look at the extent of threats posted by various pollutants, the causes, existing policies, and recommendations for strengthening them.

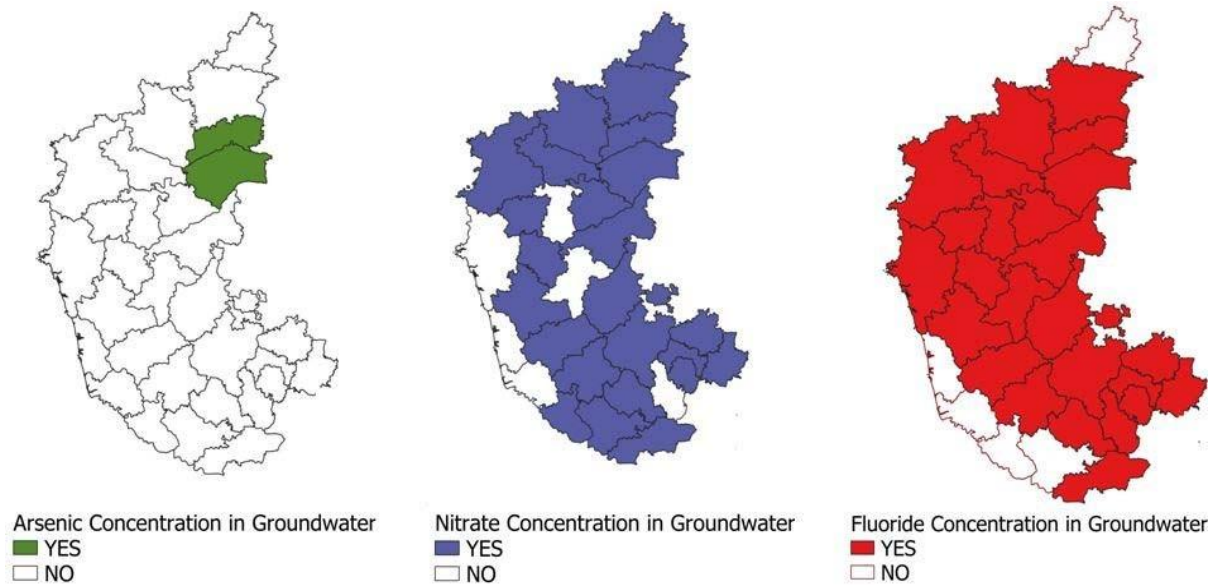
The health of aquatic ecosystems is affected not only by polluted water, but also insufficient water or changed hydrological conditions, especially in rivers. As human intervention in the flow of rivers, through dams and diversions, has increased, the flow patterns of rivers have been affected dramatically, in turn affecting the health of aquatic ecosystems, not to mention land animals that may be dependent on the flows. The issue of environmental flows is therefore taken up at the end of this chapter.

### **6.1 Geogenic pollutants: Fluoride, Arsenic, Iron, TDS**

The increase in geogenic pollutants like fluoride and arsenic in water has emerged as one of the serious threats to the potability of water in many parts of India, including Karnataka. As per the study conducted by the Directorate of Mines and Geology (DMG), on 2209 samples in 2011, it was observed that the Total Dissolved Solids (TDS) and fluoride content is on a higher side from the borewells and points towards the deteriorating quality of groundwater.

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<sup>51</sup> This chapter is based on the report of Sub-Group 7 on Water Quality led by Dr.Sharachchandra Lele.



**Figure 31. Groundwater contamination in Karnatak: Fluorides, Nitrates and Arsenic (Source: NRDWP data)**

**6.1.1 Status**

- Fluoride contamination of groundwater: Fluoride is a geogenic pollutant and enters our bodies through drinking. It is an acute toxin with a rating slightly greater than lead. It is one of the most bone-seeking elements known. While small amount of fluoride ( less than 1mg/L) is beneficial to dental health, more than 1.5 mg/L damages teeth and more than 2mg/L if consumed daily can eventually lead to crippling skeletal fluorosis.<sup>52</sup> Other diseases include osteoporosis, arthritis, brain damage, and thyroid disorders. In Karnataka, fluoride contamination of groundwater exists in 18 out of 30 districts. The total number of habitations affected by fluoride contamination is about 1038 where as the number of suspected fluorosis cases hover around 8,000+ (under National Programme for Prevention and Control of Fluorosis, NPPCF). Mainly affected districts in Karnataka are Chickballapur, Kolar, Tumkur, Mandya & Raichur. (see Figure 31).
- Arsenic contamination: The health hazards of arsenic consumption through water (even at very low concentrations, i.e., few tens of µg/L) include melanosis, leuc melanosis, keratosis, hyperkeratosis, and cancer. Karnataka is the only state outside the Indo-Gangetic belt to have problems of geogenic arsenic contamination in groundwater. So far 21 habitations have been detected as being affected by this contamination. These contaminations mainly show up in regions near to mining areas. Raichur district alone has half of the affected habitations (see Figure 31). The deep groundwater extraction can also add to raising the arsenic level in the water.
- Iron contamination and excess TDS: Another possible issue with groundwater quality is the excessive presence of iron and salts (the latter represented by total dissolved solids or TDS). Iron in drinking water is classified as a secondary contaminant by USEPA because it can promote bacterial contamination. The main effects of iron and high TDS are in the form of corrosion or clogging of plumbing, staining effects of iron and poor taste. In Karnataka given the high use of groundwater, it is not surprising that 11 out of 30 districts are reported of having excessive TDS (>500mg/L). While the

<sup>52</sup> <https://www.downtoearth.org.in/coverage/indias-groundwater-is-flooded-with-fluoride-12676>

presence of iron is reported in many districts across Karnataka, levels greater than 1mg/L are reported from locations in Uttara Kannada district and Shimoga district [65].

### 6.1.2 Causes

Geogenic pollutants are randomly distributed, but are mobilised by some human intervention like deep borewell pumping or mining. In the case of fluoride, the dissolution of fluorides present in rock minerals into groundwater is the source of geogenic fluoride contamination. The pumping of deep groundwater adds to the mobilisation of Fluoride. The other contributors to the rising fluoride levels include phosphate fertilizers, sewage sludge, or pesticides. Arsenic may be mobilised by groundwater pumping but may also leach into groundwater from mining areas. Iron presence and TDS is linked to the nature of rocks, and TDS in particular is likely to be present in all groundwater. But again deeper borewell water tends to have more salts than open well water.

### 6.1.3 Current policies/programmes and gaps that remain

Currently, the policy for addressing these contaminants focuses on filtering out the pollutant, primarily by installing Reverse Osmosis (RO) plants. Under *Shudhaneeru* programme of GoK, more than 10,000 plants have been commissioned by Rural Development and Panchayat Raj (RDPR), mostly on BOOT basis, with private party/CSR/NGO involvement. While this is a short-term solution, there are several challenges these RO plants face:

- a) Reach/equity: not all affected habitations get covered.
- b) Output water quality not guaranteed: the current level of testing may not guarantee contamination-free water at all times.
- c) Financial sustainability: The plants are supposed to be transferred to the Gram Panchayats eventually. But given the high O & M costs, it is not clear how the Gram Panchayats will be able to sustain them.
- d) Resource sustainability is unclear: The source of water to these RO plants is groundwater. Given the rate of depletion of groundwater, it is possible that the source may fail after a few years.
- e) Monitoring is inadequate: There is regular monitoring the quality of drinking water supplied and coverage of habitations affected by geogenic pollutants, but the slip back (when RO plants fail or sources fail) is often missed out.

The other major concern with regard to RO plants is the problem of reject water, which contains higher concentrations of the contaminant. The reject water invariably gets disposed of into surface channels, eventually leaching back into shallow aquifers.

### 6.1.4 Recommendations

Overall, the state will aim to become free of the threat of geogenic pollutants by 2025.

- ✓ Incorporate RO-reject management costs and plans into the RO plant installation and operation programme; reject water to be used only for non-food crop irrigation.
- ✓ Limit the installation of RO Plants to areas with TDS > 2000 mg/l to avoid the unnecessary creation of reject water hazard.
- ✓ Incorporate RO plant operations in source management programmes such as water security plans and watershed development.

- Take up rejuvenation of the aquifer in areas affected by geogenic pollution by implementing strict limits on groundwater pumping.
- Focus on rainwater harvesting in coastal areas (which are also high rainfall areas) to reduce dependence on groundwater.
- Improve the rigour of monitoring of output water quality, through third party audit to and continuous tracking of geogenically affected habitations, also incorporating high quality datasets generated by research organizations, verifying and incorporating where possible citizen-generated data, and public display of these results.

### 6.2 ***Nitrates and pesticide pollutants***

The increasing levels of nitrates and pesticides pollutants in groundwater have serious health implications. The major health issues due to intake of nitrates are methaemoglobinemia and cancer [66]. The major health hazards of pesticide intake through food and water include cancers, tumours, skin diseases, cellular and DNA damage, suppression of immune system and other intergenerational effects [67]. Even at low concentration, pesticides may exert several adverse effects that may manifest at biochemical, molecular or behavioural levels. The actual transport, presence and impact are of course influenced by drainage, rainfall, microbial activity, soil temperature, treatment surface, application rate as well as the solubility, mobility and half-life of individual pesticides.

#### 6.2.1 **Status**

- **Nitrate contamination:** As per NRDWP Data, nitrate contamination is more common in groundwater than fluoride. Though the health risk posed by nitrates is significant, good research tracing the sources of nitrate contamination and linking to health outcomes is scarce. Nitrate flows into surface water are probably significant, but because surface water sources are not used (currently) for drinking, there is no systematic information on this. While monitoring the sample of 15 lakes in Bengaluru, the Lake Development Authority was reported to have found presence of nitrate, phosphate, lead, mercury and E.coli above the permissible limit in almost all of them.<sup>53</sup> The Swachhh Bharat Abhiyan (SBA) has reduced open defecation, but may be inadvertently increasing the contamination of groundwater by nitrates as thousands of soak pits get dug across the landscape, often without maintaining minimum distance from wells [68]. Nitrates are now being reported in the groundwater in almost all districts of Karnataka (see Figure 31).
- **Pesticide contamination:** The information on the pesticide contamination is limited again because of lack of monitoring. The effect of pesticide contamination on human health takes two pathways. The first is through the consumption of fish that are contaminated by the pesticides. The second is the direct consumption of pesticide contaminated water. The latest State of Environment report by EMPRI [69] reports pollution of surface water bodies due to seepage of fertilizers and pesticides in Kolar, Bangalore, Mandya, Kodagu, Chikmagalur, Hassan, Bellary, Koppal, Raichur, Belgaum & Dharwad districts. (Chapter 14).

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<sup>53</sup><https://bangaloremirror.indiatimes.com/bangalore/civic/high-pollution-levels-lakes-varthur-agara-lake/articleshow/47558193.cms>

### 6.2.2 **Causes**

- The major cause of nitrate pollution and pesticide pollution is the overuse of artificial fertilizers in agriculture and missing regulatory standards regarding the same.
- In the recent years the shortcomings of Swachhh Bharat Abhiyan (SBA) has made it a possible source for nitrate contamination [68].
- Nitrate and pesticide contamination is a public health hazard, but coordination between public health departments, drinking water agencies and agriculture department is limited.

### 6.2.3 **Current policies/programmes and gaps that remain:**

There appears to be no regulatory policy on the use of these chemicals from a water pollution/health perspective. Consultations are ongoing at the Central Government.

### 6.2.4 **Recommendations**

- Initiate extensive monitoring for pesticide presence in groundwater and streams agricultural areas.
- Develop regulatory policies around use of pesticides in agriculture.
- Modify SBA guidelines to avoid increasing the nitrate problem by increasing spacing requirements or changing technologies, including twin-pit toilets.
- Promote organic and low-input agriculture.
- Ensure coordination between public health departments and water-related departments through inter-departmental forums as attempted in some neighbouring states.

## 6.3 ***Salinity***

Salinity ingress in groundwater is a major problem in coastal areas. This leads to several health conditions including rising level of hypertension, elevated blood pressure and other cardio vascular conditions. The solution to the problem lies in regulating groundwater extraction. Current policies are not working adequately; this relates to the weakness of groundwater regulation in general.

### 6.3.1 **Recommendations**

In addition to regulating groundwater extraction, the coastal areas (which are also high rainfall areas with lateritic rock) should use rainwater harvesting, especially in urban areas, to alleviate water stress and reduce groundwater pumping.

## 6.4 ***Biological contamination***

Biological contamination mainly occurs in rivers and streams that are downstream of habitations and add to the cost of the downstream population. Contamination of water with animal and human excreta on a prolonged basis leads to Coliforms and certain lethal strains



of E. coli. Thus the entry of untreated sewage into water bodies poses serious health hazards of skin diseases, cholera, and other water borne diseases. Another major concern is the eutrophication of the surface water bodies that results from increasing the Biological Oxygen Demand (BOD) of the water body, as a consequence of which most aquatic organisms are unable to survive in it.

### 6.4.1 **Current status**

- Biological contamination of surface water bodies (streams, rivers and lakes/tanks) is probably present downstream of all habitations in the state, and especially high in streams flowing through urban settlements. Monitoring of the status of surface water bodies in the state is unfortunately very sparse. BOD levels are being monitored on 17 river stretches at 83 locations under a nationally-supported programme by the CPCB. The priority stretches identified are Arkavathy and Shimsha (BOD>30 mg/L) and 11 stretches in all (including Dakshina Pinakini) that are in 3-30 mg/L range. [70].
- Biological contamination of shallow groundwater is ubiquitous in urban areas, and again SBA may be adding to it. Biological contamination is affecting environmental health significantly, as well as health of farmers downstream who use the water for irrigation. It also causes the stench around rivers and lakes. The Vrishabhavathy river [53] and Bellandur lake [71] are just extreme examples of a widespread problem.
- Biological contamination is also happening in shallow wells, but since these have dried up or disappeared due to groundwater exploitation in the eastern maidan region, the problem has indirectly been reduced. The extent of biological contamination in shallow wells in coastal and Malnad region is not clear. The shift to hand pumps and shallow borewells in these regions has presumably reduced the hazard from this contamination.
- Lake status not being monitored systematically by state agencies, but there is enough evidence to indicate that most lakes are polluted. For instance, 17 lakes in Bengaluru have been declared as critically polluted by CPCB.<sup>54</sup> A survey by KLCDA suggested that most of the 200+ lakes in Bengaluru receive some amount of pollution, which in its extreme form translates into the repeated incidents of unmanageable froth and occasional fire at Bellandur and Varthur lakes, which are at the tail-end (literally receiving end) of untreated domestic sewage and other effluents in the eastern part of Bengaluru. The water quality data from KPCB on samples collected from 53 lakes in Bengaluru show that water from most of these lakes are unfit for consumption even by animals let alone humans or bathing [72].

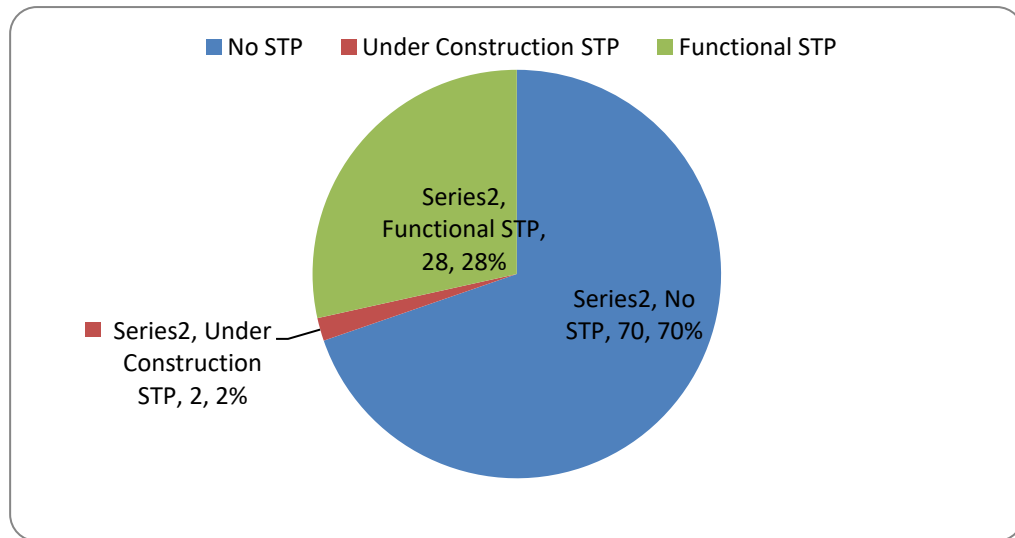
### 6.4.2 **Causes**

- The major reason for this problem is that sewage treatment has lagged far behind the rapid growth of the urban population in Karnataka. Even Bengaluru has only 2/3 the sewage treatment plant (STP) capacity that is required. Of the other 274 ULBs, as many as 191 do not have any installed STPs (or even STPs under construction).<sup>55</sup>

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<sup>54</sup> <https://www.thehindu.com/news/cities/bangalore/bengaluru-tops-in-water-bodies-with-chemical-pollution/article23324428.ece>

<sup>55</sup> Data provided by the Urban Development Department, Government of Karnataka.



**Figure 32. Status of STPs in ULBs (Source: data supplied by Urban Development Department, GoK)**

- Even after setting up STPs, sewage does not reach the STP (e.g., in Ramanagara, or V-Valley STP in Bengaluru which has been operating at 2/3<sup>rd</sup> its capacity).
- Also the currently deployed and affordable STP technologies can only reduce the organic matter and are not effective in for reducing N and P levels.
- Though chlorination is used to reduce the Fecal coliforms in water, it create its own pollution.
- SBA campaign will reduce surface runoff of fecal matter into water bodies, but does have some nitrate contamination risks (see above).

**6.4.3 Current policies/programmes and gaps that remain**

- Monitoring: Surface water monitoring of 17 river stretches is being done by CPCB, but this is clearly inadequate. E.g., the Vrishabhavaty river is highly polluted and the polluted water is used in agriculture before it reaches the Arkavathy. But it is not part of this river monitoring network. Similarly there are many other polluted stretches that are likely to be missed out. The state agency (KSCP) does not seem to have a systematic programme of its own to monitor the health of streams, rivers and lakes.
- Monitoring institutions: SPCB staff are always under pressure not to reveal extent of violations, especially when violators are government bodies (actually should be other way around: govt bodies must show highest compliance as a model). SPCB also cannot prosecute agencies who have representatives on its own Governing Board, such as BWSSB or KUWSDB.
- Sewerage Infrastructure: State is pursuing funds under JNNURM, AMRUT and international loans for upgrading infrastructure using conventional technologies and large-scale sewage treatment plants (STPs). This is expensive, slow and water-intensive (flushing based technologies). Focus on STP construction ignores the problem of sewerage connectivity and operation of STPs. (O&M is often outsourced to



private contractors who are not interested in treatment quality.) KSPCB monitoring of public STPs effluent quality is inadequate/faulty (under-reports BOD levels compared to independent tests).

- **Sanitation worker safety:** Poor sewerage line maintenance and septic tank/soak pit maintenance is a major problem. This even results in the death of sanitation workers on a regular basis.
- **Decentralised STPs:** Karnataka has been a pioneer in implementing decentralized (apartment-/commercial building-scale) STPs. Since 2007, under the “ZLD rule”, at least 3,000 such STPs have come up in Bengaluru itself. This has reduced the burden on the sewerage board. But this policy has many lacunae, leading to partial compliance and high costs to compliant entities. For one, ZLD rule is highly impractical, as no apartment or commercial complexes can reuse 100% of their secondary treated water. Second, the capital and operating costs of smaller STPs are much higher (due to diseconomies of scale), and imposing them on apartment dwellers when the statutory responsibility lies with the sewerage board or ULB seems unfair.
- **Wastewater reuse:** Karnataka is also pioneering the reuse of treated water for groundwater recharge through its K&C Valley-Kolar-Chikballapur project. But this approach is untested and fraught with many risks, as groundwater contamination by N, P and other chemicals not removed by STPs is likely and irreversible. There have already been multiple episodes of partially treated or untreated water being delivered by this project.<sup>56</sup> Moreover, treated and untreated wastewater has been flowing to farmers downstream of Bengaluru (on the Dakshin Pinakini and on the Vrishbavathy) and of other towns for several decades now. Diverting all treated water to other farmers leaves these downstream farmers (and lakes) with only untreated water.
- Sludge management standards are missing and sludge is not adequately monitored.
- Most importantly, there are no ambient water quality standards for surface water bodies. There are CPCB’s Water Quality Criteria, which (although incomplete in terms of parameters used) help classify a water body as being fit for a particular use. But there is no legal mandate (in the Water Act or Environmental Protection Act) requiring water bodies to meet any particular water quality goal.

#### 6.4.4 Recommendations

Overall, there is a need to take up sewage management for urban areas in mission mode (this may be called “SBA+”). This includes:

- Adopt a multi-scale multi-technology approach: This shall include improved soak pits & septic tanks, black and grey-water separation, small-scale STPs, meso-scale (lake-side) STPs, new low-energy or space-saving treatment technologies, and local reuse, along with some large STPs, rather than imposing only conventional centralised water-intensive technology alone. Constructed wetlands are essential to remove N & P from water, and must be an integral part of sewage management. In-stream bioremediation in SWDs should be explored. Involve public in overall planning of sewerage systems and in monitoring.
- Encourage innovation and adoption of new technologies such as vertical eco-filtration, green bridge systems, and in-stream treatment.

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<sup>56</sup> <https://www.deccanherald.com/city/kolar-lakes-get-dirty-smelly-707905.html>



- Large-scale STPs run by public agencies:
  - Focus on connectivity as much as on constructing STPs themselves.
  - Do not subcontract STP operations; the responsibility of operations should be taken by the para-statal or ULB owning it. And involve citizens as watchdogs of water quality from STPs.
- Decentralised STPs: Since the statutory responsibility for providing sewerage and sewage treatment is with the para-statal or ULB, the creation of decentralized (private) STPs should be incentivized, rather than being imposed/ This can be achieved by providing property tax or betterment charge offsets and a clear road map for long-term; providing technical support and market linkage for wastewater reuse, removing ZLD requirement and facilitating local reuse
- Reuse: Require all municipal parks and gardens surrounding government offices to use only secondary treated water drawn from neighbouring decentralized STPs for all irrigation purposes.
- Finance: Support a sewage management mission through an environmental cess on property tax.
- Focus on removing social stigma on sewage management through upgrading salaries and imposing high safety standards.
- Septage management should be given high priority.
- The use of secondary treated wastewater for groundwater recharge is inadvisable at this stage. Long-term independent monitoring of the quality of secondary treated water and the mode of filtration in groundwater should be carried out at a pilot scale before revisiting this concept.

### **6.5 Industrial contamination**

Karnataka is among the leading industrialized states of India. The discharge of effluents to water sources from the industries are the major source of Industrial water contamination. This raises serious health concerns like, skin diseases, peptic ulcer, autism, and cancer.

#### **6.5.1 Current status**

- Several rivers and streams face industrial contamination, including heavy metals, of which Vrishabhavathy is the classic example. Tungabhadra and other rivers near industrial areas are also facing the same problem .The major concern is that currently, the national monitoring programme does not monitor rivers for industrial pollutants.
- In case of lakes, as mentioned above, the sample study of 14 lakes by the LDA, indicates that 14 lakes had mercury above the permissible limit. The results of BWSSB's Central Testing Station show that even at the level of major distribution points before the consumer households, shows that in 10 samples even the Cauvery water at the BWSSB's aerator had iron, silver, molybdenum and aluminum above the permissible level [61].
- Not just in rivers and lakes, even in groundwater, industrial contamination is a serious concern. Industrial contamination (heavy metals) in groundwater is known to be occurring in many pockets, typically around industrial estates, but there is poor data



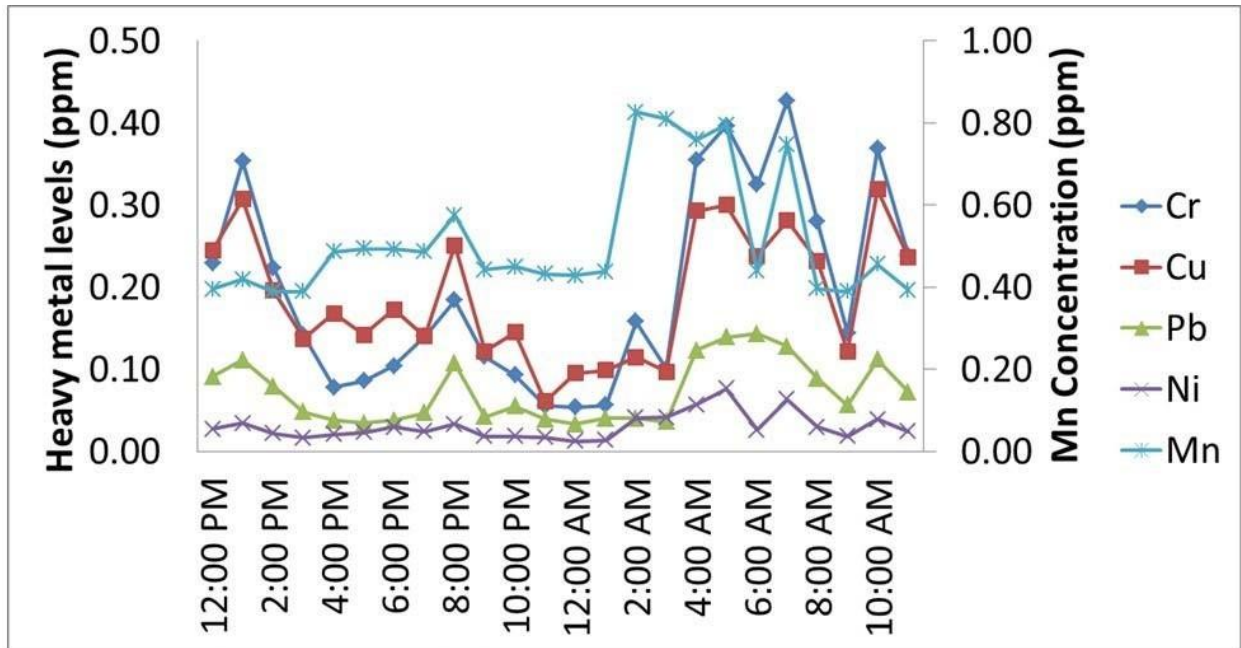
on this to systematically trace the sources. A study of the Kabini river downstream of the industrial area in Nanjangud showed high levels of heavy metals in the water and the sediments [73].

- The latest Karnataka State of Environment report prepared by EMPRI [69] also reports industrial contamination on the Mangalore-Udupi coastline due to petrochemical and industrial pollution at Baikampadi Industrial Estate at Panambur and neighbouring industrial activities (MRPL, MCF, MPT) (see chapter 14).

### 6.5.2 **Causes: proximate and deeper**

- Monitoring is weak and incomplete:
  - There is no legal mandate to monitor water quality of rivers and lakes. And monitoring is being done only when pressure mounts (as when the Lokayukta directed KSPCB to monitor water quality in the Vrishabhavathi) or funds are available under some national programme.
  - The monitoring programmes does not monitor heavy metals and other industrial contaminants.
  - The spatial frequency of monitoring is also inadequate. Only some rivers are monitored, and that too only in some stretches.
  - Most importantly, frequency of monitoring of surface water quality is also inadequate and sampling is on grab sampling basis. Whereas what is required is 24 hour full-cycle monitoring as there is clear evidence that polluters are releasing industrial pollutants after daylight hours (see Figure 33).
  - Since systematic monitoring of groundwater quality for industrial contamination around industrial estates is not done, it is not possible to trace the injection of effluents into abandoned borewells.
  - Enforcement: Individual Effluent Treatment Plants (ETPs): The ETPS of individual industries are poorly monitored.

Figure 2. Variation in heavy metal concentrations in Vrishavabhavati stream downstream of Peenya Industrial Area in Bengaluru [Source 1]. The changing colour of the water samples arranged by time is enough to indicate the change in industrial pollutant levels.



- **CETPs:** The policy regarding Common Effluent Treatment Plants (CETPs) is unclear and ineffective. State-run CETPs, such as the one in Peenya (Bengaluru), have been dysfunctional for years. Industry-run CETPs are also in similar condition. Private CETPs seem to function better, but they cannot handle the entire treatment burden.
- **Legal framework:** Legally, no standards have been set for the allowable concentration of heavy metals in irrigation or in ambient conditions in water bodies.
- **Enforcement:** The enforcement of the Water Act leaves much to be desired. The high workload of consent management in the KSPCB is partly responsible for this. But there are also reports of corruption in this process. Most important, even after violators are identified, the KSPCB is unable to successfully prosecute most of them: the success rate in its entire history of criminal prosecution is about 25% [74]. A weak legal cell, inadequate staff, and a slow and cumbersome legal system (which means the median time for a case to close is 6 years!) are driving this problem.

### 6.5.3 Recommendations

- Expand the effort on industrial contaminant monitoring and tracing of sources 10-fold.

- CPCB recommendations on “Implementation of ZLD for water polluting industries” and “Implementation of continuous monitoring systems” should be strongly implemented. All monitoring data must always be placed in the public domain.
- Separate the monitoring wing from the consent management wing in KSPCB.
- Determine ecological carrying capacity and set load-based standards in critically polluted areas.
- Ask industry associations like Chamber of Indian Industries to play a proactive role in bringing small-scale industries into compliance.
- Strengthen the legal wing of KSPCB, and target large violators to set examples.
- Request the Karnataka High Court to set up a green bench for pollution cases.
- Encourage and work with citizen groups for monitoring and for building public pressure on polluting units to mend their ways.

### 6.6 *Emerging contaminants*

In urban areas, a huge variety of new chemicals are being used in the household and commercial sectors, such as cleaners, antibiotics and other drugs, cosmetics, etc. These if at all reach the STPs, the STPs are not equipped to treat them. It is likely that antibiotic resistant strains of infectious diseases could be one outcome of this trend, and signs of such antibiotic resistant strains have already become visible in two locations in downstream of Bengaluru, viz., Bellandur tank<sup>57</sup> and Byramangala tank [75]. .

#### 6.6.1 **Recommendation:**

The state needs to invest much more in identifying the harmful chemicals, researching their impacts and then encouraging reduction in or elimination of the use of the most harmful chemicals, since solutions involving treatment post-contamination are likely to be quite expensive.

### 6.7 *Overall Recommendations for Water Quality*

The state will take up measures for mitigating water pollution from domestic, industrial and agricultural sources on a mission mode. For mitigating domestic pollution, the primary responsibility will lie with ULBs and Gram Panchayats, whereas for industrial pollution, the primary responsibility will lie with the industrial units. The strategies will include a combination of improved standard setting, greater investments, changed technologies and scales, creating stakeholders in treated water, enhanced and reliable monitoring, and improved enforcement and accountability. The use of treated water for groundwater recharge will be avoided until thorough empirical evidence and technological capabilities are built up regarding its safety, efficacy and disaster risk mitigation.

- Setting ambient water quality standards for all surface water bodies through a process of public consultation and identification of designated best use; and deriving effluent

<sup>57</sup>

<https://www.thehindu.com/todays-paper/tp-national/tp-karnataka/drug-resistant-bacteria-in-bellandur-lake/article25117229.ece>



concentration and load standards based on the designated ambient quality and ecological carrying capacity; revision/issue of discharge permits accordingly.

- ✓ Set quality standards for water use that include criteria for not only biological contaminants but also for heavy metals and other chemical contaminants.
- ✓ Ambient quality monitoring to cover all major surface water bodies and all river stretches; 24x7 automated monitoring on all stretches adjacent to industrial areas; monitoring of groundwater contamination on monthly basis in a 2km radius around all industrial estates; inclusion of heavy metals in all monitoring protocols; contaminant plume modelling to be part of the monitoring strategy. Third party scientific monitoring of effluent discharge to be taken up regularly and citizen monitoring also to be encouraged.
- ✓ Involve chambers of industry and commerce in promoting self-regulation and common effluent treatment by industries
- ✓ Incentivise decentralised sewage treatment plants. Incentivise separation of greywater and black water and in situ treatment of greywater. Incentivise dual plumbing for reuse of treated water for flushing. Provide technical support for those adopting these measures
- ✓ Adopt multi-scale sewage treatment technologies, including in-stream treatment, lake-side treatment, and apartment-level treatment. For centralised treatment plants, ensure sewerage connectivity is completed in parallel with plant construction.
- ✓ ULBs /parastatals will operate sewage treatment plants themselves and shall not outsource operations, so as to ensure quality and accountability
- ✓ Ensure integration of sewage treatment plans with reuse plans, and lake management plans. First charge on treated wastewater will be green spaces and lakes.
- ✓ All STPs and treated wastewater diversions are to be subjected to environmental clearance procedures including public hearings.

### **6.8 Overarching legal, institutional and governance recommendations for ensuring Water Quality<sup>58</sup>**

- ✓ Amend Karnataka Water Rules:
  - Set standards for ambient quality based on designated best use, which is to be determined through public consultation for each water body.
  - Make standards comprehensive by including industrial contaminants in what was hitherto seen as only sewage contamination scenarios (e.g., irrigation water use).

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<sup>58</sup> See Chapters 7 and 8 for more detailed recommendations on administrative and legal dimensions of water pollution governance.

- Make ULBs and Sewerage Boards statutorily responsible for 100% sewage disposal
- ✓ Increase financial support for KSPCB through cesses and plan support.
- ✓ Increase KSPCB autonomy, allow it to fill all sanctioned posts and to recruit more staff as required, but also increase its accountability and efficiency by changing the governing structure.
- ✓ Increase public education, outreach, transparency and participation in all pollution matters. Involve citizens in monitoring and in building public pressure on violators.
- ✓ Improve access to environmental redressal by strengthening and publicising Appellate Authority (AA, as a state-level Green Tribunal). Set up AA benches at sub-state level. (
- ✓ Strengthen State Environment Impact Assessment Authority (SEIAA): Right now the quality of scrutiny happening at the SEIAA level leaves much to be desired.

### **6.9 Environmental Flows in Rivers<sup>59</sup>**

Environmental or ecological-flows are required for the maintenance of natural river flow regimes, maintenance of longitudinal (upstream downstream) connectivity and lateral connectivity with the floodplains, sustenance of aquatic biodiversity including animals and vegetation, groundwater recharge, prevention of salinity incursion into agriculture and settlements, supporting water-based livelihoods, maintenance of estuarine conditions and to support the cultural and spiritual needs of the people. The current paradigm of river management in India consider that “so much of water going waste into the sea” but this notion has been seriously questioned by scientists [77]. The natural flow regime shapes riverine biota in many ways. Any hydrological modification therefore threaten the ecological balance. Headwater regions offer certain important environmental conditions to which many endemic and habitat specialist species have co-existed on evolutionary time scales, while estuaries serve as important nursery ground for fish as juveniles face low predation pressures and have adequate food resource to grow thereby supporting an extraordinarily rich life. Flows in rivers, along with the sediment and nutrients they carry, sustain very productive estuarine and marine ecosystems and also recharges coastal aquifers, thus supporting human livelihoods. These regimes are now under serious threats from human modifications of streamflows, the scale of which is unprecedented.

#### **6.9.1 Setting e-flow criteria**

To assess whether changes in flow regimes are ‘acceptable’ or ‘unacceptable’, one needs standards. Unlike the case of water quality or pollution, where standards have been defined for many parameters and with respect to many uses, the science and policy regarding environmental flows is still in its infancy.

Much of the initial focus has been on maintaining some “minimum flows during the dry season”. The Himachal Pradesh government prescribed in 2005 that the lean season flow post intervention (such as after constructing a hydropower project) should be at least 15% of the pre-intervention lean season flows [78]. Now, the Ministry of Environment, Forests and Climate

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<sup>59</sup> This section draws partly on 76. Krishnaswamy, J., et al., 2018, "Defining Ecological Flows for Karnataka", Note submitted to TGWP, Task Group on Water Policy, Karnataka Jnana Aayoga, Bengaluru..

Change (MOEFCC) also prescribes this limit for environmental clearance of any project involving river water withdrawal or diversion, as instructed by the National Green Tribunal [79].<sup>60</sup> Such a minimum flow limit is relevant to the east-flowing rivers of Karnataka, where upstream irrigation project dams (e.g., Upper Bhadra, Malaprabha, or KRS) capture part of the monsoon flows and divert it to agriculture during the latter half of the hydrological year, thereby dramatically reducing dry season flows in the river downstream of the dam. The combined impacts of such interventions across states have already been quite dramatic. For instance, the Krishna and Cauvery basins are 'closed' basins, which means hardly any flows reach their estuaries on a regular basis [80]. Within Karnataka also, the river beds of these major rivers run dry or almost dry for many months in many stretches. Even upstream of major dams such as the Malaprabha, smaller dams built recently are reducing fish diversity [81].

More recently, however, as the impacts of changes (not just reductions) in flow regimes have been studied, it has become clear that flows in rivers need to deliver a range of river conditions, including velocity, flow variability, depth and river bed submerged width that are important for aquatic habitat, silt flushing, water quality and aesthetic river condition [78]. In particular, in west-flowing rivers, the introduction of dams (largely hydropower dams) has a very different impact: it reduces monsoon flows and *increases* lean season flows. That is, since hydropower generation happens throughout the year, it creates a much more even flow regime in a river that meets the sea in a short distance. This changes the salinity and sediment flux in the estuary dramatically. Furthermore, diurnal (day-vs-night) fluctuations in hydropower generation means that there are dramatic changes in the depth of flow and salinity in the river within a 24-hour cycle.

For instance, a study by ATREE [76] indicated that in undammed rivers/tributaries such as Aghanashini, Gangavalli, Pavinkurve, the dry season (March-May) salinity levels in estuaries mimic those of sea water, reaching 35 ppt and reduce gradually upstream with a sudden drop to freshwater only after reaching approximately 15 ppt, sometimes 30-40 km upstream of the estuary. This gradient of salinity allows for upstream migration of estuarine fish in the dry-season. However, in rivers such as the Sharavathi with its hydro-power dams, sudden releases from the dams make estuary and immediate upstream stretch of river dominated by freshwater, reducing salinity to about 0.67 ppt (2014) and 3 ppt (2017) just 5 km from the mouth. This alters the fish habitat enormously.

Thus a multi-dimensional index or set of criteria for low and high flow levels (inter-seasonal and intra-day), salinity, temperature, pH and dissolved oxygen would be required to define 'environmentally sound flows' in a river more comprehensively. This index would then be correlated better with aquatic diversity and productivity in the river and the estuary.

### **6.9.2 Current status of Karnataka's rivers**

A comprehensive assessment of the state of e-flows in Karnataka's rivers is currently not available. However, the following partial data are available.

- Most east-flowing rivers do not meet the 15% minimum lean season flow criterion.
- Fish diversity is clearly declining downstream of dammed streams as compared to undammed streams [81].

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<sup>60</sup> <https://indianexpress.com/article/india/maintain-environmental-flow-of-15-20-per-cent-in-rivers-national-green-tribunal-to-states-4795117/>



### 6.9.3 Impacts of changing flow regimes and vulnerability of the existing biota

Again, data on what impact the changes in hydrological regimes have had on the biodiversity and fish productivity of the east- and west-flowing rivers are very limited, partly because many dams got built several decades ago and so no pre-dam baselines are available. However, an attempt has been made by ATREE to estimate the vulnerability of fish biota to *further* changes in existing flow regimes [76]. To do so, they created a Fish Importance Index which sought to capture the vulnerability of fish species to flow conditions depending upon their location in the flow and their ranking in the IUCN threat category. Priority catchments/river stretches are marked in orange and red in Figure 34.

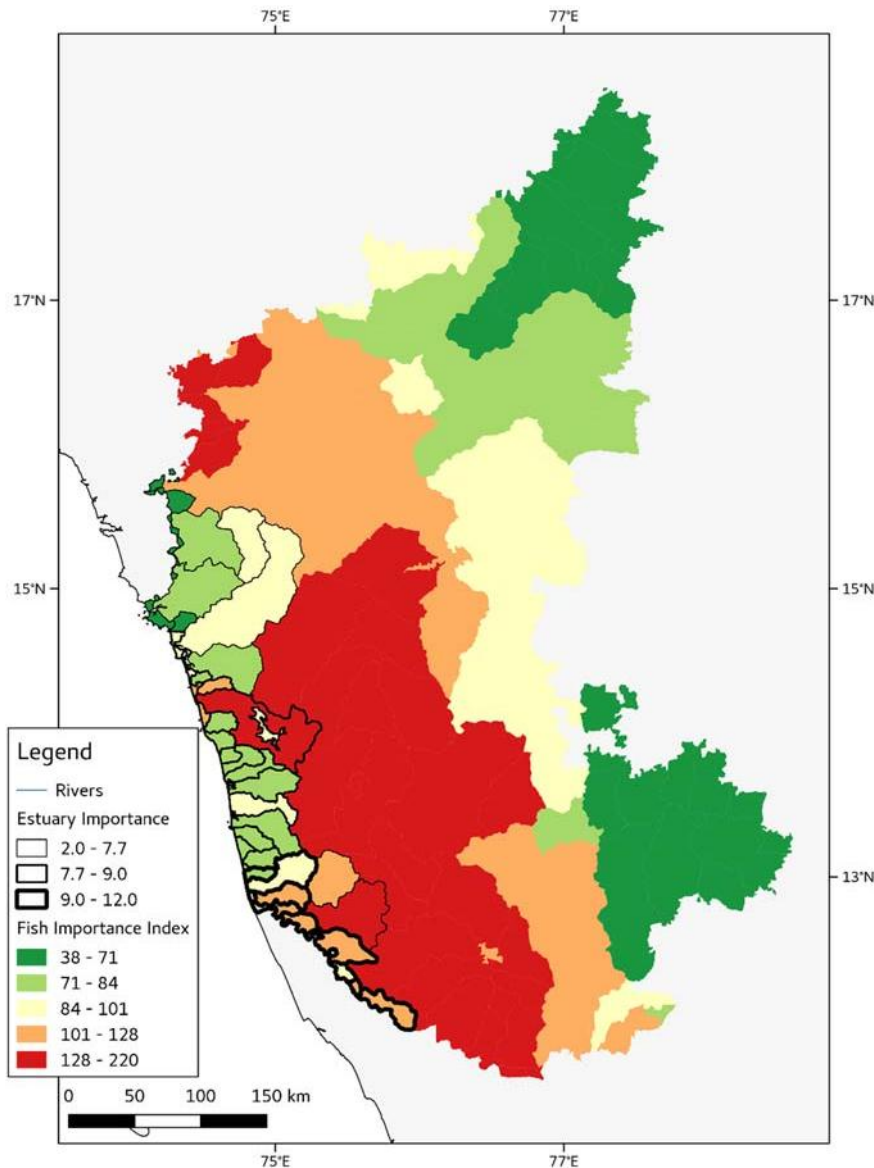


Figure 34. Mapping of Fish Importance Index and Estuary Importance across Karnataka's rivers (Source: [76])

They then simulated the impact of changes in flows on the Fish Importance Index and found, for instance, that a 5% reduction in flows reduces FII of in the estuarine part of the Netravati

basin by 47%. Thus, even small hydropower schemes on west-flowing rivers may have big impacts. Similarly, on the Mhadei, a stretch between Degaon to Kishnapur (40 km) with its undammed tributaries (Bhandura, Kotni, Bail, and Kalasa) is threatened due to hydrological barriers including an inter-basin irrigation canal. As of today, only the Aghanashini remains as an undammed west-flowing river in Karnataka.

Further, drawing further upon field observations and the literature, the ATREE study concludes that east-flowing rivers have severe water deficiencies which threaten aquatic biodiversity in summer. The following segments are known to be important for biodiversity, especially for vulnerable mammal species such as otters:

- In the Cauvery River:
  - Downstream of KRS dam all the way past Srirangapatna, encompassing the Gendehosalli mini-hydel for a distance of approx. 25 km
  - Downstream of mini-hydel (Bhoruka) at Hemmige, near Talacad for a distance of about 15 km
  - The entire stretch flowing through Cauvery Wildlife Sanctuary, starting at the Gaganachukki & Barachukki waterfalls.
- In the Tungabhadra:
  - downstream of Tungabhadra dam, past Hampi till Kampli bridge for a distance of approx. 35 km. This stretch of the river is also designated as the Tungabhadra Otter Conservation Reserve.

#### **6.9.4 Recommendations**

The aquatic habitat and in-stream and estuarine fisheries of Karnataka have already been substantially negatively affected by large dams already constructed. To avoid further impacts, and to mitigate the impacts of existing dams to some extent, the following measures should be taken:

1. Ensure some in-stream releases during the lean season from major dams on east-flowing rivers, say at least 10% of pre-dam lean season flows.
2. Undammed tributaries below existing dams in highly regulated basins such as Kali and Sharavathi should be prioritized for conservation and no new projects should be proposed on them. Similarly, no new projects on undammed tributaries (as Kumaradhara sub-basin) in head-water catchments with multiple small dams such as Nethravathi should be allowed.
3. Restore summer season salinity levels in estuaries. Salinity levels in river water upstream of estuary should be at least 20 ppt in dry season and gradually reach 5 ppt at about 20 km upstream. This will require some trade-off with respect to power production in dry season.
4. Maintain the ban on sand mining in river beds throughout the state.
5. Catchment and estuarine vegetation: Maintain semi-evergreen, evergreen and high canopy riparian stretches of forest along catchments in the west-flowing rivers that are not protected (E.g. LTM Reserve and Sharavathi WLS). And maintain mangroves



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in estuaries and prevention of their conversion to walls/barrages that are being proposed along the length of the riverine-estuarine mixing zone in the Aghanashini.

6. Make provisions for experimenting with solutions for fish migrations upstream and downstream of hydropower dams, such as fish ladders.

## CHAPTER 7. WATER GOVERNANCE REFORMS - ORGANIZATIONAL<sup>61</sup>

### 7.1 Background

Water management is not simply a techno-managerial problem. The multiple stakeholder, multi-scale and scarce nature of water makes it a complex problem of governance, including dimensions of both water resource **development** (making water available) and **regulation** (preventing over-appropriation, over-use or pollution). Governance of both kinds—especially if it has to be of long-term value—takes place through **institutional arrangements**, i.e., **legal**, **financial** and **organizational** rules and processes<sup>62</sup> through which these decisions about development and regulation are taken. All of these interact with the specific hydrological, technology and socio-economic use of water that is ongoing—such as urban use, agricultural use or industrial use. These are crucial to enabling better water governance, because none of the scientific monitoring or technological solutions can be implemented without enabling and supportive institutional arrangements.

In this chapter, we focus on the **organizational** and (to a small extent) financial dimensions of water governance.<sup>63</sup> The legal dimensions of water governance in Karnataka and the recommendations for changes to improve water governance are presented in the next chapter.

### 7.2 Current function-wise organization structure in Karnataka

#### 7.2.1 Resource management

On the resource side, the functions are distributed as follows:

Catchment areamanagement: This function is distributed between the Forest Department, the Watershed Development department, the Animal Husbandry Department (that manages some grasslands), and the Agriculture Department. Only the first two have some catchment area protection programmes, although the FDs programmes have often over-emphasized tree planting in general and single-species plantations in particular. Many other departments also indulge in check-dam building activities.

Surface water resource management: Surface water (in streams, rivers & lakes) is by law state property. The major focus here is on developing structures/systems to dam, lift, divert and transport surface flows for irrigation, and this function is carried out by the Water Resources Department (i.e., the erstwhile Major and Medium Irrigation Departments) and the Minor Irrigation Department, with the **Neeravari Nigams** being quasi-companies nested under WRD. The Minor Irrigation set up the Jala Samvardhana Yojana Samsthe (JSYS) as a government-owned society to facilitate the implementation of the World Bank-funded

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<sup>61</sup> This chapter is based on the report of Sub-Group 11 on 'Institutional Reform and Governance Systems' prepared by Dr. Sharachchandra Lele.

<sup>62</sup> These three are often intertwined. For instance, the BWSSB Act is a legal instrument that makes it possible to set up an organization called BWSSB with all its staff, and financial support for BWSSB makes the laying of 100 km long pipelines to Bengaluru possible. On the other hand, the implementation of a subsidy programme for (say) drip irrigation may not involve a new organization nor a new legal instrument. Nevertheless staffing and legal issues can enter here also.

<sup>63</sup> It should be noted that the concept of 'governance' covers not just the structures and processes created by the executive or legislature at central, state or local levels, but also the judiciary, the media, the knowledge producing organizations, and civil society actors, not to mention the political parties. Nevertheless, since the government does not have direct control on these other actors in governance, we focus here primarily on the legislative and executive arm of the state government, to whom this report is addressed.

Community-Based Tank Management Project [82], but the society was eventually wound up and merged back with MID.

The WRDO (within WRD) regulates the lifting of water from reservoirs and rivers by private entities (such as industries) or para-statal for power generation or city supply, although its role is advisory and the final decisions appear to be taken at higher levels.

Groundwater resource management: Since by law, groundwater continues to be treated as private property, the state only has regulatory powers which are vested in the Groundwater Directorate and the State Ground Water Regulatory Authority. The Central Groundwater Authority plays some minor additional regulatory function.

Water Quality and Pollution: The primary agency to regulate water quality and prevent water pollution is the KSPCB, although there is no specific water pollution related wing within KSPCB. Some (moral, not legal) responsibility on the quality side also rests with the rural and urban water supply agencies.

### 7.2.2 Resource provisioning

On the **utilization** side, the functions are distributed across many more agencies.

Agricultural water supply: Apart from the irrigation departments mentioned above, the Command Area Development Authorities (CADAs, under WRD) are supposed to help with the final (tertiary and field channel level) distribution of surface irrigation water. The Agriculture Department handles components such as drip irrigation subsidy, while the state electricity supply companies are indirectly involved because of the free electricity supply for irrigation pumpsets. Efforts have been made to set up Water Users Associations (WUAs)/Water Users Cooperative Societies (WUCSS) with farmers as members to manage the final distribution of irrigation water.

Urban water supply and sewerage: Karnataka Urban Water Supply & Drainage Board (KUWSDB) is a para-statal responsible for bulk water supply and for setting up sewerage infrastructure for ULBs. The exception is Bengaluru, which has its own para-statal (BWSSB). Distribution is managed by the ULBs themselves (with the exception of Bengaluru and some other major cities). KUIDFC implements certain urban water supply projects.

Rural water supply and sewerage: Karnataka had set up a Rural Water Supply and Sanitation Agency (KRWSSA) but because of legal problems, this has been merged back with the Rural Development & Panchayati Raj Department.

Use for Hydro power generation: The Karnataka Power Corporation builds and operates large hydro projects (which form a substantial fraction of power generation in Karnataka), whereas private agencies generally build and operate micro-hydel projects.

There is no separate agency to monitor or enable ecosystem water needs (e.g., in rivers). The Fisheries department only seems to focus on coastal and tank-based fisheries.

### 7.2.3 Information provision

On the **information provision** side, the functions are distributed between the following:

Surface runoff measurement and rainfall monitoring is done by WRDO (augmented by Central Water commission), with additional rainfall monitoring and meteorological monitoring being done by KSNDMC (augmented by IMD). The Neeravari Nigams and the MID monitor reservoir and tank levels respectively, from which also river/stream flows can be estimated.



Groundwater status monitoring is done by the GWD, augmented by the Central Ground Water Board's monitoring network. Groundwater use monitoring is not done.

Irrigated area monitoring/estimation is done by the Neeravari Nigams (indirectly) and also indirectly by the Directorate of Economics & Statistics that collects landuse and cropping pattern data. Landuse maps are also generated periodically by the KRSAC, although not specifically irrigated area mapping.

### 7.2.4 **Training and Knowledge building**

**Training** is done mainly by the Water and Land Management Institute and (increasingly) by the ACIWRM. These institutes also do some amount of knowledge building through their research programmes.

The major knowledge building is done by commissioning studies or monitoring by different organizations—typically the Universities of Agricultural Sciences for agriculture and watershed development-related research, and a few others. The state government provides very limited support for hydrological research. Much of the data collected by its agencies remain unanalysed and often unavailable to researchers.

### 7.2.5 **Financing**

**Financing** is routed through KUIDFC for urban sector projects, or through KUWSDB or BWSSB directly, while the Neeravari Nigams in theory can directly obtain external funds for irrigation. The finance itself comes from multi-lateral agencies such as the World Bank and the ADB, the central government through JNNURM and AMRUT programme, and centrally sponsored schemes for watershed development.

## 7.3 ***Key lacunae/challenges***

There is no question that Karnataka has made enormous strides since the 1960s in terms of **supply of water** for agriculture and for domestic and industrial use. It did so by building up a water supply infrastructure that is large and complex, developed through the expertise of multiple state agencies. Karnataka's state water agencies have many firsts to their credit: the history of having built one of the first major dams in Mysore and several large dams subsequently, the first para-statal devoted to urban water supply and sewerage, the creation of separate Nigams (corporations) for each major irrigation project, and so on.

Nevertheless, as has been described graphically in chapter 1 and further elaborated in each subsequent chapter, the water sector in Karnataka today is facing a major crisis: of looming scarcity, ongoing inequitable distribution, highly unsustainable use and polluting outcomes, and financial unviability. How has this come about? Beyond the specific choices of technologies (e.g., water-intensive agriculture) or strategies (e.g., unmetered water supply in most towns) lie the institutional arrangements—legal, administrative and financial—that drive these choices and constrain regulation or even occasionally misdirect implementation efforts. These institutions reflect an understanding of the problem that was appropriate for the era of resource abundance but are now inadequate if not misfits in an era when resource limits have been reached. They also reflect a statist mindset that has become unsuitable in a period of dramatic growth of private borewells and an overall recognition of the limits to top-down governance. In particular, the organization of water agencies in the state suffers from the following lacunae in their vision, knowledge paradigm, governance approach and structure:

### **7.3.1 Focus on infrastructure development, not enough attention to resource management and regulation:**

The organization (and underlying vision) of Karnataka’s water agencies is from an era when development of water resources through infrastructure development, i.e., building of dams, canals and pipelines, was the focus of water governance. This has undoubtedly played a significant role in meeting the goal of food security and also provisioning of water for domestic and industrial use. However, this framework is now outdated. It does not reflect or respond to the changed situation on the ground, where the combination of state-led (surface water) and privately-led (groundwater) water utilization has led to situation of over-use, basin closure and groundwater depletion. So the regulatory apparatus, including processes for inter-user, inter-sectoral, intra-basin, and inter-regional allocation are extremely weak in the case of surface and groundwater.<sup>64</sup> What is needed are basin-level regulatory authorities within a larger state-level regulatory framework and with regulatory apparatus within each sub-basin as well.<sup>65</sup>

However, care must be taken to learn from the failures of River Basin Organizations elsewhere and the failure of the Karnataka Groundwater Regulatory Authority itself. There are two approaches to water regulation and governance: a centralised regulatory system with a single “apex authority that seeks hydrometric data and nationally agreed standards and procedures in decisions over water quality and allocation” and a polycentric (or nested) river basin management that “is institutionally, organisationally and geographically decentralised, emphasising local, collective ownership and reference to locally agreed standards” [83]. The latter approach, using Gram Panchayats and Wards/small ULBs as the basic unit within a basin and sub-basin scale allocation framework is more likely to be fruitful in a large, densely populated and diverse state like Karnataka.

### **7.3.2 Inattention to externalities:**

When water is perceived as abundant, the possibility that diverting water from one source may affect someone else downstream tends to be ignored or underplayed. Similarly, the solution to pollution is seen simply as dilution. This results in not paying adequate attention to the hydrological and environmental impacts of projects. Many projects are termed as “drinking water projects” and thereby exempted from environmental and social impact assessment and public hearings. This includes projects with significant impacts such as the Yettinahole diversion project, which would transport water over 300 km. The quality of public debate could have been greatly enhanced and the controversy addressed more effectively if rigorous and transparent environmental and social impact assessment had been carried out by independent and credible agencies. More recently, the KC Valley Wastewater diversion project, which is a first-of-its-kind project for groundwater recharge using secondary treated wastewater being pumped into minor irrigation tanks, was carried out without any environmental impact assessment or public hearings. The subsequent failure of the project to maintain water quality dramatically underlined the need for such environmental due diligence.<sup>66</sup> This also reflects on the loopholes in the ‘environmental clearance’ process at the state (the SEIAA) and central level. Similarly, pollution regulation exists, but standard-setting, monitoring and enforcement need significant strengthening.

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<sup>64</sup> A symptom of the continued ‘developmental’ mindset is the fact that, after the integration of the Groundwater Directorate into the Minor Irrigation Department, the Department was renamed as “Minor Irrigation and Groundwater Development”, when in fact the state is facing a crisis of groundwater ‘overdevelopment’.

<sup>65</sup> Currently, there is a Water Permissions Committee for approving water diversion projects—the only way major inter-sectoral allocation seems to be decided upon—but none of its proceedings or decision-making criteria are publicly available.

<sup>66</sup> <https://www.thehindu.com/news/cities/bangalore/bengalurus-treated-sewage-spews-froth-in-kolar/article24453914.ece>



### 7.3.3 **Integrated management is missing in thinking and in structuring**

In Karnataka (as in other states), we see repeated instances of what the 12th Plan document has called “hydro-schizophrenia”, where the left hand of surface water does not seem to know what the right hand of groundwater is doing. For instance, the single most important factor explaining the drying up of post-monsoon flows in our rivers is the over-extraction of groundwater. Yet, the Ground Water Directorate (as also the CGWB) continue to operate on the basis of outdated concepts of ‘safe yield’ or ‘over-exploitation’ that assume all groundwater recharge is available for pumping and utilization, forgetting that all recharge would have otherwise ended up as discharge (baseflow) into the rivers [16]. Similarly, the Watershed Development Department focuses on increasing groundwater recharge across the landscape (where farmers then pump out and use the groundwater), but that adversely affects inflows into irrigation reservoirs downstream (Batchelor et al. 2003). Similarly, KUIDFC’s so-called IUWRM project for small towns continues to focus on importing river water from elsewhere, neglecting local water resources (ground and surface).

The separation of surface and groundwater, with different legal status and separate monitoring and regulatory agencies, has thus meant that integrated planning and management across surface and groundwater are non-existent. The splitting of monitoring between GWD and WRDO reflects this fragmentation. Addressing this problem will require changing the **knowledge** paradigm, the agency **structure**, and the **mandates** given. First and foremost, it will require collection and analysis of all water related information through a single framework in a single agency (with inputs of citizen science). Second, it will require re-structuring the large surface irrigation agencies into much smaller entities under an independent regulatory framework. Third, it will require mandating integrated management in both command area PIM groups and in non-command areas, and urban areas.

### 7.3.4 **Functional mismatch**

Agencies are designed with particular functions in mind and staff are recruited accordingly. If they are then saddled with additional functions that reflect different skillsets and accountability, they are generally unable to deliver on those tasks. For instance:

- a. The function of constructing dams and canal structures for irrigation is a much more ‘engineering-oriented’ function as compared to the function of actually distributing the water in individual fields, maintaining field channels and distributaries and recovering water charges, etc. The creation of separate Command Area Development Authorities (CADAs) was supposed to address the latter part, but it has not worked. CADAs are also staffed by engineers, and have really become extensions of the Neeravari Nigams, overlapping with the function to be played by the Water Users Associations under PIM. Most importantly, the financial capacity of WUAs needs rethinking. Experience from Gujarat shows that vesting of the power to retain the revenue collected makes WUAs more effective. Further, the human resource available to WUAs to effectively function needs further enhancement. Mandatory commitment from the state government to address the concerns related to financial and human resource related issues seems a plausible solution.
- b. The function of bulk supply (big pipelines from rivers to urban/rural areas) is quite different from that of distribution, requiring different skills and hence staffing. The work of distribution involves a significant interface with people and understanding of their needs, not only engineering skills, which may suffice for bulk water supply. Yet, KUWSDB is often saddled with both, and ULB staff are also recruited as per engineering norms.



- c. Similarly, MID is an executive agency, which has historically maintained minor irrigation tanks. It has recently been saddled with the task of maintaining, monitoring and regulating urban tanks/lakes as well (with the formation of the KTCDA)<sup>67</sup>. This neither matches the skills in MID, nor reflects the spirit of the 74<sup>th</sup> amendment, according to which the ULBs are the rightful custodians of the tanks in their jurisdiction.

### **7.3.5 Lopsided, inadequate staffing and missing expertise:**

First and foremost, the water sector is highly understaffed. A large number of positions in the state's water agencies remain unfilled. E.g., 180 out of 882 posts in Krishna Bhagya Jala Nigam Ltd are unfilled at this time. Almost 50% of the posts in Karnataka Neeravari Nigam Ltd and 38% positions in the Cauvery Neeravari Nigam Ltd are also unfilled.

Secondly, the monitoring and regulatory agencies are particularly under-staffed. The GW directorate, which is tiny as it is, has only 31 staff members—half their official strength! Similarly, the WRDO, the surface water monitoring and regulatory agency, has only about 40 staff, which is much lower than their official strength. The total staff required to properly monitor, analyse and regulate surface-cum-groundwater resources and their use in the state would be many hundreds, at multiple levels from the state to the gram panchayat or urban ward. Even the KSPCB, constituted under a national law, has almost 200 positions unfilled.

Thirdly, the staffing pattern is also highly lopsided in disciplinary terms, being dominated by civil engineers (several thousand positions), reflecting the focus on infrastructure development. Although groundwater Even the hydrogeology profession (currently less than 30 positions) is biased towards groundwater 'exploration and development' (akin to prospecting for petroleum) and not trained in understanding recharge and discharge phenomena linked to surface water. While civil engineers and hydrogeologists will continue to be needed, the unfilled positions may also represent a golden opportunity for change. The situation now needs other disciplines and much more interdisciplinary cooperation. Hydrologists with training in surface water, groundwater and eco-hydrology are needed in much larger numbers. Agronomists are required for crop water budgeting, environmental engineers in wastewater treatment. Moreover, if programmes such as Participatory Irrigation Management, Participatory Groundwater Management (under ABHY) or Ward-level Integrated Urban Water Resource Management are to succeed; staff with training in social sciences, community organization and outreach, and town planning will be required.

The goal, therefore, has to be to make a manifold increase in the capacities of the agencies managing water in Karnataka at all levels (state, command area, gram panchayats, and ULBs). This can be done through both in-house enhancement of capacities (through capacity building of existing personnel as outlined in Chapter --- and by inducting fresh personnel) and through building robust partnerships with institutions of excellence across the country. It will also require reorienting mindsets of existing staff, i.e., an active Change Management programme.<sup>68</sup> ACIWRM has made a beginning in this direction under an ADB-funded project that involves training all the water agency staff in IWRM, but this process needs to be speeded up and expanded, and more important, with the change supported from the top with reorientation of agency goals and performance evaluation criteria.

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<sup>67</sup> Karnataka Tank Conservation & Development Authority, with the Secretary MID as its chief executive.

<sup>68</sup> Such a programme was successfully attempted by the Tamil Nadu Water and Drainage (TWAD) Board 84. Suresh, V. and V. Nayar, 2006, "Democratisation of water management: Establishing a paradigm shift in the water sector", in Anonymous (Ed.) *Reforming public utilities to meet the water and sanitation MDG*, vol., World Development Movement and WaterAid, London,

### **7.3.6 Lack of incorporation of best data & knowledge:**

From within the engineering paradigm, Karnataka's agencies had the reputation of being some of the most technically competent agencies in the country. However, any agency would need to constantly learn through a process of research and development, which would have to be a combination of internal and external R&D activities. Unfortunately, other than the Watershed Development Department (which under the World Bank funded Sujala project has invested heavily in monitoring and research), most agencies have not been able to invest in R&D or collaborate with the large body of independent researchers present in the state and elsewhere. Even much of the work of project development is now being outsourced to consultants,<sup>69</sup> thereby reducing the scope for skill development within the agencies.

### **7.3.7 Inadequate decentralization, transparency, accountability and participation:**

It is assumed that since all these entities are part of or directly controlled by the state government, they are accountable to the people of the state of Karnataka because the state government is eventually an elected government. However, the population of Karnataka state is equal to that of one major European nation like France or the UK. If its resources are to be truly democratically governed, the structures of governance need to be much more decentralized, and even the state-level entities must facilitate much more public participation, transparency and accountability than they currently do. Some examples should suffice:

- a. The attempt to decentralize irrigation management through PIM (participatory irrigation management) has not made much head way. Only half of the targeted number of WUAs might be functioning, and even their functioning leaves much to be desired. In parallel, the CADAs continue to function, when in fact their role is to be devolved to the WUAs. And the CADAs continue to be understaffed.<sup>70</sup>
- b. The Neeravari Nigams are companies in namesake only, since their staff are state government employees and CEOs are also state-cadre IAS officers, who get regularly shifted around. Furthermore, although they are registered as companies, all their staff are 'state government employees' recruited through a common state-level process (KPSC) and transferred regularly across Nigams. In effect, the staff belong to the Water Resources Department and the companies are only divisions of the WRD, with very limited autonomy.
- c. The Irrigation Consultative Committees set up for each project, do not have adequate or systematic representation of the farmers in the command area.<sup>71</sup> The minutes of the meetings of these committees do not appear to be in the public domain. These committees are playing the role that is actually meant to be played by the Federation of WUAs in the particular command area.
- d. The BWSSB, although meant to serve only the citizens of Bengaluru, has no direct accountability to the people of Bengaluru or to the BBMP. BBMP has no representatives on BWSSB's governing board, which have a large number of state department representatives (7 out of 14) and others non-official members nominated with no clear process or criteria. Nor are there any civil society representatives or eminent citizen members. The Chairperson of BWSSB

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<sup>69</sup> See, e.g., status report on 'Implementation of waters supply in 9 small towns', from KUIDFC, December 2017.

<sup>70</sup> Based on "Note on Participatory Irrigation Management (PIM) in Karnataka", submitted by K J Joy, and note on "PIM – A way forward" submitted by Rajendra Poddar, Director, WALMI.

<sup>71</sup> In the RTI document on the WRD website, it is mentioned that the heads of the Neeravari Nigams are consulted by way of 'arrangement for consultation with members of the public'.

changes frequently (virtually every year) and is often holding the position as an additional charge. The BWSSB's regulations are not in the public domain, nor are the DPRs of their externally funded projects, or even performance data regarding water service.

- e. The KSPCB's governing body is similarly dominated by state department representatives (10 out of 17), including from agencies that are likely to be polluters (BWSSB, other ULBs) and 3 representatives from industry, agriculture and plantation sector. But it has no representatives from the public who are actually affected by pollution, nor any science or social science experts. Karnataka has followed a healthy tradition of appointing independent chairperson's for a fixed 3-year term. But the Member-Secretary, who is effectively the CEO of the organization, still comes on deputation from the Forest Department, making the post under-perform.
- f. The Karnataka Groundwater Authority, constituted in 2012, is also made up largely of representatives of different government departments rather than having independent members representing key disciplines and primary stakeholders. Moreover, it appears to have met very infrequently, with no minutes publicly available. The KGA is housed within the Groundwater Directorate, which itself is poorly staffed, as mentioned below.
- g. Special purpose vehicles such as JSYS and KRWSSA reduce accountability and may work for one-time implementation, but not for long-term governance.

### **7.3.8 Wastewater reuse: Falling between the cracks**

Wastewater has till recently never been seen as a resource, only as a pollutant to be disposed of under the framework of the Water (Prevention and Control of Pollution) Act, 1974. But with the expansion of urban areas, the amount of wastewater being generated is significant, and with the expansion of treatment facilities (and the scarcity of fresh water), the possibility of re-using this treated wastewater has emerged as a distinct possibility. Indeed, reuse of treated wastewater is already taking place (officially) in Bengaluru through sale of treated wastewater to some industries by BWSSB (notably the airport) and through the internal reuse of treated wastewater in apartments and in some industries as a result of the KSPCB's requirement of 'zero-liquid-discharge' (ZLD) [54]. Apartment level treatment and reuse has been made mandatory now across all cities as per the CPCB's orders. In parallel, the central government has now mandated that thermal power plants should wherever possible use treated wastewater for their cooling tasks.

It should also be noted that use of un-treated wastewater flows has been happening in locations downstream of urban centres (especially Bengaluru) for several decades now. These (urban wastewater) flows being almost the same throughout the year makes them especially valuable for farmers seeking to irrigate during the non-monsoon period. One may say that that these farmers have now developed 'customary rights' in these wastewater flows. Diversion of these flows (as has commenced under the KC Valley-Kolar wastewater diversion project) will affect these 'customary rights-holders' downstream.

A third dimension of wastewater reuse is its use for ecosystem purposes in urban lakes. Jakkur lake in Bengaluru has year-round water for fish, birds and plants because it receives treated wastewater from a BWSSB-owned sewage treatment plant [85]. Again, there is no legal 'right'

that the lake (or lake custodian) has on this wastewater flow, and this has been demonstrated by BWSSB deciding recently to divert all the treated wastewater to a power plant nearby.<sup>72</sup>

At the same time, wastewater (treated or otherwise) represents 'return flows' within a river basin, which is often regulated under the orders of inter-state water dispute tribunals, and in which certain assumptions about the quantum of return flows is made. Since typical wastewater reuse in landscaping and cooling towers represents a 'consumptive' use, this will lead to declines in return flows [86].

**Institutional arrangements:** The Government of Karnataka has approved of a wastewater policy in 2016. But by virtue of being a policy document, it is a statement of intent. As such, it provides no statutory rights to any current user of treated or untreated wastewater, or put statutory limits on how much of this return flow can actually be abstracted or diverted for consumptive uses, or specify statutory procedures to be followed in determining who may be given the treated wastewater from a particular user (in effect who 'owns' the wastewater). The policy also pays limited attention to the risks to public and ecosystem health involved in indiscriminate reuse, such as the KC Valley-Kolar wastewater project that uses secondary treated wastewater for groundwater recharge.

In short, when water becomes scarce, wastewater becomes a resource. This is both an opportunity and a hazard. Untreated or inadequately treated wastewater can be a public health hazard, but the water itself is a precious resource, and users may continue to use it and may be seen as developing customary rights over it. Treatment of wastewater, being expensive, often results in the 'treating agency' (the Sewerage Board or ULB) looking for a 'buyer' for the treated water (such as Bangalore International Airport or Karnataka Power Corporation or some other industrial area or SEZ) who is different from the customary user (such as the farmer downstream in the Vrishabhavathy or Dakshina Pinakini valley or urban lake like Jakkur). Thus the conflict over wastewater is bound to increase in the absence of an adequate framework.

### **7.3.9 Excessive dependence on courts for conflict resolution**

The Indian judiciary has been commendably active in environmental matters in general and water-related matters in particular. The courts (High Court and Supreme Court) and the National Green Tribunal have given several exemplary judgements in matters relevant to Karnataka's water resources. However, using courts as the sole conflict resolution mechanism not only puts a heavy burden on an already over-burdened judicial system, but also increases the chances of delays, judicial overreach and/or poor judgements based on inadequate understanding of the complexity of water-related matters.

For pollution related matters, there is also an Appellate Authority (AA) set up under the Water and Air Acts. Till recently, the AA was seen as only a place for industries to appeal against SPCB orders (such as denial of consent to operate). However, the Supreme Court has clarified that appeals to the AA can also come from the public who may be affected what they consider wrongful granting of consent or other SPCB orders. This has opened up significant possibilities of the AA acting as a much more accessible conflict resolution forum [87].

## **7.4 Recommendations**

The organization arrangements must be restructured in a way that is conducive to integrated, participatory, transparent and effective governance of water resources in the state suitable for

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<sup>72</sup> <http://economictimes.indiatimes.com/news/politics-and-nation/yelahanka-power-plant-could-kill-jakkur-lake/articleshow/56231589.cms>



water governance in the 21<sup>st</sup> century and the realities of water in the state. We proposed the following:

### 7.4.1 New institutions for nested water governance

1. Broadly speaking, learning from the experiences of Maharashtra, Rajasthan and other states, and drawing up the Model Water Framework Bill and the Model Groundwater Bill, it is recommended that a **4-tiered Water Resources Regulatory System** be set up in the state for allocating and then regulating the use of water resources. The 4 tiers would be:
  - a. State-level Water Resources Regulatory Council;
  - b. Basin-level River Basin Authorities for allocating water;
  - c. Sub-basin level agencies/Milli-Watershed Associations/Federations of WUAs,
  - d. WUAs in command areas, Water Management Committees of Gram Sabhas/Panchayats in non-command rural areas, and Ward-level committees in ULBs for regulating surface and groundwater use within their jurisdictions.

The structure will be autonomous, multi-disciplinary, participatory and professional, backed by an integrated water data agency (see 7.4.6 below). They will operate under a framework law that spells out the goals and principles of regulation, and a separate law that enables their creation and functioning. The regulatory functions of the current Groundwater Authority and WRDO will be merged into these regulatory authorities. The details of this regulatory structure are to be worked out through a broad consultative process within 1 year, before the enactment of necessary statutes.

2. PIM will no longer be seen as a programme, but rather as the **statutory** foundation on which water management will happen in command areas. Water distribution structures will be refurbished and then transferred to WUAs. Federations of WUAs covering each command area of a major or medium irrigation project will enter into agreements with the respective NNLs regarding the quantum and timings of water supply, which will in turn be governed by the overall allocations specified at the basin and sub-basin level. The work, funds and staff of the CADAs will be transferred to the Federations. (Details are given in Chapter 7). In parallel, the Neeravari Nigams will be given more autonomy to function as bulk water suppliers, with their own dedicated staffing, a full-time CEO, and a governing board that is more representative of stakeholders/citizens of the river basin in which that NNL functions.
3. A Participatory Integrated Groundwater, Tank and Watershed Management System will be set up in the non-command areas. It will function within allocations specified by the basin- and sub-basin level authorities. The process of integrated Gram Panchayat-level water security planning begun under the Atal Bhujal Yojana in the talukas with over-exploited groundwater status will be the basic building block in non-command areas, which will be extended to the whole state and will get statutory backing to be converted into a water management/regulation process. In CMCs, city corporations and BBMP, ward-level committees will be mandated and empowered to carry out similar integrated urban water management (IUWRM) that includes rooftop rainwater, lake water, ground water, wastewater and imported river water.



**7.4.2 Ensuring adequate and transparent environmental and social impact assessment of new projects and more rigorous enforcement of pollution control**

1. All water resource related public and private projects (whether for irrigation, industrial or domestic use, including so-called drinking water projects) or involving inter-watershed diversion will be subject to clearance by the basin-level water resource regulator for which transparent and credible environmental and social impact assessment and public hearings will be conducted, and projects modified in light of feedback received.
2. The SEIAA which currently scrutinizes category B projects will ensure that the hydrological and socio-environmental impacts of all water-related projects are analysed thoroughly.
3. To strengthen enforcement, KSPCB will increase citizen involvement and create dedicated divisions for water pollution-related enforcement (separate from air and noise pollution) in each of its regional offices.

**7.4.3 Separation of functions and revision of mandates**

1. The Karnataka Urban Water Supply & Drainage Board will be tasked with only development, implementation and operation of bulk water supply projects, i.e., provision of bulk water to ULBs or multiple villages. It will not engage in distribution, which will be the domain of ULBs and Gram Panchayats. It will also execute groundwater based water supply projects and sanitation projects for handover to relevant agencies (ULBs or Gram Panchayats).
2. The Bangalore Water Supply & Sewerage Board will be renamed the Bengaluru Water Board, and it will have the mandate of 'managing and distributing all water', including local rain, storm and groundwater, wastewater and imported water for the citizens of Bengaluru (BBMP area). The bulk water supply division of BWSSSB (the one maintaining Cauvery stages) will be merged with KUWSDB.
3. KTCDA will be a strictly regulatory body dealing only with tank encroachment. It will be an independent authority with an independent chairperson and professional staff and CEO. Custodianship of all urban tanks will be transferred to the respective ULBs and of rural tanks to the respective Gram Panchayats or Gram Sabhas.
4. The NNLs' functions will be restricted to bulk supply of surface irrigation water. The CADA's functions will be handed over to the WUAs and their federations. The WALMI will be entrusted with the function of providing technical support to all WUAs and their Federations for planning and execution of conjunctive water management in the command areas and all associated developmental functions.

**7.4.4 Transparent and accountable governance and professional management**

1. BWSSB's governance structure and procedures will be modified for greater professional management, for ensuring greater public input, expert input, transparency and accountability to the citizens of Bengaluru. It will have fixed term independent chairperson and more independent (expert and public) members and less only 3 ex-officio members. It will be required to facilitate and work closely with the ward-level committees for IUWRM. Its Chairperson and CEO will be selected through open well-defined selection processes.
2. KUWSDB's governance structure will be modified for greater professional management, for ensuring greater public input, expert input, transparency and

accountability, and it will be renamed suitably in light of the redefined mandate. It will have fixed term independent chairperson and more independent (expert and public) members and only 3 ex-officio members. Its Chairperson and CEO will be selected through open well-defined selection processes.

3. The Karnataka State Pollution Control Board will be restructured to increase its autonomy, ensure professional management, greater public and expert participation in its governance and greater transparency and accountability in its functioning. Its staff strength will be enhanced fourfold, and its monitoring and enforcement wing will be separated from its consent-management wing. Its regional presence will be enhanced in line with pollution hotspots, and its legal cell will be strengthened. Its financial resources will be augmented with a special environmental levy.
4. The Environmental Appellate Authority set up under the Water and Air Act will be strengthened substantially to become an effective green court (or dispute resolution mechanism) at the state level. This will require selection of highly qualified members, expansion of benches to regional centres, provision of support staff for research and investigation and building awareness of the availability of the AA as an alternative to the more expensive court process.
5. The Neeravari Nigams will be restructured to ensure independent professional management, independent staffing, and governing bodies that have more representatives from citizens/stakeholders from the river basin in which that NNL functions.

### **7.4.5 Staffing and training**

1. The staff strength for groundwater monitoring and regulation will be increased manifold at all levels (state, regulatory agency, ULB, Gram Panchayat) and in all agencies: monitoring, irrigation management, urban water supply, and pollution control.
2. Water resource agencies will recruit hydrologists with training in groundwater, surface water and eco-hydrology and an orientation towards integrated water management, not surface water development or groundwater prospecting alone.
3. All agencies involved in water distribution, whether rural, agricultural, or urban, will include community organizers and outreach staff. Moreover, “change management” training will be provided to all staff to improve their public interface and ability to meet new performance criteria.
4. The water and sewerage divisions of all ULBs and BWSSB will be strengthened by expanding staff strength, and training in IUWRM, induction of groundwater specialists and social workers, and change management training to improve their public interface and ability to meet multiple performance criteria.
5. KSPCB will expand its legal cell manifold, expand its overall staff strength, and induct economists to better estimate public and private costs and benefits of regulation.
6. The newly proposed regulatory agencies in 7.4.1 will be provided with adequate support staff from multiple disciplines mentioned above. Again, training in integrated management and public interface will have to be part of their induction programmes. Refresher courses must be held every 10 years or so for all staff.



### **7.4.6 Water resources monitoring and knowledge building**

The organizational structure for collection, analysis and dissemination will be revamped in order to create a **unified (surface water + ground water) data agency to monitor and provide information**, analysis and decision-support at multiple levels from Gram Panchayat, to sub-basins, basins and the state level. The structure is elaborated upon in Chapter 9.

A process for commissioning and utilizing independent, high quality long-term research on the changes taking place in Karnataka's river basins in terms of resource availability and use the effectiveness of various policies and institutional processes, will also be initiated. The details are provided in chapter 9.



## CHAPTER 8. WATER GOVERNANCE REFORMS - LEGAL<sup>73</sup>

Legal instruments, including constitutional provisions, laws, rules, administrative law/procedures/regulations, case law and common law are a vital part of the institutional framework for all governance, including water governance. We review the existing legal framework for the water sector in Karnataka, keeping in mind as before the goals and principles that we should aspire to in the water sector, as elucidated in Chapter 7. In each case, we draw upon corresponding sections of the previous chapter to identify lacunae in the legal framework and recommend changes that would provide a firm and functional legal basis for the reforms suggested earlier.

### 8.1 Groundwater

The legal regime on groundwater in Karnataka is characterised by the co-existence of unfettered land-based groundwater extraction rights and limited regulation by the State.

#### 8.1.1 Existing legal regime on groundwater and its limitations

##### Historical common law regime: land-based rights

Some of the most important legal principles governing groundwater even today in India were laid down in British common law as early as the middle of the nineteenth century and have not been updated since. This common law doctrine was/is one of 'absolute dominion', which the landowner the right to take substantially as much groundwater as desired from wells dug on his/her own land. Landowners do not own groundwater but enjoy access as part and parcel of their ownership rights to the land above. Initially, this was an unfettered right.

The only nuance that came in actually runs contrary to well established groundwater hydrology. It seeks to distinguish between "defined" and "undefined channels". "Groundwater that percolates through underground strata, which has no certain course, no defined limits, but which oozes through the soil in every direction in which the rain penetrates is not subject to the same rules as flowing water in streams or rivers". On the other hand, where groundwater was found to flow in defined channels, case law says that rules applicable to surface water would also apply. This has been interpreted to mean that the right of the landowner would then be "limited to use and consumption for household and drinking purpose, for watering their cattle and even for irrigating their land or for purposes of manufacture provided ...it does not ... materially diminish or affect the application of the water by riparian owners below the stream in the exercise either of their natural right or right of easement, if any." [see 88 for details].

This distinction is completely meaningless in scientific hydrogeological terms since groundwater occurs in aquifers. Aquifers are rocks or rock material in which the pores or fissures have been saturated with water, and water is transmitted from one point in the aquifer to another due to the interconnectedness between these pores/fissures. This transmission does not generally take the form of "channels" like streams and rivers.

In practice, even this flawed distinction has applied only in exceptional cases, and land-based extraction rights have remained largely uncontested and unfettered. This is the main reason for groundwater depletion.

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<sup>73</sup> This chapter is based upon the Summary Note titled "Water Laws in Karnataka: Review and Suggestions for Reform" finalised by the Sub-Group 12 on Legal Aspects of the TGWP, led by Prof. M. K. Ramesh and Prof. Sujith Koonan.

This approach is unsuitable for three reasons:

- a) If groundwater is the saturated layer of soil, weathered rock or fissured rock that extends for long distances beneath the surface, then clearly it is a common-pool resource (where one person's pumping will affect availability for another person) and not amenable to privatization, because it will rarely be the case (or never in India) that the entire aquifer lies under a single person's private land.
- b) Groundwater, or at least the renewable portion of groundwater (unconfined or semi-confined aquifers) is in fact an integral part of the hydrological cycle and interconnected with surface water flows. So assigning groundwater rights without considering their impact on surface water (or vice versa) creates serious problems of negative externalities.
- c) Land-based groundwater rights in particular are socially inequitable, because they give virtually exclusive access to the landowning class. This completely overlooks the fact that groundwater serves the basic needs of life of many people who do not own land.

It is clear that the land-based unfettered groundwater right and the consequent private appropriation has to be abolished, and the legal status of groundwater needs to be redefined in light of the Public Trust Doctrine enunciated by the Supreme Court of India, among others. This is also essential from a human rights and environmental point of view.

### Limited state regulation through statutes

The state has, in recent times, sought to regulate groundwater use through two main statutes, but with limited effect.

1. *The Karnataka Ground Water (Regulation for Protection of Sources of Drinking Water) Act, 1999*

This is based on a model bill framed by the central government in 1970 and modified from time to time till 2005. It sets a very limited objective for itself, viz., regulation of groundwater use to the extent it is required to protect public sources of drinking water in the State. It follows mainly the following regulatory tools:

- a) Permission to sink a well within 500 metres from a public drinking source. This regulation is not applicable when the government sinks wells for the public.
- b) Notification of 'water scarce area' to prohibit or restrict groundwater use in such areas for the duration of water scarcity.
- c) Notification of 'over exploited watershed' to prohibit wells in such areas.

These powers have not worked in practice.

2. *Karnataka Groundwater (Regulation and Control of Development and Management) Act, 2011*

Key features of this Act are:

- a) Establishment of 'Karnataka Groundwater Authority' to take measures to control the groundwater use in the state.



- b) Control of groundwater use is mainly through permits. Every user of groundwater needs to get permission from the Authority.
- c) The permit may be issued by the Authority with terms and conditions
- d) The Authority has the power to change the terms and conditions subsequently and it has also the power to cancel the permit
- e) The system of permit for groundwater users is not automatically applicable throughout the State. It is applicable only in areas specifically notified by the government upon the advice of the Authority.
- f) It requires machineries for drilling or sinking well to be registered with the Authority.

This 2011 Act is based on the Model Bill 1970/2005 circulated by the central government. While it represents an attempt in the right direction, it is still highly inadequate because it is based on an old understanding of groundwater challenges that (for instance) ignores the link between groundwater and surface flows. Moreover, by creating only a state-level authority, actual on-the-ground regulation is rendered practically impossible. A centralised agency simply cannot regulate the activities of millions of groundwater users in the State.

In practice, this Authority has hardly functioned at all—its minutes are not available, the orders issued by it are few and impractical, and even they are hardly implemented (e.g., asking individual borewell owners to register their borewells by paying 50 Rs.).

### **8.1.2 Recommendations for Reforms**

It is clear that the state of Karnataka needs to urgently revise the current groundwater statutes to address the (ground)water crisis in a holistic and effective manner. Any new statute (whether standalone for groundwater or a part of an integrated management statute) must clearly incorporate the following elements emerging from various Plan documents and court rulings, as also developments on the ground that reflect a new emerging reality of groundwater:

- a) Adopting the Public Trust Doctrine enunciated by the Supreme Court<sup>74</sup> and formulated in the Model Sustainable Management of Groundwater Bill, 2016, viz., that **groundwater (and all water) is a common-pool resource at a basin-scale held in public trust**, and that the state **at all levels** from the village to the state government is the custodian of the resource<sup>75</sup>, while explicitly repealing common law and other doctrines.
- b) A recognition of the two-way link between groundwater and surface water. Therefore, conjunctive use of groundwater in surface irrigation command areas must be

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<sup>74</sup> The Supreme Court has held that “Our legal system includes the public trust doctrine as part of its jurisprudence. The State is the trustee of all natural resources which are by nature meant for public use and enjoyment” [MC Mehta v. Kamal Nath(1997) 1 SCC 388]. The Supreme Court has also made clear that it “must make a distinction between the Government’s general obligation to act for public benefit, and the special, more demanding obligation which it may have as a trustee of certain public resources” [Intellectual Forum v. State of A.P.(2006) 3 SCC 549]. It further explained that “The public interest doctrine is a tool for exerting long established public rights over short term public rights over private gain” [Fomento Resorts & Hotels Ltd. v. Minguel Martins (2009) 3 SCC 571].

<sup>75</sup> This applies to groundwater as a resource (aquifer) and not to mechanisms (wells/tubewells) for abstracting it. We need a law that is built around the need to regulate unreasonable use of sources of groundwater that threaten the aquifer to ensure that the resource (aquifer) itself is protected and can provide a sustainable basis for meeting the basic needs of every person for decades to come

incorporated into surface irrigation law, and the impacts of groundwater pumping on baseflows of rivers must be taken into consideration when defining permissible levels of groundwater use.

- c) A recognition of the aquifer as a system that may or may not overlap exactly with surface watershed boundaries, but that connects groundwater users (and baseflow users) with each other and with land use changes happening in recharge zones of the aquifer, and therefore incorporate measures to protect recharge zones and carry out aquifer-wise regulation.
- d) An acceptance of the Precautionary Principle when dealing with a resource that is generally invisible in its movements, and that contains a non-renewable component that is not easily distinguishable from the renewable component. This also implies that all areas must be brought under regulation by default, not requiring individual notification, as is the case just now.
- e) The adoption of decentralization principles embodied in the 73<sup>rd</sup> and 74<sup>th</sup> amendments, along with the principle of environmental subsidiarity, which demands that only those matters which cannot be dealt with locally (such as downstream impacts) be dealt with at the appropriate higher scale (sub-basin or basin scale). Using the Model Groundwater Bill, 2016 as a starting template in which Gram Panchayats/Gram Sabhas and ULBs or ULB wards are made the basic unit of day-to-day management, formulate a 4-tier framework to effectively regulate and protect groundwater in the State (as spelt out in Chapter 7 in detail).
- f) A clear incorporation of rules for transparency and accountability at each level of governance.

## **8.2 Irrigation and command area development**

Irrigation law is one of the oldest and most developed areas of water law in India. Irrigation laws enacted during the colonial period took away the rights and privileges people used to enjoy over water sources and vested control over (surface) water resources with the government. This continues to a great extent even now and the Karnataka Irrigation Act is not an exception in this regard. At a general level, it represents a classic manifestation of the power of eminent domain where all surface water sources are under State control and the power of the State in this regard is subject to hardly any restriction, except the limited right of individuals to claim compensation.

### **8.2.1 Karnataka Irrigation Act, 1957— Key Features and limitations**

Broadly the objective of this Act is to facilitate state control over surface water resources in the State. The power to decide how and to what extent the surface water resources in the State are to be used vests with the state government. Some of the key features are:

- a) State control—Construction, control and maintenance of irrigation are by the government, more precisely the irrigation department. This includes the power to decide the period of supply, quantity of supply and areas to be supplied.
- b) Grants power to the state government to control groundwater use but for a limited purpose, that is to protect the irrigation system.
- c) A purpose of the Act is to empower the irrigation department to take all measures necessary for construction and maintenance of the irrigation system (e.g. access to lands, land acquisition etc.). This power also includes restriction of land rights in



command area, for instance prior permission of Irrigation Officer is required to sell or transfer any land where an irrigation project has been commenced to irrigate such land.

- d) Irrigation officer has the power to determine the crop to be cultivated.
- e) Prohibits fishing or plying of vessels in irrigation structures without permission from the Irrigation Department.

While the Act talks about the power of the State, reference to individual users is mainly in a language coated with duties, for instance the duty of users to maintain field channels.

### **8.2.2 The Karnataka Command Areas Development Act, 1980**

This Act seeks to facilitate comprehensive and systematic development of the areas in which land is benefitted by irrigation projects. This mainly includes the power to borrow money from external agencies and functions related to land improvement, crop regulation and groundwater regulation.

### **8.2.3 The 2002 PIM amendment to the Irrigation Act**

The Karnataka Irrigation Act, 1965 was amended in 2000 to enable Participatory Irrigation Management (PIM) by creating Water User Associations what would take over works that the irrigation department has been doing in the command areas. Major functions of Water User Associations are:

- Development of irrigation facilities at the farm level;
- Distribution of water at the farm level;
- Operation and maintenance of irrigation systems at that level;
- Collection of water charges from farmers;
- Preparation of water budget; and
- Resolving of irrigation-related disputes between farmers.

### **8.2.4 Key limitations**

The legal framework for (major) surface irrigation in Karnataka has evolved to an extent in keeping with the times, but not enough. The Karnataka Irrigation Act, 1965 still essentially follows the command and control approach and a reflection of the principle of eminent domain or state control. The CADA act created a new arm specifically for managing the command areas of major/medium irrigation projects, but again was top-down. The addition of PIM provisions, however, has complicated matters in terms of who will play what role in surface irrigation. The main lacunae are as follows<sup>76</sup>:

- The Nigams that were set up for facilitating the channelling of funds (such as World Bank funds for executing the Upper Krishna Project, which required setting up of Krishna Bhagya Jala Nigam Ltd). The same is true for most of the other Nigams. The structure of these Nigams is that of wholly owned state enterprises. The idea was that these companies would be like bulk producers of water (like a power generation

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<sup>76</sup> We focus here on major and medium surface irrigation only and discuss minor irrigation in the next section.

company). If so, the Nigams need much more autonomy from the state than given at present. At the same time, since the state has effectively transferred surface water rights for those rivers/dams to these companies, the state must ensure a better representation of citizens from those basins on the Boards of these companies.

- At the same time, they do the work of distribution to a significant extent, which involves a lot of public interface, but without statutory guidelines. The Irrigation Consultative Committees for each major command (Nigam) are set up by government order under the Water Resources Department. Instead, they need to be completely restructured to ensure that they are basically the interface between the WUA Federation (as distributor) and the NNL (as bulk supplier) and must be given statutory status, as part of a full-fledged PIM Act.
- The adoption of PIM through the 2002 amendment marks a significant deviation from the basic premise and approach of the Act. It takes away a number of key powers and functions of the irrigation department under the Irrigation Act and entrusts such powers and functions with Water User Associations. Nevertheless, the PIM Amendment to the Irrigation Act is quite inadequate and legally weak and confusing. There are two versions of WUAs: those registered under the Societies Act and those to be registered under the Cooperative Societies Act. The WUAs' financial powers are also quite inadequate: they collect water charges on behalf of the state and then have to wait for an eternity to get a share back from the treasury. The Amendment also created Water Users Federations at the distributary and command area level, without spelling out their structure, process for election or powers. It also created a state-level Apex Federation which is both pointless (because each command area has its own ways of managing water) and non-autonomous (because the Ministers of Major and Minor Irrigation control it).
- The CADA Act overlaps almost completely with the PIM Amendment to the Irrigation Act.
- Another problem with the Act is that it does not address groundwater in the command area. This is inappropriate in a context where groundwater is increasingly an important source of irrigation, even in command areas of surface irrigation projects, as farmers tap water seeping from the canals and try to evade their duties or water charges as surface irrigators.

### **8.2.5 Recommendations for Reforms**

- A separate PIM Act is required, which will give statutory status to WUAs in the command areas of major and medium irrigation projects. All adult citizens of villages in the command area must by definition be members of the WUA (even landless citizens), thereby ensuring more democratic and equitable ownership of water coming into their village. The WUAs will have jurisdiction over surface water as well as power to regulate the use of groundwater (which is used conjunctively in command areas). WUAs will have powers to collect water charges upfront and remit the NNL's share to the NNL. The WUA will be the implementing agency for all land and water related activities or programmes in its jurisdiction, and will also have to task of provisioning for domestic water use. (See details in chapters 3 and 7 also.)
- The Act will also give statutory recognition to the Federation of WUAs at the command area level. The Federations will be constituted bottom-up, and will not have any state officials on their governing bodies. They will have statutory status to receive and manage funds and powers to appoint staff. Their function will be to maintain common structures at the distributary and higher levels, and to represent the farmers in the

negotiations with the NNL. The forum for this negotiation will be a Consultative Committee that will be given statutory status, replacing the Irrigation Consultative Committees. This committee will not have any representation from state-level elected officials.

- The CADA Act will be repealed and its functions transferred to the WUA and the WUA Federation. Corresponding powers to receive funds will be given to the latter bodies.
- The water allocations to the command area (and any reductions due to inter-sectoral transfers) will be regulated by a Water Resources Regulatory System (WRRS) tier at the basin level (see section 8.6 below).
- The regulatory role in inter-sectoral transfers currently played by the WRDO and the Water Permissions Committee (again created by executive order) will be transferred to the appropriate tier of the WRRS (see section 8.6 below).

### **8.3 Minor Irrigation and Urban Lakes**

The Minor Irrigation Department was constituted to manage the smaller (mostly traditional) irrigation tanks in the state, of which there were originally about 25,000. There is, however, no separate Minor Irrigation Act as such, and the state government uses various mechanisms, including the registration of the Jala Samvardhana Yojana Samsthe (JSYS) as a Society to receive funds from the World Bank for the Tank Rejuvenation programme implemented during 2002-2012. The PIM Amendment to the Irrigation Act sought to give WUA status to tank command farmer groups created under the JSYS programme, but it is unclear whether this has actually happened. In 2014, the state passed the Karnataka Tank Conservation and Development Authority (KTCDA) Act but did not notify its Rules till 2017. The structure of the KTCDA is co-terminus with the MID and there is no clear separation of roles or powers and responsibilities between them.

For lakes, as mentioned in the chapter on urban water (chapter 5), a government-owned NGO similar to JSYS, called Lake Development Authority was formed for implementing lake improvement projects. The Karnataka High Court passed a judgement striking down the functioning of the LDA as a regulatory body or as the custodian of lakes, and the state was forced to pass a separate Karnataka Lake Conservation and Development Authority (KLCDA) act (also in 2014) and the KLCDA started functioning after Rules were notified in 2016. Here, the more autonomous structure of the KLCDA and the fact that custodianship of urban lakes had been transferred to various agencies other than MID (the municipality/ULB, authorities such as Bangalore Development Authority, or Karnataka Forest Department), there was clearer separation of roles, with KLCDA performing a regulatory function (technical approvals, encroachment prevention).

The repeal of the KLCDA Act in 2018 and the merger of urban and rural lakes/tanks under the jurisdiction of KTCDA has created enormous confusion about mandates, roles, etc. The KTCDA being wholly controlled by the MID, there are repeated news items about all urban lakes being transferred to the MID, even though the latter has no expertise in managing urban lakes for non-irrigation functions.

#### **8.3.1 Lacunae: role of state-level bodies**

It is not at all clear why a state-level urban lake or rural tank conservation and development authority is required. Under the spirit of the 74<sup>th</sup> amendment, urban lakes should be in the custody of and managed by ULBs. Under the spirit of the 73<sup>rd</sup> amendment and PIM, the

custodianship of minor irrigation tanks should be with the rural community consisting of multiple stakeholders (not just farmers) who use the tank water. The JSYS programme had piloted this idea through Tank User Groups, but the lack of statutory status and clarity of powers vis-à-vis the Gram Panchayats on the one hand and the MID on the other rendered them unsustainable in the long run. Learning from this experience and that of other decentralized resource governance efforts, it is clear that minor tank management must also vest statutorily with the citizens of the village served by the tank. The problem is that the MID and the state government are unable to visualize a world in which MID does not need to play a role in day-to-day tank management and some of its staff may have to be transferred to the village-level tank management bodies. In the case of rural tanks, as mentioned earlier in section 8.1), the complex link between watershed development in the catchment, groundwater management and tank management makes it even more essential that day-to-day operations and regulation happen at the village scale.

What then is the role for a state-level 'conservation and development' agency? State-level public goods such as biodiversity conservation, inter-tank and inter-lake regulation (because these water bodies all exist in cascades) and regulating the conversion of these water bodies to other functions and to prevent encroachments where conversion is not appropriate, and technical support in rejuvenation or management are some possible functions. Some of these functions (especially water allocation/hydrological regulation) may be played by the WRSS proposed below.

### **8.3.2 Recommendations for reform**

The KTCDA Act must be amended to create an authority that is:

- a) Substantially autonomous from the state departments, including MID, with an independent CEO and a governing body that has substantial representation from civil society, experts, ULBs, and Gram Sabhas that are managing tanks.
- b) Has separate wings for rural tanks and urban lakes
- c) Is given the role of only a regulator and facilitator with no authority for day-to-day management, with powers focused on tank conversion proposals and water diversion proposals, technical appraisal of tank rejuvenation proposals, conflict resolution between cascaded tanks/lakes (till the WRRS is set up), and technical support.

Custody and management rights of rural tanks will be with the local Gram Sabha and of urban tanks with the ULBs. These rights will include fishery rights, and rights to manage all water use. In the rural areas, tank management will be part of the integrated water management structure proposed in section 8.1.2 above.

## **8.4 *Domestic water supply and sewerage***

### **8.4.1 Urban water supply**

Urban water supply is governed mainly by two statutes— The Bangalore Water Supply and Sewerage Act, 1964 and Karnataka Urban Water Supply and Drainage Board Act, 1973. While the former is specific to the city of Bangalore, the latter is applicable to the rest of urban areas in the state.

Key features of the Bangalore Water Supply and Sewerage Act, 1964 are:





- a) It is applicable to water for domestic and non-domestic purposes and sewerage.
- b) Empowers the Board to take care of provisioning and regulation of water supply and sewerage.
- c) Duty of the Board includes provisioning of water supply; improving the existing supply of water; making adequate provision for the sewerage and the disposal of the sewage. However,
  - i. Duty of the Board is subject to several 'conditions'; and
  - ii. Duty of the board is subject to indeterminate terms on quality and quantity which may create problems when citizens want to enforce it.
- d) Quantity and quality indicators mentioned in the Act are 'adequate' & 'wholesomeness' respectively.

The Karnataka Urban Water Supply and Drainage Board Act, 1973 creates a Board in order to:

- a) Provide financial assistance by way of loans and advances to the local authority;
- b) Carry out functions such as planning and execution of schemes at the expense of the local authority, run water supply and sewerage undertakings including for an area that cover more than one local authority, levy and collection of water rates;
- c) Plan and execute a scheme even when a local authority refuses; and
- d) Approve, prepare or execute any scheme.

### **8.4.2 Rural water supply**

Rural water supply is governed mainly by the Karnataka Panchayat Raj Act, 1993. This Act makes construction and maintenance of water supply one of the mandatory functions of Gram Panchayats. It also follows the same approach insofar as quantity and quality norms are concerned as the GPs are governed only in indeterminate terms—'pure and sufficient'. This Act is enabling or empowering in nature when it comes to the power of the GPs to direct individuals, for instance, the power to direct individuals to abate nuisance.

This Act also envisages Village Water Supply & Sanitation Committee (VWSC) as a local level institutional mechanism for water supply and sanitation (s 61A). In addition to PRIs, the Government of Karnataka has set up Karnataka Rural Water Supply & Sanitation Agency (KRWSSA) at the state level and the district level for planning, construction and operation of rural water supply and sanitation facilities. [The KRWSSA was not established under any Act; it was registered as a Society under the Societies Act. This gave it a certain non-governmental status. It has now been dissolved/merged with the Rural Development and Panchayath Raj department.].

### **8.4.3 Lacunae and reforms required**

1. A basic recognition of the human right to domestic water ("Water for Life") as repeatedly recognized by the Supreme Court needs to become part of the legal framework. This can be achieved through the adoption of the Water Framework Bill as mentioned above.



2. There are no specific and mandatory rules to ensure quality of drinking water. The only guidance on quality is an indeterminate term—‘wholesomeness’. The existing drinking water quality norms under BIS standards and CPCB guidelines should be made mandatory for service providers in rural and urban areas. This is best achieved through amendments to the Karnataka Water Rules, where it will then apply to apply water providers. However, care has to be taken not to impose this standard on all domestic water supply, as this will involve excessive costs (drinking water being a small component of domestic water use). It should be made applicable only to drinking water kiosks and other such facilities, including of course sellers of bottled water.
3. Similarly, there is no guidance on quantity norms except the term ‘adequate’. Quantity norms are specified in more detail in the Urban Water Supply and Sanitation Policy 2003. But it is not legally binding. Specifying quantitative norms as part of a Water Framework Law, at least as aspirational goals, will address this lacuna. Universal coverage for domestic water supply or access also should be explicitly incorporated into the framework law.
4. The urban and rural domestic water supply laws need to be amended to include specific rights for individual users and specific duties for service providers and some mechanism to enforce people’s rights. In other words, the enabling and empowering nature of these laws needs to be replaced with rights and duties.
5. There is also no clarity on who owns the wastewater from domestic use. As the examples in Chapter 5. show, wastewater is increasingly sought after and its value will only rise in the future. The urban and rural water supply laws need to be amended to clarify that the agency or individual (in the case of decentralised wastewater treatment) who treats the wastewater is the ‘owner’ of the treated wastewater, but they must respect any customary use rights of that may have developed by downstream use before they take decisions to divert the treated water to other uses or users.
6. In the case of the KUWSDB Act and Rules, the three-tier structure of a Chairman, a Managing Director and a Chief Engineer should be replaced with a 2-tier structure (removing IAS officer control) and the Board restructured to have more presence of civil society groups and experts. It will have fixed term independent chairperson and only 3 ex-officio members. Its Chairperson and CEO will be selected through open well-defined selection processes.
7. In the case of the BWWSB Act, amendments are required to make the BWSSB’s governing body more representative of the citizens it serves and inclusive of multi-disciplinary independent experts. (See chapter 7.) Rules need to be amended to make the BWSSB’s functioning more transparent and consultative, and to interface with ward-level committees. Its Chairperson and CEO will be fixed-term independent appointments, through open and well-defined selection processes.

### **8.5 Water Quality and Pollution Regulation**

While there is no explicit framework for water quality supplied (see previous section), the legal framework for pollution regulation is the central Water (Prevention and Control of Pollution) Act 1974 and Rules thereunder. The Water Act constituted the KSPCB (which regulates both water and air, and now other forms of pollution as well), whose functioning is governed by the Karnataka Water Rules of 1976. Virtually all water pollution regulation happens under this framework, which is now integrated under the Environmental Pollution Act 1986 and its Rules.

### 8.5.1 Lacunae

As pointed out in Chapter 6, there are many lacunae in the legal framework and overall governance structure for regulating the quality of water and the disposal of effluents. The lacunae are at several levels:

1. Inattention to industrial contaminants in setting standards: The so-called Water Quality Criteria outlined by the CPCB do not contain many of the contaminants that now routinely occur in surface and groundwater, especially industrial contaminants like heavy metals (see Table 10). Even the standards for effluent discharge are faulty, as they do not specify heavy metal concentrations if the effluent is discharged on to land (see Table 11).
2. No Ambient Water Quality goals: The WQCs of Table 1 are neither legally notified nor are they used as benchmarks against which to measure enforcement success. They are simply used to indicate which water body is suitable for what. What is required therefore is a public process by which each surface and groundwater body is assessed in terms of what use it is meant for (designated best use) and therefore what the water quality goal for that water body should be. Enforcement should then work backwards from that goal. This would also mean that agencies providing water for particular uses (drinking, bathing or irrigation) will have to statutorily adhere to those standards.
3. While the responsibility to not release excessive industrial pollutants is laid explicitly on industries, there is no parallel responsibility any agency to ensure that untreated domestic sewage is not released into water bodies. Subsequently, courts have passed several judgements placing this responsibility on the ULBs or para-statals created for sewerage management. But this is not followed in practice: ULBs and para-statals are not legally answerable to the KSPCB for preventing sewage-based pollution.
4. As discussed in detail in Chapter 6, the governance structure of the KSPCB leaves much to be desired. The practice in Karnataka of appointing an independent Chairperson for KSPCB has been a generally healthy one, but needs strengthening in terms of the selection process. The Member-Secretaries have always come on deputation, rendering the post weak and less accountable to the Governing Body. And the governing body has no representation of potentially affected persons (pollutees) and very few independent experts. Changing the governing structure will require creative use of the central Water Rules (now notified as Rules under the EPA) and amendments to the Karnataka Water Rules. The presence of the chair of BWSSB on KSPCB's governing body also creates a conflict of interest as BWSSB is primarily a potential polluter (if its STPs are inadequate or do not function).

**Table 10. Criteria for determining whether water quality is adequate for particular uses (by CPB: not legally notified) [from 1]**

Source	Use for	Physical parameters	Chemical parameters	Biological parameters	Heavy metals	Details
Surface water	Raw water source - chlorination	No	Yes (3)	Yes (1)	No	Criteria set for four parameters i.e. pH (6.5-8.5), BOD5 ( $\leq 2$ mg/l), Dissolved Oxygen (DO) ( $\geq 6$ mg/l) and total coliforms (TC) ( $\leq 50$ MPN/100 ml).
	Recreation (organized bathing)	No	Yes (3)	Yes (1)	No	Criteria set for four parameters i.e. pH (6.5-8.5), BOD5 ( $\leq 3$ mg/l), Dissolved Oxygen (DO) ( $\geq 5$ mg/l) and total coliforms TC $\leq 500$ MPN/100 ml).
	Drinking water source – conventional treatment	No	Yes (3)	Yes (1)	No	Criteria set for four parameters i.e. pH (6-9), BOD5 ( $\leq 3$ mg/l), Dissolved Oxygen (DO) ( $\geq 4$ mg/l) and TC ( $\leq 5000$ MPN/100 ml).
	Fisheries	No	Yes (3)	No	No	Criteria set for three parameters i.e. pH (6.5-8.5), DO ( $\geq 4$ mg/l) and Free ammonia as N ( $\leq 1.2$ mg/l).
	Irrigation /controlled disposal	No	Yes (4)	No	No	Criteria set for three parameters i.e. pH (6.0 to 8.5) Electrical Conductivity at 25°C ( $\leq 2250$ $\mu$ mhos/cm) Sodium absorption Ratio (SAR $\leq 26$ ), Boron ( $\leq 2$ mg/l)

**Table 11. Effluent discharge standards notified under the Environment Protection Rules 1986 [from 1]**

Discharge of	Discharge to	Details				
		Physical parameters	Chemical parameters	Biological parameters	Heavy metals	
Treated effluent	Surface water body	Yes (4)	Yes (17)	No	Yes (14)	Standards set for <b>40</b> parameters which includes standards for TSS ( $\leq 100$ mg/l), BOD5 ( $\leq 30$ mg/l), COD ( $\leq 250$ mg/l), residual chlorine ( $\geq 1$ mg/l) and trace metals (As, Hg, Pb, Cd, Cr6+, Cr, Cu, CN, Se, Ni, Mn, Fe and V)
	Public sewers	Yes (2)	Yes (7)	No	Yes (14)	Standards set for <b>23</b> parameters which includes standards for TSS ( $\leq 600$ mg/l), BOD5 ( $\leq 350$ mg/l) and trace metals (As, Hg, Pb, Cd, Cr6+, Cr, Cu, CN, Se, Ni, Mn, Fe and V)
	Coastal water	Yes (4)	Yes (16)	No	Yes (14)	Standards set for <b>34</b> parameters which includes standards for TSS ( $\leq 100$ mg/l), BOD5 ( $\leq 30$ mg/l), COD ( $\leq 250$ mg/l), residual chlorine (1 mg/l) and trace metals (As, Hg, Pb, Cd, Cr6+, Cr, Cu, CN, Se, Ni, Mn, Fe and V)
	Land application –irrigation	Yes (3)	Yes (5)	No	Yes (2)	Standards set for <b>10</b> parameters which includes standards for TSS ( $\leq 600$ mg/l), BOD5 ( $\leq 350$ mg/l) and trace metals (As and CN)

**8.5.2 Recommendations for Reforms**

The Water Act is a central Act, but it empowers state pollution control boards to notify more stringent or additional standards and take other actions required for pollution prevention and regulation. The recommendations here are therefore a combination of exercising this latitude and urging long-term amendments by the Centre.

- Notify ambient water quality standards suitable for each such desired best use. These standards will include thresholds for heavy metal and other industrial contaminants also.



- Notify a process by which the intended best use of each surface water body is arrived at through a participatory process, whereby the desired water quality of that water body is identified and it becomes incumbent on the KSPCB to take measures to meet those goals.
- Notifying additional standards for (treated) effluent discharge into water bodies and reuse in the form of treated wastewater for irrigation (permitting only for non-food crops) and for groundwater recharge, so as to include heavy metals and other industrial contaminants. Notify (under the EPA 1986 environmental clearance requirements for large-scale wastewater based irrigation or groundwater recharge projects. DPRs submitted for all such clearances will include multiple options for achieving similar outcomes, including demand-side management, leakage reduction, local supply augmentation, recycling, and so on. Public hearings will be a mandatory part of such clearances, and will be seen as a positive opportunity to seek public input.
- Amend Karnataka Water Rules to make the appointment process for Chairperson of KSPCB more credible, and a professional selection and long-term appointment of the Member-Secretary (effectively CEO) directly by the Governing Board.
- Urge the Centre to amend the Water Act in order to ensure better representation of the affected public and independent experts in the Governing Body, renaming Member-Secretary as CEO, and clear naming of Governing Body. Till such amendment, creative use of the provisions of the Water Act will allow for significant shifts in the composition of the Governing Body.
- Request the Karnataka High Court to set up a green bench at the High Court and Trial Court levels to expedite pollution cases.

### **8.6 Needed: An overarching Water Regulatory System**

The analysis and recommendations in the previous sections respond to existing legislation and their lacunae. Perhaps the biggest lacuna is the absence of adequate legislation on the inter-sectoral, inter- and intra-basin, and upstream-downstream transfer, abstraction or diversion of water resources (including wastewater). The Irrigation Act, which is the oldest and most powerful legal instrument for managing the water resource was enacted at a time when irrigation was perhaps the only focus of water resource management, and water was seen as a seemingly unlimited resource that had to be somehow harnessed for people's use (primarily irrigation use). However, today other sectors such as domestic use and industrial use have become significant and at the same time, with the closure of the east-flowing river basins, there is a realization that water as a clearly limited resource that has to be allocated between these competing users as well as providing for environmental flows and downstream states.

The legal framework has, however, not kept up with this transition. There is no statutory mechanism for allocating water across sectors (such as from irrigation to urban use) or across upstream-downstream users within a river basin, or a sub-basin, or even a milli-watershed. This absence of legal principles, procedures and norms is leading to many types of water conflicts. The National Water Policy 2002 has mentioned certain priorities: drinking water as being topmost priority, followed by irrigation, hydro-power, ecology, industries and navigation. The State Water Policy does not explicitly mention this sequence, but the state has consistently given drinking water the highest priority. This is in accordance with the idea of 'water for life' being a 'fundamental human right'<sup>77</sup>. However, as mentioned in earlier chapters, the term 'drinking water' often cloaks what is actually 'urban' water use, including non-essential

<sup>77</sup> <http://www.unwater.org/water-facts/human-rights/>



domestic use and commercial-industrial-institutional use. Thus, there is a need for a better specification and balance between water for life and other water needs/uses, and a statutory mechanism for allocation between and across users.

### **8.6.1 Learning from water resource allocation/regulation elsewhere**

Following from the last point above, the possible mechanisms for water resource allocation and regulation and experience from across India need to be understood. Traditionally, government departments/ministries (such as irrigation department and water-related government institutions) were responsible for regulation of water resources. Thus, in Karnataka, as mentioned in the previous chapter, WRDO, a small wing within the Water Resources Department, is responsible for making recommendations as to how much water may be diverted from a river or a reservoir for urban/industrial use. There is no process of public hearing to get inputs as to the effects of the proposed reallocation. Moreover, this role is recommendatory, and final decisions are taken at a higher level in an opaque manner, with no clear criteria. And the bigger decisions about whether to build irrigation projects or to renovate existing dams or tanks or to divert wastewater appear to be only limited by inter-state tribunal awards, not by any intra-state considerations of upstream-downstream rights or environmental impact. Finally, groundwater pumping, being outside this framework, is undermining the hydrological basis for even these surface water allocations.

Thus, there is a clear need for some clearer and more systematic regulatory system that ensures key principles such as social equity, efficiency or cost-effectiveness and environmental sustainability in allocation and provisioning of water. Such a system is also needed to ensure that disputes arising out of water allocation are settled on the basis of established norms and principles rather than on the basis of social and economic power and bargaining capacity.

Currently, the manner in which this concept has been operationalized in some states of India is by setting up an 'independent water resource regulatory authority' at the state-level. This regulatory authority is vested with the power to make rules, implements these rules and settles disputes in respect of its sphere of regulation. The rationale for such an 'independent regulator' was freedom from political interference, to improve the credibility of regulation in order to facilitate private sector participation in the water sector, and to involve qualified persons given the technical nature of water regulation. The Andhra Pradesh Water Resources Development Corporation Act, 1997 is regarded as a pioneer in this regard. This institution, though technically separate from the government, continued to be controlled by the government. Subsequently, a number of states have enacted laws for the establishment of 'independent' water regulatory authorities (e.g., Maharashtra, Rajasthan and Uttar Pradesh).

The Maharashtra experience, which has received mixed reviews, nonetheless provides the best basis for learning about the strengths and weaknesses of the extant approach of 'independent state-level regulators'. On the positive side, the MWRRA has managed to function for about last one decade and it has provided a venue for stakeholders including people's movements and civil society organisations to raise their concerns related to water allocation and implementation of water projects. On the negative side, concerns have been raised on the Maharashtra Model being the starting point of making water a commodity (transferable water entitlements) and for people to lose their political bargaining power to an independent water regulator. The experience with the WRRRA approach has been a matter of much debate [89].

These pitfalls can be avoided by adopting the following approach:



1. Water regulation must be governed by a statute that lays down basic principles and procedure. This includes normative concerns (equity, sustainability, etc.) and also requirements for transparency and for public hearings in all major decisions.
2. The regulatory agency must not be a repository of all three forms of power: legislative, executive and judicial powers. For instance, it should not define entitlements, implement the entitlements, and also adjudicate between conflicting entitlements. One possibility is to make the state-level regulator the allocator of initial entitlements, and then have river-basin level regulators who implement and adjust the entitlements as time goes on.
3. It may be made simple by vesting certain key functions such as inter- and intra-sectoral allocation, pricing and approval of water resource development projects designed by different agencies.
4. A single state-level regulatory (like the Maharashtra model) is inappropriate because it can only do bulk water allocation. Therefore, the institutional design need to follow the principle of subsidiarity wherein regulatory agencies are present at different levels to regulate micro level aspects such as allocation within basins and further down allocations amongst farmers within a village or citizens within a town.
5. The institutional mechanisms for provisioning of water through ULBs and Gram Panchayats, and through the Neeravari Nigams to the WUAs can continue. Basin-level regulators will act as a forum for settlement of disputes. For regulating groundwater in an integrated manner with surface water, the institutional mechanisms proposed in the Model Groundwater Bill, 2016 need to be modified and adapted to fit within the overall regulatory framework.

### **8.6.2 Recommendation**

The state should legislate a multi-level (state- and basin-scale) Water Resources Regulatory Authority System (WRRAS). The WRRAS will have state- and basin-level benches, with each bench being multi-disciplinary, will allocate water use rights across scales and sectors, and create the framework within which Gram Panchayats and ULBs will have to devise their water security plans and regulate water use in a fair and sustainable manner. The Irrigation Act will be superseded by this WRRAS Act, which will also cover wastewater allocation.

The smaller building blocks of this system, viz., the PIM and Integrated Groundwater Management institutions, as well as ward-level urban water management institutions, at the local level have already been spelt out. The major elements that need detailing are the sub-basin, basin- and state-level tiers of this regulatory authority. That will require careful consideration of the strengths and weaknesses of WRRAs in other states and clear separation of powers to define entitlements, powers to implement entitlements and powers to adjudicate disputes over entitlements—an exercise much larger in scope than that of this TGWP.

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In summary, the state will move towards a more normative, integrated, multi-scale, transparent and participatory governance framework and will carry out legal reforms listed above that are necessary to complement and support the organizational reforms spelt out in Chapter 7.



## CHAPTER 9. SYSTEMS FOR DATA, INFORMATION, AND KNOWLEDGE GENERATION<sup>78</sup>

The proper management of water requires information on what is happening to the availability of the resource, as well as how far the resource is reaching the users and being used and impacted by uses and users in turn. This requires collecting data, converting it into information and eventually into knowledge that is relevant for various stakeholders. For instance, Gram Panchayats may need to know whether they are supplying adequate water to all the households in their jurisdiction and how long their supplies might last. Dam operators may need to know how much inflow is being received from the catchment into the dam, whether it is changing over time and why. Farmers may need to know when to expect the next round of irrigation water from their canal. The state government may need to know whether groundwater stocks in different aquifers are declining, or whether the flows in an interstate river meet downstream commitments, and so on. The citizens of the state would of course be interested in all these matters.

Data may be collected for different parameters at various spatial and temporal scales: e.g., water levels in bore wells, level of water stored in dams, daily rainfall, or daily flows in different streams and rivers. Moreover, these data have to be analysed in order to generate information that is useful for management—e.g., extent of groundwater recharge, consumption by different users, likely return flows or fraction of population served. And this analysis must become available in a timely and user-friendly manner with a high degree of reliability to multiple actors: resource managers, water service providers, water users, regulators, and the general public.

Finally, we need to constantly convert this information into knowledge of the socio-hydrological system, i.e. an understanding of the cause-and-effect relationships. This is particularly important and challenging because both the biophysical and social dimensions of water are far from fully measurable or fully understood and they are dynamic in nature—e.g., because of climate change or because of economic development—and because investments in water governance tend to be of a long-term nature

In this chapter, we assess the current status and limitations in these spheres, and make recommendations for strengthening their quality, reliability and usefulness, keeping in mind the needs of the revised paradigm, approaches and institutional framework suggested in previous chapters. In particular, the need for integrated, multi-user oriented, highly decentralized, and transparent water governance inform our recommendations.

### 9.1 *Current Status and Limitations*

We briefly assess the current status of data collection, analysis and research support in the state using criteria of adequacy, quality and (most important) accessibility of data across agencies, water users and the general public.

#### 9.1.1 Data collection/monitoring

Currently, the state of Karnataka has invested significantly in data collection on some dimensions of the water sectors and less so in others.

- **Rainfall** is the source of all replenishable water flow. It is monitored by network of 1392 daily rain gauge stations set up over many decades and managed by WRDO. This averages to about 8 rain gauges per taluka. In addition, a much denser network of

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<sup>78</sup> This chapter is based upon the report of Sub-Group 9 on Data Management, led by Dr. Mukund Rao.

6,400+ Gram Panchayat-wise telemetric rain gauges has been set up and is managed by the Karnataka State Natural Disaster Monitoring Centre (KSNDMC) since 2010. The Indian Meteorological Department (IMD) manages a separate set of about 310 rain gauge stations ( including 97 automatic rain gauge stations)

- **Other weather parameters** (temperature, wind speed) are relevant to understanding evapotranspiration and crop water demand. Temperature monitoring has been happening in the long-term at a few (7) weather stations maintained by WRDO, and also at least 26 automatic weather stations of IMD. KSNDMC also gathers weather data telemetrically from 747 weather stations around the state.

Thus, it appears that there is fairly adequate monitoring of rainfall and other weather parameters in the state. A subset of these stations are IMD-certified. The biggest lacuna here is **poor data access** and **data sharing**. KSNMDC data are available real-time, but full-fledged public access to archived data is blocked by official state policy of charging for KSNDMC datasets. WRDO's data are only available at the end of a year, and even that only after being ratified by the Directorate of Economics and Statistics, and are generally made available only in printed form, even though the National Hydrology Project has invested several hundred crores of rupees in their data centre and data digitisation. IMD data are also not available unless paid for, with only simplified gridded datasets being in the public domain. Further, in the absence of hydrologically relevant analysis of these datasets (such as basin wise rainfall estimates), both water managers and users often cannot make use of these data in their decision making.

- **Surface flows in streams and rivers** are monitored in two ways. Direct measurements of flow happen daily at 40 stream gauging stations operated by WRDO and another 40 operated by the Central Water Commission. Some of the WRDO stations have now been automated and more are slated for automation soon. Flows are also estimated indirectly from daily data on changes in reservoir levels (coupled with data/assumptions on evaporation, releases, seepage losses and reservoir level-storage relationships). The reservoir level data are available for 13 major reservoirs and ~40 medium reservoirs. In addition, the Minor Irrigation Department is supposed to monitor the levels in thousands of MI tanks in the state, but it is not clear how many are still being monitored, and the MI data are only available at local offices. Given the large number of rivers and streams in the state, this level of monitoring is grossly inadequate. Moreover, data on flows in rivers that are part of inter-state sharing are kept secret, when in fact transparent data sharing can reduce infructuous debate. Increasingly, urban use is generating significant 'return flows' to rivers (although in polluted form), but there is no gauging being done at these locations.
- **Groundwater storage/status:** Groundwater, which is being tapped by at least 9 lakh borewells and 4 lakh open wells in the state, is being monitored at ~1000 locations, which amounts to an average density of 1 observation well in 200sqkm. Given that groundwater extraction is happening in a highly decentralised manner from wells on small farms and individual urban households, the granularity of data is grossly inadequate. Moreover, given the complex and heterogeneous nature of the aquifers in Karnataka and the preponderance of hard rock aquifers, the measurement of a single 'level' of groundwater in observation borewells in particular provides very limited information. There is little information available on aquifer boundaries at the local level. The CGWB has conducted a pilot programme on aquifer mapping for Tumkur District, and is said to be completing the mapping for the rest of the state. Hence, there is little in terms of data that can provide effective decision support to a variety of users in the state.

- **Water release, extraction and provisioning data:** Water is released to farmers through canals from irrigation tanks and reservoirs, pumped to cities and industries via pipelines, lifted by farmers from rivers and reservoirs and (most significant of all) pumped from groundwater aquifers by all manner of users. While some data (with limited reliability) on releases are available, disaggregated data on what actually reaches the farm or the urban end-user are not available (except in a few cities where metering is fairly widespread). For instance, in most ULBs only average litres supplied per capita are estimated (without factoring in leakages and other losses), and there is no information on what fraction of the citizens get what level of service. The biggest gap is of course in data on groundwater pumping, which is completely unmonitored. The Minor Irrigation Census conducted by the central Ministry of Water Resources provides information on presence of different irrigation structures (open wells, borewells, etc.) but this information comes about 10 years late, and is not easily available at the fine (village) level.
- **Evapotranspiration** by natural and agri-horticultural vegetation: The biggest consumer of water is vegetation, both natural (forests or grasslands) and planted (crops or gardens), and ultimately what matters is not the water released to a user but its consumptive use. The amount consumed varies by vegetation/crop type and irrigation intensity. Direct measurements of evapotranspiration (using flux towers) are difficult and expensive, but currently the state is investing nothing at all in these measurements: a handful of flux towers funded by the central government have been set up in recent times.
- **Landuse:** Indirect estimation of evapotranspiration would require accurate data on landuse, cropping pattern and irrigation practices. Currently, data on cropping pattern and irrigated area data are collected by Directorate of Economics & Statistics at the village level, but are not reliable and not available on a village-wise basis. Remote sensing of landuse is currently carried out by Karnataka State Remote Sensing Application Centre (KSRSAC). But the adequacy of its resolution and its accuracy are not peer reviewed, nor are the maps available in the public domain.
- **Water quality:** As mentioned in chapter 4, drinking water quality is monitored periodically in villages (under the National Rural Drinking Water Programme) and towns (although the density and frequency of monitoring in towns is unclear). Pollution, however, is only monitored at the point of release (if at all), while ambient quality of surface and ground water is not systematically monitored except for a few river stretches. Moreover, the absence of 24-hour monitoring protocols makes it easy for polluters to evade detection.
- **Aquatic ecosystems:** There is no systematic monitoring of the status of aquatic biodiversity in streams, rivers, lakes/reservoirs or estuaries.

As can be seen, data on water availability and use, especially consumptive use in the form of evapotranspiration and use of groundwater, are highly inadequate, of mixed reliability, at poor granularity in comparison with the scale and complexity of water flow and use. None of this data is available real-time, and also largely unavailable in the public domain.

### 9.1.2 Information for decision-making

How are the available data being compiled, analysed and disseminated to provide information and insights into information that resource users, regulators, water managers or policy-makers can use to make decisions? What are the limitations, especially given the new directions

proposed? We provide a brief overview below, starting with the resource side and then moving to utilization.

### Water resource status

- Given that the state only manages surface water resources, the focus of interpretation of data collected has been on issues such as dam management (e.g., given inflows and current storage, and given demands in the command area, how much should be released), and on availability of water at particular locations for new dam projects. In the latter case, the analysis role played originally by WRDO appears to have dwindled and is increasingly taken over by consultants, thus reducing in-house capacity.
- Groundwater level data are analysed by GWD using methodologies prescribed by CGWB to identify talukas that are safe, semi-critical, critical and over-exploited, and the estimated 'net groundwater availability for future irrigation development' is also reported. Analysed data-sets, apart from the periodic groundwater assessment, are not available readily for decision making.
- In theory, all borewells drillers are supposed to maintain 'litho-logs' in which detailed information on the geology (type and depth of different hydrogeological zones, depth of fractures encountered, yield of the borewell, etc.) are to be entered and copies of these are to be given to the GWD. In reality, however, almost none of this information is being supplied by the drillers or being compiled in any usable manner.

Some of the key limitations are as follows:

- No information is being generated on whether rainfall-runoff relationships are changing over time (either due to climate change or due to change in catchment characteristics or water use practices in the catchments). So the impacts of upstream watershed development on downstream reservoirs continues to be a bone of contention between the Watershed Development Department and the Minor Irrigation department.
- The methodology of estimating 'groundwater availability' is coarse, unreliable especially in hard rock aquifers, but most important conceptually flawed as it ignores the changes in aquifer storage even in the gross estimation of the ratio between extraction and recharge. More significantly, it ignores the links between groundwater and surface water. Therefore, the impact of groundwater pumping on surface flows (baseflow) decline is not understood at all.
- New techniques for directly estimating extent of groundwater over-exploitation, i.e., utilisation of non-replenishable (historical) groundwater using (e.g.) oxygen isotope fractions have not been deployed so far.
- The biggest gap therefore is the absence of integrated (surface+ground) water balance for individual basins and sub-basins, that will indicate how water is being utilized within the sub-basin, for what and by whom, and what is the net effect on downstream regions or instream uses.

### Water use and impacts

In the case of water use, the focus of state agencies is often on revenue targets (water charges collection) or costs (pumping costs for city supply) and so there is little systematic analysis of even available data (and therefore pressure to generate additional/new data). In particular, the absence of performance monitoring of agencies based on service quality benchmarks means that there is limited analysis of actual water service delivery and (for instance) the

extent of tail-end deprivation or cropping pattern violation in command areas of surface irrigation projects or similar aspects of domestic water supply.<sup>79</sup>

### Compilation and dissemination

Currently, various pieces of the above water-related data are being compiled and made available in various ways:

- The KSNDMC has a webGIS platform that is viewable (<http://www.ksndmc.org/KsndmcGis/KSNDMCMMap.aspx>), but all data are not publicly downloadable nor automatically shared with other government agencies
- The WRDO has a Data Centre and a Geomatics unit, but none of the datasets are publicly accessible or even viewable.
- The Karnataka GIS (K-GIS) platform currently provides many other datasets (landuse, geomorphology, lithology, agro-climate as well as administrative boundaries) in a publicly viewable (not downloadable) form with some online analytical tools as well (<http://164.100.133.211/kgis/Base.aspx>).
- ACIWRM is in the process of establishing a K-Water Resources Information System (K-WRIS) with support from the Asian Development Bank (<http://www.aciwrn.org/service/karnataka-water-resources-information-systemkwris/>). When completed, this is supposed to “comprise a spatial system bringing together quantity-quality-condition aspects of surface water, groundwater and water dependent ecosystem” and thereby enable “different departments to communicate, exchange data, and use the information that has been exchanged for intra and inter departmental use in planning, implementing, monitoring and evaluating different schemes and programmes”. The extent of public accessibility of the data is unclear.

The biggest challenge to decentralised decision on water in the state of Karnataka is the lack of granularity, transparency and easy access to data. Even when available, data is simply not of the desired frequency, density, and reliability for it to be effective in decision making at different levels. Such limitations allow “ad-hocism” to creep into decision making on water management and governance. This will become a serious barrier as the state attempts to move towards better regulated, more science-based, efficient, transparent and participatory forms of water governance.

Overall, we see that the combination of inadequate data gathering, fragmented data compilation and reluctance to share data across departments and with the public, coupled with the lack of agencies with a clear mandate to generate and analyse data in this manner is one of the major lacuna in the current set up.

### **9.1.3 Long-term knowledge-generation**

The state has supported knowledge generation on several topics indirectly or partially related to the water sector. Some of the investments are indirect. For instance, the Watershed Development programmes, funded in recent years by the World Bank, have made significant allocations for Monitoring & Evaluation of their effectiveness. The state is also investing funds in agricultural research through its agriculture universities on dryland cropping or water-

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<sup>79</sup> This is not to say there is no knowledge about this. Clearly, frontline officials have their observations. But there is no systematic, comprehensive and quantitative information available in the public domain.

efficient rice cultivation practices. The Environmental Management Policy and Research Institute (EMPRI) has conducted research on lakes.

However, the state does not appear to have a systematic approach to investing in long-term knowledge generation in the core areas of the water sector, such as surface irrigation water use, groundwater use, and urban water management. There is no institutionalised research centre in the UAS system on Agricultural Water Use. The WRD (major irrigation) does not have an R&D wing of its own, nor a long-term programme to fund water-related research by other organizations. Given that state's budget for the water resources sector in 2017-18 was Rs 2015 crores of revenue expenditure and Rs 12,417 crores of capital expenditure, even a 1% outlay on research would amount to Rs140 crores. The state also has support from the ADB and potentially from the ABHY (Atal Bhujal Yojana) that can be utilized towards supporting research in the short run.

## **9.2 Data and analysis needs for 21<sup>st</sup> Century Water Governance**

The previous chapters have outlined a different paradigm for water governance in Karnataka. This paradigm will also require data, analysis and knowledge generation to go beyond conventional approaches. If water is to be managed and governed with an eye towards equitable distribution, sustainable use and democratic governance, and this requires a multi-layered governance system that builds from the Gram Panchayat level upwards to sub-basin and basin scales, then the data-analysis-knowledge systems must be tuned to this paradigm.

The data needs of such a paradigm are vast, especially since it seeks to bring groundwater within the ambit of water governance. Moreover, if the process of multi-tiered governance is one of building up from the bottom, this means that citizens at a highly decentralised scale (such as Gram Panchayats or ULB wards) will have to get involved in water governance and will therefore need this information at that scale. This will require a judicious combination of the latest high quality (but increasingly low-cost) instrumentation and data management coupled with 'barefoot hydrology and hydrogeology' wherein users are involved in data gathering and analysis so that they can relate to and trust the decisions being made about their water resources.

## **9.3 Recommendations**

The state must build a comprehensive, coherent and open water data and information system supported by rigorous knowledge generation. To achieve this, the state will launch a **Jal Jnana-Vijnana Mission** that will invest substantially in strategies along four dimensions:

- a) expanding granularity and scope of water data gathering, increasing comprehensiveness and reliability, and making data fully publicly accessible in near real-time, coherent, reliable and open access water data compilation system,
- b) creating systems for timely, rigorous and useful analysis of this data for decision support,
- c) supporting the generation of rigorous knowledge generation for the long term, and
- d) building widespread public awareness and support for better water management.

### **9.3.1 Strengthening data gathering**

1. The network of stream gauges, reservoir level monitoring and observation wells will be expanded to a high level of granularity, viz., at least 1 observation well, stream gauge



and tank/reservoir level monitoring point per Gram Panchayat. The data gathering will be a 50-50 combination of automated and manual measurements, and made available in real-time (for automated sensors) and near-real-time (for manual measurements) an open-access GIS platform (see below). These will be complemented by data gathered through citizen science wherever possible. All data will be validated by independent researchers on a regular basis. Substantial additional staff with background in surface hydrology, groundwater hydrology and agro- and eco-hydrology will be recruited for this purpose at all levels (state, district and taluka), and provided training in IWRM.

2. Aquifer mapping at the village or Gram Panchayat scale will be taken up on a priority basis. This will adopt a participatory approach, integrating with the water security planning at village or Gram Panchayat level. At least 50% of the state will be covered in the next 3 years.
3. Creating updated stage-volume curves for all major, medium and minor irrigation tanks and urban water bodies using latest technology in bathymetry.
4. A major new initiative will be measurement and estimation of consumptive water use (especially evapotranspiration) by a) setting up a minimum of 25 ET measuring stations (using flux tower and other methods) located in irrigated agriculture, rainfed agriculture, forests, and other landscapes, and b) estimation of season-wise irrigated areas and cropping pattern at micro-watershed scales using remote sensing, drone-based mapping, and field measurements to build seasonal (and eventually monthly) estimates of consumptive water use.
5. The water quality monitoring network will be extended beyond current GP level monitoring of drinking water to monitor pollution in surface and groundwater as already indicated in section 8.2.
6. All data collected by all state agencies as well as central agencies (CWC, CGWB, IMD) will be made available in near-real-time in the public domain on an open-data GIS platform. This platform could be the Karnataka Water Resource Information System being prepared by ACIWRM or the Karnataka GIS system managed by KRSAC. It will meet high standards of integration, inter-operability, timeliness, openness and user-friendliness.<sup>80</sup>
7. Encourage R&D institutions and industries to develop and commercialise low-cost, indigenous flow meters that can be made available to private and public water users for measuring pumping rates as well as consumption rates.

### **9.3.2 Data analysis for decision support**

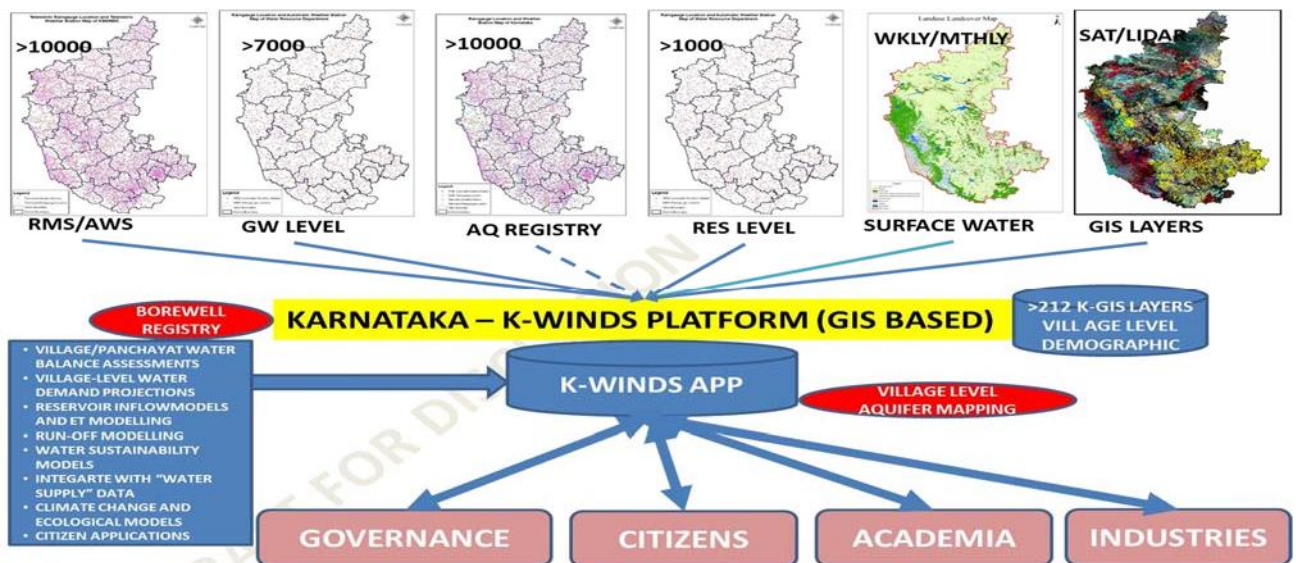
1. The conversion of data into usable information at multiple scales will be facilitated by a Karnataka Water Information Network and Decision-Support System (K-WINDS). Such a decision-support system would take data from the GIS water data platform mentioned above, and
  - a) Generate village-scale or micro-watershed scale water balances that can be compared with commitments made or allocations given by the River Basin-scale Regulatory Authorities.

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<sup>80</sup> The Andhra Pradesh government's APWRIMS (<http://www.apwrims.ap.gov.in>) provides a good starting template.

- b) Generate information on water service delivery again at a highly granular scale to help identify areas of shortfall and reasons for the same.
- c) Generate preliminary hydrological, environmental and social impact assessments for any new water transfer or dam project proposed in the state.
- d) Compile annual State Water Balance based on nested water balances at basin and sub-basin scale by integrating all dimensions of water availability and use.
- e) Encourage development of service providers who can provide Well Health services on the K-WINDS data.

The visualised architecture for K-WINDS is given below:



2. To enable the above data collection and analysis to be carried out in an integrated manner, a **Jala Vijnana Mission Directorate** will be created for next 5 years, with the following objectives:

- a) to collate across agencies and make available water resource related data at village/ward scales, and to generate an understanding of the inflow, use and outflow of water (i.e., a disaggregated water balance) in the sub-basins and at finer scales on a regular basis.
- b) To implement/coordinate all the additional data gathering activities mentioned above and carry out the additional analyses mentioned above.
- c) Make publicly available all these data on an open data GIS platform, for both viewing and downloading for analysis by all.
- d) This Mission will be headed by a professional and will be organized at basin, sub-basin and micro-watershed scale. It will be staffed at each scale by a multi-disciplinary team.





- e) Eventually, the Mission will coalesce with the WRDO and the GWD (the two lead agencies for water data monitoring) to form a single Karnataka State Water Data and Information Agency.
  - f) This Mission/Agency will be governed by an inter-ministerial council to ensure that it answers to the needs of, and gets cooperation, from all water-related ministries (Water Resources; Minor Irrigation; Forest, Ecology & Environment; Urban Development; Rural Development).
  - g) The council will include the representatives from the Basin-level Water Resource Regulatory Authorities as the major data users, from independent experts, and from civil society who can guide the socio-technical dimensions of data gathering and analysis.
  - h) A process of external peer review to ensure data quality and analytical rigour will be built into all activities.
3. Given the decentralised approach to water management and regulation proposed above, a cadre of 'barefoot hydrologists' at the Gram Panchayat and ULB Ward level will be built who will service the regulatory apparatus at those scales, beginning with the Gram Panchayat-scale Water Security Plans under the ABY programme, and then extending to the entire state. Partnerships with CSOs and educational organisations will be built to provide the necessary support, and these barefoot hydrologists will be involved in all aquifer mapping, monitoring and analysis activities. The team of barefoot hydrologists will have the capacity to generate data analysis for community-level decision support systems.

### **9.3.3 Supporting Long-term Knowledge Generation**

1. The state shall devote at least 1% of all (revenue + capital) annual expenditure in the water sector for supporting independent, high quality, multi-disciplinary socio-hydrological research on salient water issues in the state.
2. An independent Research Advisory Board will be formed by the Water Resources Department for screening and guiding such research, to ensure both quality and relevance of the research to the pressing water problems of the state.
3. The research will cover hydrological, hydro-meteorological, small and large-scale water supply technologies, irrigation technologies and water use in agriculture and other sectors, and the socio-economic determinants and impacts of water use.

### **9.3.4 Building public awareness through outreach**

Given the magnitude of the challenge confronting the state, the deep-seated notions of water as an unlimited resource, and the contestation over water resources, it is clear that a transition to the new paradigm of water management can only take place if supported by changes in perceptions and attitudes of water users, i.e., the citizens of the state. Thus, it is imperative that a parallel process of massive outreach be taken up. The process must aim to build citizen awareness about and understanding of the nature and gravity of the water crisis facing the state and the need for holistic, equitable and sustainable solutions. This will be done through mass media, and a variety of interactive programmes that have both generic and context-specific content.



## CHAPTER 10. THE WAY FORWARD

This is an extremely ambitious water policy document of a kind that has probably never been drafted before in India. It combines key elements of strategy with the broad direction of policy. It has many region-specific dimensions that reflect the enormous agro-ecological diversity of Karnataka. It, therefore, demands a very carefully crafted architecture of implementation, where the government works in close partnerships with a large number of stakeholders in the water space

To ensure full-fledged and consistent implementation of this water policy and the set of strategies outlined therein, the following structure is proposed:

- A State Water Governing Council (GC) headed by the Chief Minister and including the Ministers for Water Resources, Minor Irrigation, Agriculture and Urban Development will be created. It will meet on a half-yearly basis to review progress in implementation and remove policy bottlenecks.
- An Executive Committee (EC), headed by the Chief Secretary, will serve the GC. It will include the Development Commissioner, relevant Secretaries and key knowledge and implementation partners from the Knowledge Bank Group who will be from outside government. The EC will take all operational decisions. It will meet on a monthly basis.
- A Knowledge Bank Group (KBG) with experts from within and outside the government will be created to render continuous technical support and advice to the Executive Committee. This will be housed in and supported by ACIWRM.

Given the radical nature of the proposals contained in this water policy and the huge paradigm shift it entails, it is clear that to foster its widespread acceptance, as also given the urgency of action required on the ground in the multifarious elements of water policy, a 5-year multi-media campaign will need to be initiated to spread the key messages contained in the policy with the help of PRIs and various knowledge and civil society organizations in the state, like Karnataka Rajya Vijnana Parishat, Karnataka Science and Technology Academy, Karnataka State Council for Science & Technology, Bharat Gyan Vigyan Samithi, etc. One of the functions of the KBG will be to plan and execute this campaign with the support of the EC and the guidance of the GC.

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## ANNEXURE 1: KARNATAKA JNANA AAYOGA

### PROCEEDINGS OF THE GOVERNMENT OF KARNATAKA

#### Subject: Reconstitution of Karnataka Knowledge Commission.

- Read:** 1) Government Order No. ED 110 URC 2008, dated 5/9/2008  
2) Government Order No. ED 462 URC 2013, dated 28-12-2013  
3) Notification No. ED 364 URC 2016, dated 26-12-2016.  
4) Government Order No. ED 354 URC 2016 (Part-1) dated 02-08-2017

#### Preamble

Karnataka has emerged as the Knowledge Capital of the country. The State needs to take on the global challenges in terms of innovation, conservation of heritage, generation of new knowledge, application of knowledge in every sphere of life, skill development, enhancement of competencies, creation of better human capital to create new knowledge economy besides creation of a more human society. Keeping that in view, the Karnataka Knowledge Commission was constituted in 2008, vide Government Order No: ED 110 URC 2008, dated 5-9-2008 read at (1) above, under the guidance and Chairmanship of renowned Space Scientist Dr. K. Kasturirangan. After completion of term. The Commission was reconstituted and the term was extended till December 28, 2013 vide G.O. read at (2) above. Further, the term of the Commission was extended for 03 years vide Notification read at (3) above. Subsequently, the Commission was re-constituted under the Chairmanship of Dr. K. Kasturirangan vide Government Order No. ED 354 URC 2016 (Part-1) dated 02-8-2017 read at Sl.No.4 above.

The State Government has duly considered the necessity of Knowledge Commission in addressing the key aspects of development of the State with Knowledge and techno – managerial recommendation and advice. Consequently, after taking the role to be played by the Karnataka Knowledge Commission in making Karnataka a Knowledge State and a knowledge economy, in to account, the Government aptly decides to reconstitute Karnataka Knowledge Commission Hence the following order.

#### **GOVERNMENT ORDER NO. ED 354 URC 2016 (Part – 1)**

**Dated: 25.06.2019**

In the circumstances explained above, the Government is pleased to reconstitute the Karnataka Knowledge Commission with the following eminent persons as Chairman and Members.

Sl.No	Name and Address	Designation
1	Dr. K. Kasturirangan, Former Chairman of ISRO, Ex- Member (Science), Planning Commission, Gol, Emeritus Professor, National Institute of Advanced Studies, Bengaluru	Chairman
2	Dr. Mukund Kadursrinivas Rao Adjunct Professor, NIAS and Head of NIAS Centre for Spatial Analytics and Advanced GIS, NIAS, IISc Campus, Bengaluru	Member -Secretary



## Karnataka State Water Policy 2019



Sl.No	Name and Address	Designation
3	Sri. P.G.R. Sindhia Former Minister for Home, Transport and Finance, Government of Karnataka	Member
4	Sri. Mohandas Pai T V President, MEMG International India Ltd. No. 70, 4th Floor, Grace Towers, Above Navaneeth Motors, Milers Road, Bengaluru – 560052	Member
5	Prof. Anurag Behar Vice Chancellor, Azim Premji University, PES Institute of Technology Campus Pixel Park, B' Block Electronic City Hosur Road, Bengaluru	Member
6	Prof. M. R. Satyanarayana Rao, Ex - Director, Jawaharlal Centre for Advanced Scientific Research (J.N.C.A.S.R), Jakkur, Bengaluru- 560064.	Member
7	Dr. Nazeer Ahmed, Advisor, World Organization for Research Development and Education, Ex-Scientist, NASA, No. 4, 9th Cross, Jayamahal Main Road, Jayamahal Extension, Bangalore – 560046	Member
8	Prof. Sunney Tharappan, Director, C.L.H.R.D, Valencia Circle, Mangalore – 575002.	Member
9	Prof. G. Padmanabhan, Former Director of IISc, Bangalore – 560012.	Member
10	Dr. Gayatri Saberwal, Institute of Bioinformatics and Applied Biotechnology, Biotech Park Electronics City Phase I, Bangalore – 560100	Member
11	Prof. S. Sadagopan, Director, IIT-Bangalore, 26/C, Electronics City, Hosur road, Bangalore – 560100.	Member
12	Dr. Devi Prasad Shetty, Heart Specialist, Narayana Hrudayalaya, 258/A, Bommasandra Industrial area, Anekal Taluk, Bangalore – 560099	Member
13	Dr. Rajashekar H. B. Director Jawaharlal Nehru Medical College, Nehru Nagar, Belgavi – 590010	Member
14	Dr. B.M. Hegde, Ex-Vice Chancellor, Manipal University, Ganesh Lower Bendur, II cross, Mangaluru – 575702.	Member
15	Dr. P. Balakrishna Shetty, Vice Chancellor, Sri Siddartha Academy of Higher Education, Agalakote, B.H. Road, Tumkur – 572 107.	Member
16	Dr. Mohan Alva, Chairman, Alva Education Society, Vidyagiri, Moodbidri, Dakshina Kannada Dist – 574227	Member
17	Dr. B N Suresh, Vikram Sarabhai Professor, ISRO Hqs, Antariksh	Member



## Karnataka State Water Policy 2019



Sl.No	Name and Address	Designation
	Bhavan, New BEL Road, Bengaluru-560 231.	
18	Sri. S V Ranganath, Retd. IAS & Ex- Chief Secretary, GoK.	Member
19	Smt. Ashwini Nachappa, International Athletic, No. 516, 16th E Cross, 17th A Main Koramangala, 6th Block, Bengaluru- 560094	Member
20	Dr. Pulak Ghosh, Professor, IIM-Bengaluru, Dept. of QM & IS, Indian Institute of Management, Bannerghatta Road, Bengaluru – 560076	Member
21	Prof. K.E. Radhakrishna, Academician, No.6, RIEESH Layout, J C Nagar, Mahalakshmpuram, Bengaluru - 560086	Member
22	Prof. Basavarajappa K. P, Former Research Fellow, IIM-B, No. 120, 2nd Main, KUS Layout (Next to National Law School of India University) Nagarabhavi 1st Stage, Bengaluru - 560072	Member
23	Dr. S.R. Patil, Rtd. Professor & Head, Geography Department, Karnataka University, Dharwad	Member
24	Dr. Angarai Ganeshan Ramakrishnan, Professor & Chairman, Department of Electrical Engineering, IISc, Bengaluru	Member
25	Prof. O.V. Nandimath, Professor of Law & Registrar NLSIU, Bengaluru	Member
26	Dr. Radha Murthy, Director, Nightingales Home Health Services and the Nightingales Medical Trust, Bengaluru	Member
27	Dr. C.N. Manjunath, Professor & Head of Cardiology Director, Sri Jayadeva Institute of Cardiovascular, Science & Research, 9th Block, Jayanagar, Bannerghatta Road, Bengaluru - 560069	Member
28	Dr. M.K. Shankaralinge Gowda, IAS (Rtd), Ex-Chairman, Karnataka Electricity Regulatory Commission E-79, 6th A Cross, Manyata Residency Behind Manyata Tech- Park, Hebbal Ring Road, Bengaluru – 560045	Member
29	Prof. S.N. Hegde Vice- Chancellor (Retd.)Chairman, Vishranti Kulapatigala Vedike.	Member
30	Sri. P.N. Nayak Rtd., Chief Engineer, No. 202, Yadugiri Next Appartment, 11th Main Road, 14th Cross Malleshwaram, Bengaluru – 560003.	Member



## Karnataka State Water Policy 2019



### Ex-Officio Members

Sl. No	Name and Address
1	Additional Chief Secretary to Government, Finance Department, Government of Karnataka, Vidhana Soudha, Bengaluru-560001
2	Additional Chief Secretary to Government, Primary and Secondary Education Department, Government of Karnataka, 6th Floor, 2 <sup>nd</sup> Stage, M.S. Building, Bengaluru-560001
3	Additional Chief Secretary to Government, Medical Education Department Government of Karnataka, 6th Floor, 4th stage, MS Building, Bengaluru-560001
4	Principal Secretary to Government, Higher Education Department, Government of Karnataka, 6th Floor, 2nd Stage, MS Building, Bengaluru-560001
5	Principal Secretary to Government, Health and Family Welfare Department, Government of Karnataka, # 105, 1st Floor, Vikasa Soudha, Bengaluru-560001
6	Principal Secretary to Government, Information Technology, Bio Technology and Science & Technology Department, Government of Karnataka, 5th Floor, 5th stage, M.S Building, Bengaluru-560001

#### **Term of Reference: -**

#### **The Commission shall strive to give recommendations in the following areas.**

1. To focus on institution building, policy innovation and excellence in the field of education, health, science and technology, industry, entrepreneurship, research and innovation, traditional knowledge, agriculture, e-governance, rural development, etc., and other relevant areas in the context of Karnataka.
2. Build excellence in the educational system to meet the challenges of the 21st century and increase Karnataka's competitive advantage in the fields of knowledge.
3. Promote creation of knowledge in all formal and non-formal educational, scientific and Knowledge institutions of Karnataka.
4. Improve the leadership and Management of educational and knowledge institutions of Karnataka.
5. Promote knowledge applications in agriculture, rural development, health, industry and other areas.
6. Enhance the use of knowledge capabilities in making government an effective service provider to the citizen and promote widespread sharing of knowledge to maximize public benefit.
7. Promote inter sectoral interaction and interface with the objective of preservation, access, new concepts, creation, application, dissemination, outreach and services relating to knowledge.
8. Develop appropriate institutional frameworks to strengthen the education system, promote domestic research and innovation, facilitate knowledge application in various sectors.
9. Leverage information and communication technologies to enhance governance improve connectivity and reduce digital divide.
10. Device mechanisms for exchange and interaction between knowledge System in the global arena.
11. Conserve indigenous and heritage knowledge in Karnataka for better Utilization of time tested concepts and knowledge by society.



## Karnataka State Water Policy 2019



By Order and in the name of the  
Governor of Karnataka  
Sd/-

**(M.A. AHAMED JHON)**

Under Secretary to Government  
Higher Education Department (Universities-2)

To,

The Complier, Karnataka Gazette -for publication in next issue of the Gazette.

Copy to:

1. Dr. K. Kasturirangan, Former Chairman, ISRO and Former Member (Science), Planning Commission, Government of India. Director, National Institute of Advanced Studies, Bengaluru
2. The Vice Chairman, Karnataka State Council for Higher Education, Bengaluru.
3. The Vice Chancellors/Registrars of All Universities.
4. The Executive Director, Karnataka State Council of Higher Education, Bengaluru.
5. Dr. Mukund Kadursrinivas Rao, Adjunct Professor, and Head, NIAS Centre for Spatial Analytics and Advanced GIS, Bengaluru
6. Shri. PGR Sindhia, Former Minister, Home, Transport & Finance, GoK, No. 24, Doddamaralavadi Village, Maaralavadi Hobli, Kanapura Taluk, Ramanagara Dist.
7. Sri. Mohandas Pai T V, President, MEMG International India Ltd., No. 70, 4th Floor, Grace Towers, Above Navaneeth Motors, Milers Road, Bengaluru - 560052
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18. Dr. P Balakrishna Shetty, Vice Chancellor, Sri Siddhartha Academy of Higher Education, Agalakote, B.H. road, Tumkur – 572 107.



## Karnataka State Water Policy 2019



19. Dr. Mohan Alva, Chairman, Alva Education Society, Vidyagiri, Moodbidri, Dakshina Kannada Dist – 574 227.
20. Dr. B N Suresh, Vikram Sarabhai Professor, ISRO Hqs, Antariksh Bhavan, New BEL Road, Bengaluru-560 231
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25. Prof. Basavarajappa KP, Professor, IIM Bengaluru, Bannerughatta Road Bengaluru-560076.
26. Dr. S.R. Patil M. A. Ph.D, Professor of Geography, (Retd) Department of Geography, Karnataka University, Dharwad
27. Dr. Ramakrishnan Angarai Ganeshan Ph.D,(Bio-Medical Engineer), Department of Electrical Engineering, IISc, Bengaluru
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## ANNEXURE 2: SUB-GROUPS CONSTITUTED

### SG-1: Overall Perspective and Structure of Policy

1. Dr. Mihir Shah (Lead), Chair, TG-KSWP
2. Shri. S.V. Ranganath, IAS (R) Co-chair, TG-KSWP
3. ACS/PRS, Water Resources Department, Member, TG-KSWP
4. Dr. Mukund Rao, Member, TG-KSWP
5. Dr. Sharachchandra Lele, Member Secretary, TG-KSWP
6. Dr. Himanshu Kulkarni, Member, TG-KSWP
7. Ms. Jayamala Subramaniam, Member, TG-KSWP
8. Ms. Rachana, Convener, TG-KSWP, SG1-KSWP

### SG-2: Review of/Learnings from GoK Programmes Relating to Water

1. Shri. S.V. Ranganath, IAS(R) (Lead), Co-Chair, TG-KSWP
2. Prof. Mohan Kumar M. S (Co-Lead), Member, TG-KSWP
3. ACS/PRS, Water Resources Department, GoK, Member, TG-KSWP
4. Director, Karnataka State Ground Water Department, Member, TG-KSWP
5. Mr. Madhav, SE, ACIWRM representative
6. Dr. Rochi Khemka, Member, TG-KSWP
7. Dr. Sharachchandra Lele, Member Secretary, TG-KSWP
8. Mr. S. Vishwanath, Member, TG-KSWP
9. Mr. V. Balasubramanian, IAS(R), Member, TG-KSWP
10. Mrs. Rashmi Raj, SRA-KJA, Convener, SG2-KSWP

### SG-3: How best to Classify Karnataka from a Water Policy Point of View

1. Shri. S.V. Ranganath, IAS(R) (Lead), Co-Chair, TG-KSWP
2. Dr. Sharachchandra Lele (Co-Lead), Member Secretary, TG-KSWP
3. ACS/PRS, Water Resources Department, GoK, Member, TG-KSWP
4. Director, Karnataka State GW Department, Member, TG-KSWP
5. Mr. Madhav, SE, ACIWRM representative
6. Prof. Mohan Kumar M. S, Member, TG-KSWP
7. Dr. K. Mukund Rao, Member, TG-KSWP
8. Dr. Himanshu Kulkarni, Member, TG-KSWP
9. Dr. Aromar Revi, Member, TG-KSWP
10. Dr. Rochi Khemka, Member, TG-KSWP
11. Mr. V. Balasubramanian, IAS(R), Member, TG-KSWP
12. Mrs. Rachana, RA-KJA, Convener, SG3-KSWP

### SG-4: Agriculture and PIM

1. Shri. S.V. Ranganath, IAS(R) (Lead), Co-Chair, TG-KSWP
2. Prof. Mukund Joshi (Co-Lead), Special Invitee, TG-KSWP
3. ACS/PRS, Water Resources Department, Member, TG-KSWP
4. Secretary, Department of Agriculture, GOK





5. Prof. Mohan Kumar M. S, Member, TG-KSWP
6. Mr. Madhav, SE, ACIWRM representative
7. Mr. V. Balasubramanian, IAS(R), Former Addl. Chief Secretary, GOK, Member, TG-KSWP
8. Prof. Gopal Naik., Member, TG-KSWP
9. Dr. Shrinivas Badiger, Fellow, ATREE, Bangalore
10. Dr. V. S. Prakash, Special Invitee, TG-KSWP
11. Dr. Jayashri, SRA-KJA, Convener, SG4-KSWP

**SG-5: Groundwater and its integration with surface water**

1. Dr. Himanshu Kulkarni (Lead), Member, TG-KSWP
2. Director, Karnataka State GW Department, Member, TG-KSWP
3. Ms. Jayamala Subramaniam, Member, TG-KSWP
4. Regional Director, CGWB, Bangalore
5. Mr. Avinash Krishnamurty, Advisor and Director, Biome Environmental Trust
6. Dr. Ashok D. Hanjagi, Member, TG-KSWP
7. Dr. Veena Srinivasan, Fellow, ATREE, Bangalore
8. Mrs. Rashmi Raj, SRA-KJA, Convener, SG5-KSWP

**SG-6: Urban and industrial water (incl esp Bengaluru)**

1. Prof. Mohan Kumar M. S, (Lead), Member, TG-KSWP
2. ACS, Urban Development Department, GOK
3. Dr. Aromar Revi, Member, TG-KSWP
4. Mr. V. Balasubramaniam, IAS(R), Member, TG-KSWP
5. Mr. S. Vishwanath, Member, TG-KSWP
6. Maj Neil Castelino Member, TG-KSWP
7. Dr. Sharachchandra Lele, Member Secretary, TG-KSWP
8. Mrs. Rashmi Raj, SRA-KJA, Convener, SG6-KSWP

**SG-7: Water Quality**

1. Dr. Sharachchandra Lele (Lead), Member Secretary, TG-KSWP
2. Secretary, Rural Development & Panchayat Raj, GOK
3. Dr. Himanshu Kulkarni, Member, TG-KSWP
4. Representative of Chairman, KSPCB
5. Dr. Sunderrajan Krishnan, Executive Director, INREM Foundation
6. Dr. Priyanka Jamwal, Fellow, ATREE, Bangalore
7. Prof. Nandini. N, Bangalore University (Dept of Environmental Sciences)
8. Regional Director, CPCB
9. Dr. Jayashri, SRA-KJA, Convener, SG7-KSWP

**SG-8: Rural Domestic Water**

1. Dr. Himanshu Kulkarni, (Lead), Member, TG-KSWP
2. Principal Secretary, Rural Development & Panchayat Raj, GOK
3. Ms. Jayamala Subramaniam, Member, TG-KSWP
4. Mrs. Rachana, RA-KJA, Convener, SG8-KSWP



**SG-9: Data Management**

1. Dr. K. Mukund Rao (Lead), Member, TG-KSWP
2. Secretary, WRD, GoK
3. Director, Karnataka State GW Department, Member, TG-KSWP
2. Director, KSNDMC
3. Mr. M. Jayachandran, Technical Officer, KGIS
4. Representative of Chairman, BWSSB
5. Mr. Madhav, SE, ACIWRM representative
6. Dr. Ashok D. Hanjagi, Member, TG-KSWP
7. Dr. Sharachchandra Lele, Member Secretary, TG-KSWP
8. Ms. Jayamala Subramaniam, Member, TG-KSWP
9. Dr. Jayashri, SRA-KJA, Convener, SG9-KSWP

**SG-10: Technologies for Water Management (not constituted)**

**SG-11: Institutional Reform and Governance Systems**

1. Prof. Mihir Shah (Lead), Chair, TG-KSWP
2. Shri. S.V. Ranganath, IAS(R), Co-Chair, TG-KSWP
3. Dr. Himanshu Kulkarni, Member, TG-KSWP
4. ACS/PRS, Water Resources Department, Member, TG-KSWP
5. Mr. Madhav, SE, ACIWRM representative
6. Dr. Sharachchandra Lele, Member Secretary, TG-KSWP
7. Mrs. Rashmi Raj, SRA-KJA, Convener, SG11-KSWP

**SG-12: Legal Aspects**

1. Dr. M. K. Ramesh (Lead), Member, TG-KSWP
2. Dr. Himanshu Kulkarni, Member, TG-KSWP
3. Dr. Sharachchandra Lele, Member Secretary, TG-KSWP
4. Mr. Sujith Koonan, Associate Professor, Faculty of Law, University of Delhi.
5. Mrs. Rachana, RA-KJA, Convener, SG12-KSWP

**SG-13: Health, Energy and other issues**

1. Dr. Aromar Revi (Lead), Member, TG-KSWP
2. ACS/PRS, Department of Commerce and Industries, GOK
3. Principal Secretary, Department of Health and Family Welfare, GOK
4. Dr. Rochi Khemka, Member, TG-KSWP
5. Dr. Sunderrajan Krishnan, Executive Director, INREM Foundation
6. Dr. Jayashri, SRA-KJA, Convener, SG13-KSWP





## **KARNATAKA JNANA AAYOGA**

(KARNATAKA KNOWLEDGE COMMISSION)

GOVERNMENT OF KARNATAKA

ROOM NO. 432-433 and 438-439, 4<sup>th</sup> Floor, Vikasa Soudha, Bengaluru

[www.karnataka.gov.in/jnanaayoga](http://www.karnataka.gov.in/jnanaayoga)