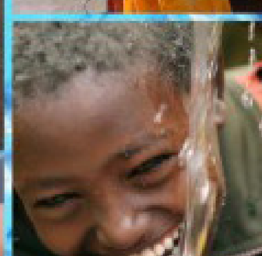
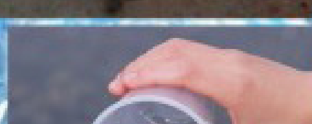
Safe And Sustainable Clean Water Access

Edited by
Whitman Direct Action

Case Studies Examining the

Socio-political and Technological Obstacles to Water Development



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Case studies examining the socio-political and technological obstacles to water development in India

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Whitman Direct Action
2008

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Contents

Acknowledgments

The Sadhana Clean Water Project would not have been possible to accomplish without the generous contributions made by several organizations and individuals. First and foremost, we would like to thank Whitman College for its support and encouragement towards Whitman Direct Action (WDA). In particular, we would like to thank the Asian Studies Department, Professor Bob Carson, the Environmental Studies Department and related alumni funds, Provost Dean Lori Bettison-Varga, and ASWC. We would also like to thank the extremely motivated fundraising wing of WDA for their determined and exhausting efforts to support this project. The financial contributions and support we have received from you has not only enabled this year's project but has supported WDA's goals of developing as a sustainable non-profit non-governmental organization (NGO).

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Daniel Bachhuber
Jessica Conrad
Yukta Kumar
Tim Shadix
Jyotsna Shivanandan
March 2008

Whitman Direct Action: Why the Water Book?

Whitman Direct Action (WDA) is a student-run organization from Whitman College in Walla Walla, Washington USA dedicated to helping marginalized people by promoting economically and environmentally sustainable community development. Our philosophy is to support a world where sustainable practices replace destructive ones, where equitable, mutual and synergistic opportunity replaces oppression, and where critical thought and action replaces apathy and fear.

This year's Sadhana Clean Water Project aims to address obstacles to clean water access in rural India. India claims the second largest population globally with 1.25 billion people: of that, 226 million people do not have access to safe water. In the state of Maharashtra alone, approximately 700,000 people contract water related diseases annually. The problem of water access is further exacerbated by competition for the limited resources available. The demand for water in India is expected to double by 2025 with few viable alternatives for water acquisition. Our project aims to explore possible strategies with local non-profit organizations and community members to improve the conditions of water access in India.

One strategy WDA would like to emphasize in addressing clean water development is the importance of networking and collaboration. To this end, we have designed the Water Book here before you, which features a collection of case studies and essays contributed by NGOs working on clean water development projects. Our intention is that the Water Book will become a transparent resource for other NGOs, the government sector, academics, and interested individuals to glean the expertise of their contemporaries in the fields of water development and water purification technology. Additionally, the Water Book serves as a unique publication, showcasing a broad spectrum of water development projects and meditations on the water problem in India.

Chapter One

Experiences of ARTS in Providing Irrigation Through Small Water Harvesting Structures to Rural Poor in India

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Andhra Pradesh is situated in the southern part of India. The state has many indigenous tribal communities who live far away from cities in the rural areas. ARTS works with 11,459 such families in 242 villages of the Srikakulam and Vizanagaram Districts (Seethampet, Veeraghatam and Burja Mandals of Srikakulam District Kurupam, GL Puram and G.M.Valasa Mandals of Vizianagaram District) in Andhra Pradesh. Many of the tribals have their own dialects, with more than 30,000 dialects spoken in all of India.

Life in these Indian villages is not easy. Rain-fed agriculture is the main occupation of the people, and its success is dependent on monsoons. Usually, the rain gods from the southwest monsoon hit our villages by the first week of July, but unfortunately rains have not reached the villages in the last three years. This hurts the crops and harvest, leading to hunger and the forced migration of adults to cities in search of work, leaving behind the young and the old in the villages. The adults who migrate return once every six or ten months, bringing back the savings they have earned in the cities.

As a result of last our last year's work, these people now have some hope. The Organization has taken up watershed and small water harvesting structures construction and renovation programmes. The programme impact is explained below through several case studies.

Watershed concept

Over the past year, our the watershed approach has been applied for the purpose of arresting rainwater runoff, rainwater harvesting, and in situ soil and moisture conservation. Community based watershed development has become the guiding principal for rejuvenation of natural resources, especially land and water. A micro watershed is a hydro-geological unit encompassing all the land and life within a drainage basin. The basin drains by a network of rain-fed streams from the ridgeline of the area to common point, which is known as the outlet.

Goals & Objectives

The watershed development programme was started with the objectives of harvesting every drop of rainwater for the purposes of irrigation and plantation, including horticulture, floriculture, and pasture development. Our broad objectives extend over all development of rural areas, through Gram Panchaayats, mitigating the adverse effects of extreme climate conditions, restoring ecological balance by harnessing, conserving and developing natural resources, encouraging villages towards sustained community action for maintenance of assets, and promoting the use of simple, easy, and affordable technological solutions.

Inputs

In Srikakulam district, the watershed has supported sustainable development in eighteen villages. The local people's participation in these projects has provided employment in the villages, helping to reduce migration to a great extent.

Results

Because of the construction of check dams, gabion dams, farm ponds, and percolation tanks, more than 200 hectares of additional area have been brought under irrigation, providing resources that are lifesaving. The treatment area has been brought under farm forestry and casuarinas plantations. These are low cost plantations with returns after a rotation of five years of almost Rs. 75,000 from one hectare (by a conservative estimate.) Under the watershed development program, the Organization introduced the concept of productivity enhancement and enterprise promotion in the villages. The gains are much more rapid and profitable through these programmes than from conventional natural resource management approaches.

The watershed development program has played a significant role in developing human resources in the area through exposure visits to observe the best practices throughout the country and through classroom training sessions.

Impact of the project

- Because of the availability of 15,870 man-days for 350 people, migration, in the Vonigedda watershed area, has been checked to some extent. An amount of Rs 1,054,733 was spent in the project towards this goal.
- Renovation increased the capacity of the existing fourteen tanks and also resulted in an increase in the groundwater level. The tube wells have also shown a remarkable difference in water levels. These conditions are favorable for jute processing and aqua culture, and could provide irrigation for 720 acres.
- Crop diversity has been practiced on about 50 hectares of land, helping to improve the soil health.
- 267 families have established plantations on 230 acres of land, producing 18,500 mango, cashew, drumstick, amala, jackfruit, soapnut, etc.
- Soil and moisture conservation have been taken up in 380 hectares of land, allowing 380 acres to be brought into cultivation with these works.
- Because of 7 gabians constructed to check the water velocity in the streams, good yields were obtained in 25 acres of land.
- About 2,963 cubic meters of water absorption trenches were formed in the foothills to check soil erosion. This has improved conditions to grow cashew, turmeric and pineapple crops.
- In sloped lands, continuous contour trenches of 1,703 cubic meters in volume were formed. These helped check soil erosion and recharge the ground water, keeping the moisture available to the plants.
- Stone bunds have been constructed across hill slopes to check soil erosion. They helped in good crop returns from cashew, pine apple, turmeric, papaya, ginger, tamarind, and banana that were cultivated on the hill slopes
- The floods that occurred last year have resulted in a large depression in the soil in the down slope of the Pamuguda check dam. This impeded the water flow to the lands of Kusumiguda, Kusumi, Patruniguda, Santhamalli, Darimalli, Naidumalli, and Masalaguda villages. These farmers experienced losses in crop yields. An overflow weir had provided solutions to the problem of siltation of two acres of land. Now the water gets stagnated in the tank.

- The tank renovation work done for Mallamma cheruvu, Sunnam cheruvu, Pamugadda cheruvu, Malli cheruvu areas has resulted in increases in the capacities of tanks. This helped in bringing 98 acres of land into cultivation.
- On twelve acres of wasted lands in Santhamalli, Darimalli and Chilagam villages, the wastelands were cleared, farm bunds were strengthened, and land leveling was performed. This project enabled farmers to start cultivating pigeon pea, maize, horse gram, finger millet and vegetables in these lands.
- In the Kusumi area, there was around 70 acres of titled land, but the records were lying with the ITDA and people lacked information about their lands. ARTS has facilitated the subdivision of the land and assigned it to the tribal people for cultivation. People started planting cashew and other crops in these lands. The project has facilitated titles for 35 acres of land for 20 families in the same area.
- High migrations in the project area caused many children to drop out of school. Due to employment creation in the watershed area, people started returning to their villages. Around 22 such children were identified and joined in the Child Labour School run by ARTS

In this presentation, we give an example of our work in Dorajamma village of GL Puram, one of the places where ARTS is working. There are 54 tribal families living in this village. The last three years the rains failed and the people faced drought, with the villages suffering the worst hit during the past year. Eighteen families migrated to Vishakhapatnam and Rajamandry in the neighbouring East Vokavari District to find agricultural labor work. Of the remaining families, some worked as labourers in the lands of rich landlords who have irrigation facilities and some went to the forest and cut fuel wood to sell in Kurupam. Women and children have become involved in the collection and sale of forest products like Mahuva (the flowers are used for brewing liquor and its oil is used for cooking), tamarind (a sour fruit used in curries), and soapnut (fruit used for washing hair) to the local traders. This situation not only forces children to leave school, but also forces them to work in the fields. Due to low returns from agriculture, people are forced to borrow money from local traders at a very high rate of interest. The repayment of this loan is usually done in kind. Children are stopped from going to school and are made to raise livestock that belong to the upper caste. Due to non-attendance of children in school, the only school in the area, called “Girijan Vikas Kendra,” was closed.

Hill Stream – A Ray of Hope

On village visits, ARTS discusses with villagers, the common problems they face. We then guide them in finding solutions to such problems. For example, the people in Dorajamma village wanted water for irrigation. Together thought of building a water tank around a small hill stream called Mogadala Ghati.

The people collected stones, sand and worked voluntarily to construct the check dam. ARTS and Action Aid India paid for cement and masonry wages. The check dam was completed by June 2000. This check dam has helped in irrigating 90.70 acres of land. The major crop grown is paddy and the output has increased from 8 quintals (1 quintal = 110 kgs) to 20 quintals per acre. The tribal people in this village are extremely happy with these results.

The improvement in the living condition in this village has encouraged villagers to think of the significance of sending their children to school. Some representatives from the village approached the department for tribal development in the local government to request an education center in the village. The department agreed to start a Residential School in the village with the condition that the villagers would provide land for the construction of the school building and meet the expenditures of its daily activities. The villagers happily contributed five acres of common land (a piece of land under the control of the village Panchayat, the village-level self-governing body) for this purpose. ARTS and Action Aid India have agreed to construct sheds to support the education program. The residential school is functioning with two sheds constructed by ARTS, which accommodates fourteen children.

Check dam fulfilled my dream-says Palakonda, Seethampeta of Dorajamma village:

> "My wife, daughter two sons, and I were just about managing with the limited yield we were getting from the three acres of land I owned. I was cultivating Ragi, Jowar, [local types of millets] and horse gram. Due to drought, four years ago, I shifted my family to the East Godavari District. We did not come back to our village for three years because of the continued drought situation. In March 2000 I heard about the check dam proposal of Magala Ghati. I returned to my village with my family and we participated in check dam construction works. The check dam was completed in June 2000. Since then we stayed back in our village and I also participated in the training conducted by ARTS on how to grow more on the limited piece of land.

> It was unbelievable for my family and me that now time the yield from my land is 21 bags per acre, while earlier it was only 8 bags per acre. The earlier production from my land was insufficient to feed my family. Now my wife and me are happy that we are able to feed our children as well. We can sell a part of the paddy for profit, and also store a part of it for meeting difficult situations.
>
> Today I am proud to say that my three children are studying in the residential school."

The small contribution of our work plays a vital role in our efforts to eradicate poverty in this remote area of India that is so much in need.

Chapter Two

A NGO's Initiative on Community Participation on Water Management

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Background information on the Vigyan Vijay Foundation

In 2001, The Vigyan Vijay Foundation (VVF) came into being when three engineers and a sociologist deliberated and made up their minds to work for community improvement. The mission quickly gained support from a doctor, community persons and other voluntary workers. Our objectives are to assist individuals, communities, and organizations in harnessing the benefits of science and technology while simultaneously developing appropriate principles and practices to improve the quality of living in communities, habitats and ecosystems.

VVF outreach programs strive towards the growth of strong communities made up of empowered individuals. Our inclusive and integrated rehabilitation approaches will ensure that the entire community is self-actualized and becomes part of the program.

VVF aims to uphold the objectives below:

1. To promote awareness through basic adult education
2. To support programs on skill-development, self-employment, micro-credit, etc.
3. To assist communities in achieving economic self-reliance through need-based projects
4. To involve communities in environmental conservation and restoration issues
5. To improve water, sanitation, and solid wastes in light of health and hygiene problems within the community

Water, Sanitation and Waste Experience

VVF works on watershed improvement projects at both urban and rural sites. Recent projects in collaboration with community members were undertaken with holistic approaches to improve the quality of life for community members and livestock alike. For example, VVF has worked in Churu District. In Rajasthan with the Rotary Conservation Trust in 45 villages to implement appropriate principles and practices for water conservation to include water harvesting in tankas, thalais, and thalabs. Additionally, awareness and participatory programs were carried out in many communities on bio-waste compost and in association with educational institutions for women and children aspiring to achieve good results in MDGs. VVF also addresses environmental issues and total sanitation campaigns through community education programs.

Regional Water Issues and Interventions

Most communities are water stressed as both the rural and urban sectors reveal a gross deficiency of water resources. In order to ease this shortage, people rely largely on groundwater and other alternatives.

With rapid population growth and the development of modern technologies, the demand for water has substantially increased. Water availability is neither adequate nor equitable to all human beings across India.

The water bodies and rivers that played a large role in forming and sustaining communities are under a threat with alarming consequences. Decentralized groundwater is used widely for agriculture and for habitat sustenance causing the depletion of sub-soil water around the country. This, in turn, makes the groundwater vulnerable to pollution with adverse impacts.

Local municipal water bodies supply clean and safe drinking water to meet basic human and livestock needs, but deficient water quality leads to health and hygiene problems with dire impacts and other consequences. Community efforts have been afforded to both urban and rural eco-systems to replenish groundwater reserves and also to rejuvenate rivers and other water bodies.

The quality of living in some urban and rural communities has been revamped with adequate water supplies and safe disposal mechanisms for solid and liquid wastes. Water-borne diseases and their effects on women, children, and communities at large have been monitored and arrested. Through self-realization, communities have made efforts to optimize available water resources.

Schools and colleges within urban communities in Delhi promote student awareness and volunteer efforts. These initiatives have propagated environmental conservation awareness throughout the community.

Environmental and Watershed Projects

Rainwater Harvesting

The implementation, operation and maintenance of rainwater harvesting systems in both the rural and urban sectors has been executed through community initiatives in urban societies, housing complexes, institutions and other sites. The concept of re-charging groundwater aquifers has been augmented with store and use systems. On some institutional campuses, ponds have been created to function as a sink for storing rainwater and recycled waste water. The purified water is used for landscape irrigation, flushing toilets and other secondary uses.

Rainwater harvesting units come in many forms. From our experience, we've gathered that it is beneficial to assess the possibility of saving costs in order to achieve optimum benefits. Old village type dug wells, which have become dried up or defunct bore wells, are often used as recharge bores linked to the rainwater catchments. After having implemented and maintained more than 200 rainwater harvesting units, we are aware that most urban and rural areas are familiar with the technology, and local grass-roots nongovernmental organizations are able to carry out the task of implementation easily. Additional training is provided for operating and maintaining the systems when needed. Wherever the systems are implemented, awareness and participation is sought from stake holders and the community as a whole. It is also ensured that only clean and safe rainwater is collected to recharge the ground water. The concept of performing maintenance is propagated and community participation is encouraged.

Recycling Water for Secondary Uses

In locations where considerable amounts of marginally polluted water are seen in the drain channels, efforts have been made to recycle this wastewater for uses of lesser importance. Eco-friendly natural treatment methods – to include, for example, decentralized wastewater treatment systems – are employed for this purpose.

These systems are encouraged and propagated by VVF in the communities we work with. We have implemented eight waste water recycling systems which are now in operation; their stake holders are very appreciative and are more water-secure as a result. In the first system, urban drain water is sourced and channeled through the treatment process and is used in colony parks at Vasant Vihar, a Delhi colony. In the second plant, waste water is sourced from a drain which receives the processed water from a sewage treatment plant. This is located in IIT (Delhi) and is used for supplying recycled water for horticulture and development research. The third plant is at the Center for Science and Environment, a nongovernmental organization. The sewage water from the building is processed and recycled for watering gardens on their campus. This treatment plant is also used for demonstration and the propagation of similar systems through workshops and seminars. VVF has also developed five more plants producing recycled water through similar mechanisms.

Research with Academia and Other Institutions

Results from our watershed projects have been provided to research institutions, namely IIT Delhi, JNU, IIT-BHU, DCE, IIT Roorkee, on the hydro-geo-chemical aspects of our work. We hope this will help the field of watershed development arrive at sustainable solutions for communities to become more water secure in the future. Also, networking with prominent nongovernmental organizations in the fields of watershed and environmental development will expand our working knowledge.

Water-Literacy Within Rural Villages

In the rural sector, villagers are encouraged to use village ponds for all water needs. We have had good experience upgrading village ponds. Take, for example, Dharampur which is 20 kilometers outside of Gurgaon. There, a medium sized pond was de-silted and rainwater channels were made to bring all rainwater catchments to the pond. Also, household waste water went through treatment processes and this recycled water was used for local agriculture and the irrigation of vegetable gardens.

Working on these projects led us to do more probing and finally create a sustainable system for treating village wastewater. Villagers are appreciative of this holistic system, and they hold an annual spring festival near the temple pond. The cattle owners and their herds access the pond from one location only, and a drinking water facility has also been provided for the cattle near the pond. This village is near the Sultanpur National Bird Sanctuary and the upgraded habitat has drawn foreign migratory birds.

Solid Waste Management and Bio-Composting

We’ve also gained experience with solid waste management through the propagation of on-site composting of clean bio-wastes and bio-compost. Manure is treated as 'wealth from waste' and taken for horticulture uses. Additionally, we’ve adopted the concept of green campuses where green buildings are developed. Through these measures, communities are made aware of the value of recycled waste and the initiatives are promoted. The city's load for solid waste management is also reduced due to these decentralized initiatives.

- Bharati College: All the bio-waste generated on the college campus is collected and segregated for composting; and, due to the large amount of compost generated, this becomes a viable means of income generation for the college. This is a self-sustaining method of waste management and also sets a good example for others to replicate.
- Pathways School: Initiatives have been taken in the school to segregate and manage the waste. Bio-composting at the school has been set-up with our help. As a result, the school at large is motivated for this action based activity.
- Botanic Garden: The biodegradable waste collected from the garden is taken for vermi-composting. This working model of bio-composting is used as a display for the school and college students to create awareness, impart their knowledge of waste management and to motivate others to take similar initiatives in their respective sites and institutions.

"Youth for Environment" and Water Development

Water Innovators: Youth have both special concerns and unique responsibilities with regards to the environment. Many environmental risks and hazards affect young people who have to live with the deteriorating environment bestowed upon them by earlier generations. Youth have been encouraged to engage in new forms of activism that will generate effective responses to ecological challenges. Many people, especially young children, are particularly vulnerable to environmental risks to include, for example, limited access to clean and safe drinking water. The youth will thus become the agents of change in the present world as they come to understand the causes and effects of environmental degradation and are also willing to work for a better environment in the future. Acting with an environmental ideology, youth have been encouraged to work for water and its conservation. Youth volunteers generate awareness and work in the various communities for water development tactics. We have lead volunteers at various schools and colleges to include Bharti College, Lady Irwin College, Institute of Home Economics, D.C.E., Harola School, etc. These volunteers go out into the community to promote awareness of the importance of water and the apt principles and practices of conservation (i.e.: the four R's: reduce, reuse, recycle and recharge).

Our Greatest Barrier to Clean Water Access

At present, India is a water-stressed nation. Adequate water resources on the surface and in the sub-soil aquifers are challenged not only by tremendous water stress and shortage with looming consequences, but also by increased costs and expenses to the communities. Both the rural and urban sectors consume more water than what is required for their needs from a deficient supply and one with ever increasing demands.

In the agricultural sector, the most efficient way of farming has yet to be introduced. Water gobbling and costlier agri-produce should be shifted to areas of ample water resources and appropriate agri-farming should be employed in water deficient and stressed regions. Water conservation measures are adopted wherever possible by the use of sprinklers and drip irrigation systems.

A supply side management assessment indicates a gross deficiency of surface water resources. To ease the water supply shortage, the nation as a whole now relies on groundwater more than surface waters. Decentralized groundwater is available where required and hence also draws heavily on the electric power supply and costs. This resource is largely used for agriculture and for human habitats in most cities and villages and for industrial purposes as well.

The privatization of natural resources has led to the degradation of age old practices of water management and conservation, thus leading to the deterioration of natural resources. There has been a change in mind-set and the traditional practices of conservation have not been upgraded to reflect this change; therefore, we've witnessed a gross failure of water management in all sectors. This adds to the deterioration of our water situation.

VVF's Future Goals and Initiatives

As an extension of our activities for urban renewal, plans are in the works to formulate appropriate city development plans for water, sanitation and appropriate waste disposal. VVF has played a pivotal role in these sectors. For example, Delhi is to host

Commonwealth Games in 2010, and we have been associated with the environmental development work to include groundwater improvement, river front uplifting, institutional development, etc. We also plan to continue networking with lead nongovernmental organizations on watershed development and sharing our experience with environmental projects during workshops, seminars, conferences etc.

Youth for water programs: We plan to promote networking among youth volunteers and to motivate more youths to volunteer for water conservation causes. Thus, targeting a greater number of communities to spread awareness is essential. VVF believes our youth are the medium for change in the present world as they are willing to work for a better environment for the future.

Our Impressions on the Water Crisis in India and Some Suggested Solutions

Water is required for domestic purposes, irrigation, and industry which are all vital to the survival and progress of Indian society. This is why important civilizations have grown and prospered around perennial rivers and other water bodies. It will only be possible to change our current situation through community participation and decentralized water resource management tactics. Communities should be motivated to apply the four R's of conservation to support the water development cause.

Urban colonies are water deficient, and, therefore, rainwater should be used to recharge groundwater aquifers or for store and use models. Rural ponds and lakes are to be de-silted and maintained in order to retain adequate volumes of rainwater to recharge groundwater levels. Awareness and participation of students, communities and their residents must be garnered for the success of our cause.

Linkages of rivers and basins with adequate water levels are judiciously derived to refill dried water bodies. Similarly, the inter-linking of groundwater reserves should be attempted where feasible. Surface water is exposed to all vagaries of pollution and is susceptible to contamination, but the groundwater is in many ways more protected, and, with some caution, it can easily be used wherever need arises. This natural resource is time tested and should be cherished and used prudently under apt legal strictures.

India has adequate surface and sub-soil water for present and future needs, but community members need to be made aware of management principles and sustainable solutions to manage its use judiciously.

Chapter Three

India's Water Future: Secure or Scarce?

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Prediction is very difficult, especially if it's about the future
– Niels Bohr

Bohr's insight doesn't seem to ring true with the assessment of India's water future. With little depression in population growth and with mismanagement of water, our per capita water availability is bound to dip below the critical level of 1000 cubic metres. This does not, however, take into account the extraneous factors – over which there is little human control – like global warming and climate change that have already begun to melt glaciers and disrupt the monsoon cycle.

At present, the country's water planning remains loyal to engineering solutions that not only burden the economy, but also exacerbate the unfulfilled promise of improving access and delivery to a growing number of water have-nots. Despite the focus on drinking water in successive five-year plans, over 20 percent of India's population does not have access to safe drinking water. In absolute terms, this number is a staggering 200 million.

Statistical puzzle

India's water sector resembles a jigsaw puzzle due to the inconsistency of water source and supply data. The Department of Drinking Water Supply (DDWS) claims that 94 percent of all rural villages have been covered with water supply by early 2004. With only six percent of the population left to be covered, the department may soon need to be closed down or its priorities shifted to other pressing demands of the rural sector.

Due to its submission, DDWS exposes the hollowness of its lofty claim. If only a miniscule population of six percent remains to be covered, why has DDWS sought Rs. 404 billion for rural drinking water coverage in the Tenth Plan (2002-07) opposed to an expenditure of Rs. 167 billion in the previous Plan period? It seems apparent from this budget request that the claimed drinking water coverage is inaccurate.

Similar variations for coverage and projected demand can be seen for the urban water sector as well. While the urban population is projected to increase, the financial allocation for urban water supply for the Tenth Five Year Plan has been pegged around Rs. 282 billion. Though it is also claimed that 95 percent of urban population too has been covered, coverage realities are, again, inaccurate.

Despite the critical shortfall in coverage and a rising demand, the government finds it difficult to fund, monitor and manage both rural and urban water infrastructure owing to a decline of public finance stability. Under such conditions, the issue of quality and equity in distribution remains grossly unattended, both in rural as well as urban areas.

Population dynamics

If current demographic trends continue, the cross-country drinking water sector is in for a serious crisis. Though projections vary, the country's population by 2050 will fall between 1345 million and 1581 million. This prediction provides clues for the planning and implementation of water policies and interventions that will provide sufficient water for India's citizenry in the decades to come. But the planners seem oblivious to these trends.

Population Growth Scenario

Source	2000	2010	2020	2050
Natarajan (1993)	1020.50	1183.10	1301.00	
United Nations (1995)				
[a] Low Variant	1013.50	1156.60	1249.70	1345.90
[b] Middle Variant	1022.00	1189.00	1327.10	1640.00
[c] High Variant	1030.50	1221.70	1406.10	1980.00

Visaria and Visaria (1996)	995.00	1146.00		1581.00
United Nations (2002)				
[a] Low Variant	1016.94	1145.90	1236.09	1241.56
[b] Middle Variant	1016.94	1173.81	1312.21	1531.44
[c] High Variant	1016.94	1201.71	1388.48	1870.06

Adapted from Table 3.12, NCIWRD Report; http://esa.un.org/unpp/

The fact that the majority of the population growth will be accounted for by urban areas may add to the existing water crisis in the cities. By the year 2050, India's urban population is projected to oscillate between 48 to 61 percent. Even if the middle variant of 55 percent is taken into consideration, 800 million out of the projected total population of 1450 million will reside in urban dwellings—adding an unprecedented 500 million to the present urban population of 309 million.

Though the noted demographer Professor Amitabh Kundu argues that the urban growth rate will slow down in the years ahead as infrastructure improves in rural areas, trends predict the contrary. Urban centers are fast becoming islands of economic prosperity and employment opportunity; therefore, there has been an exodus of Indian's from rural to urban areas. Unless there is dramatic shift in the government's pro-poor policies, urban growth will create dramatic congestion and demands upon the cities' service industries.

The shift in population, from rural to urban, brings yet another dimension to the crisis. While the rural water demand is assessed on an allocation of 40 lpcd, the corresponding urban demand is against a norm of 135 lpcd. So, a population shift means an additional demand on rapidly decreasing urban water resources. Interestingly, however, a city dweller presently receives an average of 200 litres of water a day, despite significant inter and intra-city inequities in water access and distribution.

Even if the accepted level of allocation (135 lpcd) were sustained in the year 2050, each of the metros will have to search for fresh sources of water to meet the growing demand. Already, cities like Delhi, Bangalore and Chennai ferry water from as far as 200 km away. Should this trend continue, rural areas would be robbed of their water, creating a deep rural-urban divide.

For example, the ongoing conflict between Uttar Pradesh and Delhi on sharing Ganga waters and the recent struggle over sharing the waters of the Bisalpur dam between villages and the city of Jaipur, are both indicative of an unstable water future. Far from resolving such conflicts, governments have been evading the issues by politicizing them. Can legal measures and policy frameworks rationalize consumptive use? Can governments protect water rights by ensuring equity in access and distribution?

Lacking long-term strategies as well as public finances, state governments are responding to such conflicts by exercising greater control over surface resources and groundwater reserves to serve the interests of particular sections of the society. Additionally, the fact that water sector planning is restricted to the five year plan periods further complicates the issue.

Dwindling reserves

Groundwater has been the backbone of Indian economy and consequently a critical factor in country's water future. If groundwater depression in several parts of the country is indicative of future extraction patterns, the country should be close to exhausting its groundwater reserves. While the government estimates that total groundwater use will be around 230 billion cubic meter (BCM) in 2010, some current estimates of groundwater use already exceed 250 BCM.

Statistics at times can be deceptive. The fact that groundwater reserves are shrinking faster than they are replenished is a difficult reality to dispel. Additionally, there are the recent instances of ground water appropriation by soft drink and packaged water companies. The long-standing conflict between Coca-Cola and the Placchimada village exposes the vulnerability of the poor as groundwater extraction assumes corporate proportions.

The situation is further accentuated by the fact that 82 percent of all villages surveyed by the National Sample Survey Organisation use ground water to self-supply for domestic needs. Any measure to control groundwater extraction may need to take users' rights into account. Conversely, recent groundwater legislations in Rajasthan, Maharashtra, Orissa and Himachal Pradesh have been designed to restrict villagers' access to groundwater.

Has legislation been issued to counter the panchayat's growing control over groundwater? Are state governments planning greater control over water sources to increase revenue by selling water rights to commercial users? Needless to say, a unilateral decision to seize control over natural resources leaves undesired water usage to chance, especially when the States' are resource-crunched.

A recent study by International Water Management Institute issued in Indore, Nagpur, Bagalore, Jaipur, Ahmedabad & Chennai, notes that in the latter three cities the contribution of groundwater to domestic and municipal water requirements ranges between 72 and 99 percent. Most of these cities also have a thriving tanker water economy, supplying anywhere between 14-55 million liters per day.

Annual revenue from tanker water economy in these six cities alone is reported to be worth over Rs 100 crores. If we extend this figure to cover other cities across the country, this may well be the biggest informal industry, thriving solely because of municipal water supply shortages. This informal water economy depends entirely on groundwater extraction from peri-urban areas; and, in the absence of any regulation, their use led to the emergence of well fields all over the cities' periphery.

Will the tanker economy thrive for long? It may, so long as the water sources remain within economic reach and the water cost remains attractive to the urban consumer. Even if emerging groundwater legislations were to restrict the growth of this informal industry, groundwater extraction will shift base to the municipal system that, even today, sustains much of the urban supplies through groundwater. This results in a Catch-22 situation.

By all assessments, the role of groundwater in the country's water economy seems bleak. As groundwater shrinks away from extractable limits, owing to erratic rainfall pattern and reduced recharge, the water sector will go through dramatic changes in coming years. More importantly, agriculture will be significantly affected as growing urban and industrial demands deplete farming resources.

Cropping squeeze

Drinking water accounts for just 10 percent of available water, and squeezing water out of irrigation allocations is an undeniable possibility. The irrigation sector in the country is grossly inefficient, and, administering a 10 percent efficiency norm on the existing utilisation pattern (reflected in regulation and pricing) is enough to ease water woes. But how this process will it be implemented remains unresolved.

Steady decline in exploitable groundwater reserves shifts the onus of meeting India's water demand to surface water. Estimates indicate this resource will have to contribute no less than 63-65 percent of the total water requirement in the decades ahead. This shift is critical as groundwater has thus far been informally – in a democratic decentralized manner – at hand for anyone who could afford a diesel pump.

This is likely to change. Projections indicate that the proportion of surface water required to meet domestic and municipal demands will be between 55 & 60 percent; for industrial use, the proportion may range between 69 & 72 percent; for power, it will be between 80 & 82 percent; and, all other uses will be met from surface water only. However, such demands are pitted against shrinking ponds and tanks, dried marginal rivers on account of catchments, and heavily polluted major rivers.

Meeting food requirements for a large population in the year 2050 is another challenge, as the numbers of those producing food at the farm will be reduced. The only recluse being that urban per capita consumption of cereals is much less than the rural per capita consumption and hence the food output may have to rise by 50 per cent from the present levels. Does this indicate diversification of cropping pattern from the traditional rice-wheat system?

It indeed does but for the fact that present investment policy continues to focus on rice-wheat cropping pattern and is targeting additional 35 million hectares under irrigation at a whopping investment of over Rs. 5,60,000 crore over the next three decades. Such policy concerns are in direct contravention to the emerging trends and encourage farmers to grow crops that are economically remunerative in the open markets, even if these were high water consuming.

Isn't it a paradox to talk about water-use efficiency when major irrigation projects are on the anvil at the same time? It is tossing up a `surplus' scenario amidst a largely 'scarce' resource. Unless farmers are given incentives and market back-up to grow water-efficient crops for changing food habits, the rural-urban conflict on sharing surface waters (from irrigation dams and canals) will snowball into major conflicts in the years ahead.

Imperfect Future

Water has been a subject of great controversy in India; so much, in fact, that five central ministries and as many institutions pull at the issue in different directions. For example, while the agriculture ministry demands more for irrigation, the urban ministry does likewise for growing cities; while the industry ministry demands liberalization for industrial applications, the pollution boards demands stringent regulations and penalty for wasteful utilisation.

Unless water is viewed holistically (without losing sight of the hydrological cycle) and is brought under an apex that balances competing demands through an effective institutional mechanism, sound regulation based on equity, and a system that values conservation to consumption, the water future of the country will remain in jeopardy. This situation calls for a clinical dissection of the entire sector to bypass the `business as usual' components.

Before such an 'ideal' transformation takes place, we need to emphasize technologies and institutions that are ready to take up the short-term challenges of recycling wastewater, developing cost-effective technologies, converting saline water for potable use, and enhancing water productivity across diverse uses. It is imperative that the country's large water sector, in terms of both manpower and infrastructure, disengage from its present mindset of engineering interventions and instead design solutions which require accountability from consumers.

India will be better served if those overseeing the water sector are posed the challenge of revitalising water bodies and reviving decaying marginal rivers. If economic growth includes water availability to each citizen, there is a dire need to the increase stored water per capita (The US has 5000 cubic metres of per capita stored water; China has 2500; and India has just 130). This can only be achieved, however, by creating location-specific storage facilities that conform to the constitutional mandate of decentralized governance, not by building large dams.

Chapter Four

Safe Drinking Water Scheme in Villages: A Sustainable 4P Model

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Over the course of the past few years, the Byrraju Foundation (BF) has found that water sources are still polluted in the villages they work in. Even after the filtration and chlorination of water under the Rural Water Supply (RWS) Scheme, water tests have shown that this drinking water does not even meet the most basic standards. To address this issue, BF came to the conclusion that the most viable option is to separate the drinking water from the rest of the quantity supplied by RWS. Towards this end, 52 community-based plant is supported by the Gram Panchayat (local village governments), the local communities, BF and a Panchayat-Public-Private Partenership (4P) model. This plant produces 1000-2000 liters of purified water an hour and provides access to safe drinking water for 800,000 people in 160 participant villages.

Appropriate treatment processes to purify water have been implemented to suit the characteristics of input/raw water. The purified water is delivered at a user charge of one cent a gallon which ensures its sustainability. The overarching concepts and technologies have been modified to allow the community to operate this plant. Based on this successful experiment, BF plans on setting up similar plants, as sustainable rural enterprises, in a cluster of three villages with a population of 8,000-10,000 people. A few agencies, including the United Nations-Human Settlement Program, have replicated this model and set up 12 plants within and outside Andhra Pradesh, providing access to safe water to 100,000 people. This paper, presents a case study that includes the features of this scheme, in terms of community participation, operation, sustainability, impact and lessons learned.

About Byrraju Foundation and Its Activities

BF, a not-for-profit organization dedicated to rural transformation, was been set up in July 2001. The Foundation seeks to build progressive self-reliant rural communities, with a holistic approach, by providing services in the areas of healthcare, school education, adult literacy, drinking water, environment, sanitation, livelihoods, agri-advisory services and disability rehabilitation. The Foundation currently works in 185 villages spread over 6 districts in the state of Andhra Pradesh. BF specifically works in the East Godavari, West Godavari, Krishna, Guntur, Ranga Reddy and Visakhapatnam areas. The Foundations aims to positively transform the lives of nearly a million people directly and double that number indirectly.

BF, since its inception, made rapid strides in implementing rural transformation programs, with active involvement and support of community, in the participant villages. BF distinguishes itself from other such organizations by its holistic approach with the emphasis being on creation of "soft infrastructure" to capture knowledge processes that are used in rural initiatives. These practices are perfected by starting with the identification of needs and the customized design appropriate to the areas and the communities that we work with. The experience gained from every initiative allows us to make dynamic changes to our efforts so to ensure optimum delivery. These experiences create knowledge processes that are replicated thereafter with minimal customization. BF has used it core values which embrace 6-Sigma as the tool for designing new processes and making improvements in the existing processes by involving people, applying knowledge and making things happen. All the programs of BF are divided into modules, which are well-defined value creation activities, each one having a detailed process map with clear-cut methodologies and outcomes ensuring the realization of objectives in successful implementation.

Drinking Water Situation in Villages

Safe water, though very important for maintaining proper health, is unfortunately a low priority for social health programs. In most of the villages, where BF is working, 63% of villages are dependent on irrigation canals and the remaining 37% of villages use ground water. Under the RWS scheme, most of the villages, especially in delta region, have a pond that is fed by the irrigation canal at regular intervals, which stores the required quantity of water. The water in the pond is passed through Slow Sand Filters (SSF) followed by an occasional process of chlorination, before being pumping into an overhead tank for distribution. This distribution is conducted by system of pipes that reaches a few homes having individual connections but gives access to the majority of population through common stand-posts.

Over the years water bodies are polluted due to various contaminants. The quality of raw water in the pond is extremely poor, resulting in frequent clogging of SSF's, which are designed for the raw water turbidity up to 30 NTU. But the actual turbidity is much higher, especially during the monsoon, going up to 130 NTU. The SSF's are designed for 16 hours of operation with 3-phase power, so as to supply 40 litres of treated water per capita daily. But the 3-phase power is available only for 6-7 hours a day in most of the villages which restricts the operation of SSF's to produce the specified quantity. In many instances, this leaves people to resort to pumping of untreated (raw) water. Further, the lack of adequate funds does not allow proper maintenance of the SSF's.

BF has found the presence of coliform, turbidity, chlorides and other physical and chemical impurities in excess of permissible levels in the water supplied through the RWS scheme (though this water has passed through filtration and chlorination.) On account of the above mentioned parameters, it has been observed that RWS water in 78% villages does not meet the safe water requirements. If the need for 0.2 ppm of residual Chlorine is also considered, 96% villages failed in meeting such norms. In case of upland areas, which depend on ground water, in a few pockets, high levels of TDS, including fluorides, in excess of WHO norms, have been observed.

To address the issue of providing safe drinking water, the Byrraju Foundation came to the conclusion that one viable option is to separate the drinking water from the rest of the water supplied through RWS in villages. Towards this end, a small plant, producing 1000-2000 liters an hour pure drinking water, supported jointly by community, Gram Panchayat and BF was set up. The product water, free from harmful bacteria and other impurities, is delivered in a 12-litre food-grade HDPE. User are charged US$ 0.035 in order to run the unit on sustainable basis.

Efforts of Byrraju Foundation in Providing Safe Drinking Water

Strategy

Reducing levels of pollution in the irrigation canals is a gigantic task, which needs a lot of resources, time and effort. BF, having realized the problems, has developed a strategy to address the situation on a long-term sustainable basis.

Out of 40 liters of water per capita daily supplied by RWS, about 2 litres is used for drinking purpose, which comprises of 5% of the total quantity to be supplied in villages. It is much easier to treat 5% of water supplied to drinking water standards rather than the entire quantity. So, the Foundation came up with the idea of setting up of a small community based plant producing 1000-2000 litres an hour pure water, for every 3 villages, using the best technology, to be operated by the trained youth from the village whenever normal power is available. Its sustainability is ensured by the collection of user charges for operation and maintenance. Quality of the product water is monitored strictly and local Science Colleges are involved in regular testing and quality control.

BF, involves Gram Panchayat, the community, individual donors, corporates sponsors and philanthropic organizations, in setting set up water plants. This collaboration makes it a panchayat-public-private partnership. Gram Vikasa Samiti (Village Development Committee) (GVS), a nine-member team of volunteers, representing different sections of society, including women and youth, formed and institutionalised by BF in all the participant villages, monitors the activities, on behalf of community, at the village level. Amongst donors were a few non-resident Indians as well, who contributed for this venture in the villages where they and/or their parents were born/lived. The following responsibilities are discharged by various stake-holders in this initiative:

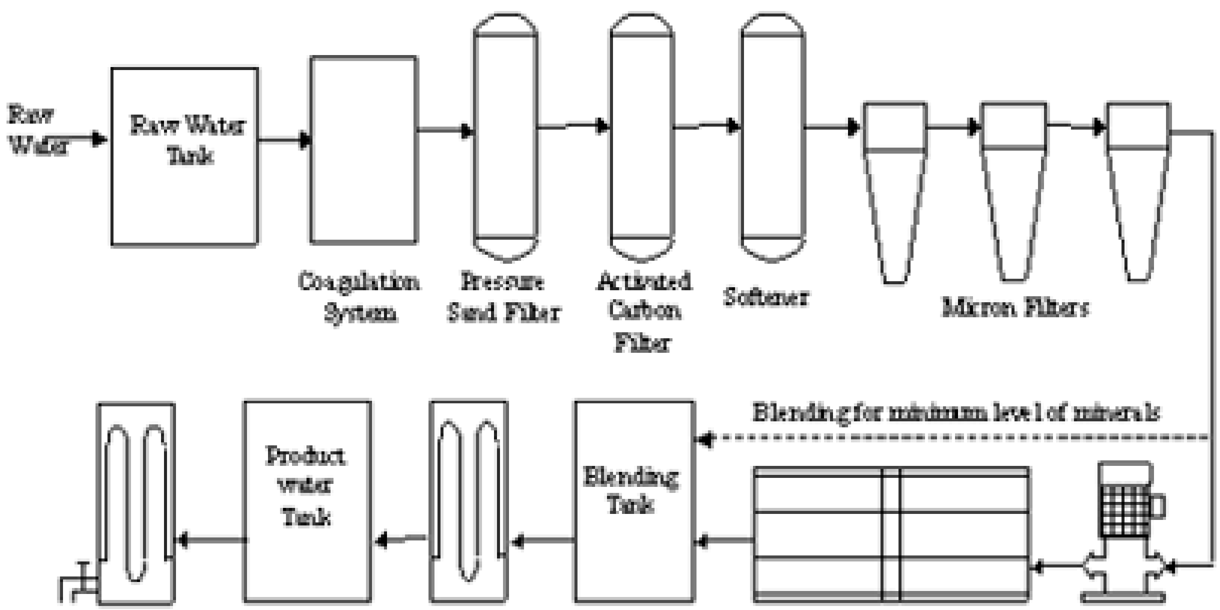
Gram Panchayat	Community (GVS)	Byrraju Foundation
Permission to draw raw water	Minimum 50% cost of equipment	Up to 50% cost of equipment
Allotment of land	Construction of Building	Selection of vendors For equipment, Technical guidance in setting up of the plant

Power Connection at Concessional tariff	Participation in operation of plant and distribution of water	Testing of water and quality assurance

Purification Process

Initially, a pilot plant, jointly supported by Gram Panchayat, Community and BF, was set up in Gollalakoderu (near Bhimavaram in West Godavari District of Andhra Pradesh), in July 2004.

A schematic diagram indicating broad outline of the purification process is given below:



Operation and Maintenance

The quality of input water is continuously checked in a thorough fashion for various parameters, like, turbidity, physical and chemical impurities, bacteria and dissolved solids in order to ensure 100% satisfactory performance. Based on the levels of impurities/bacteria, the process parameters are set for its effective removal. To overcome the power-cuts, plant is operated on single-phase, as it is available for 12-16 hours a day in village, on flexible timings, using voltage stabilisers for maintaining quality of power. 100% standby for all the critical components, like, Pumps, Motors, UV Lamps, Voltage

Stabilisers, Multi-port Valves and adequate stocks of consumables are maintained within the close distance to the Plant.

The suppliers of the Plant are ensured trouble free operation by abiding by an annual maintenance for the initial 5 years. For every 5 plants, a maintenance team is deployed within close vicinity of a cluster of villages by the supplier of equipment, so as to attend to regular preventive and break-down maintenance. Layout of Plant and components have been standardised so that the plants, operating on similar conditions, can effectively share inventories for proper operation. The GVS member identified for water programme oversees the operation and maintenance of the plant.

Capacity Building

The operational capabilities of a program are enhanced by the capacity building aspect of the community. This process identifies and solves problems by systematic community participation. To facilitate this, BF imparts skills to the community/GVS on self-reliance in setting up and meeting operational expenses for various services through user charges and/or mobilization of funds and also leadership development for its efficient and systematic implementation. For operation of Water Plant, unemployed youth, identified by GVS, are imparted adequate training on various issues, such as, technical aspects, operation, hygiene and cleanliness, testing of water quality, account keeping, marketing, simple repairs, distribution of water, etc. Initially, BF through its field staff, oversees operation and maintenance of water plant. After stabilizing the unit, creating an awareness on drinking safe water, planning of logistics for delivery of water and ironing out any deficiencies in the operational and distribution matters, the running of the plant is handed over to GVS or an entrepreneur or a self-help group. The first option given to plant operators is to form an entrepreneur or Self Help group. BF has already handed over maintenance of 9 plants to local entrepreneurs under the close supervision of GVS and more are in the pipeline to be handled so. The surplus generated is used for common good of the community in the village.

Sustainability

Sustainability of the project is ensured as (a) Project is demand driven, (b) Users are involved right from the beginning of the project implementation, (c) Empowering the Management and Users' Committee in taking responsibility of operation and management of the scheme, and (d) Cost recovery mechanism with participation of consumer. The Project is designed as a financially sustainable model, involving community in the investment. BF believes that, in the absence of an effective taxation mechanism, the community need to generate their own economic surplus to achieve financial sustainability for social initiatives. The key factors required to realize economic potential are (a) Financial deepening, (b) Market access or the crucial link to generate revenues and sustain growth, and (c) Knowledge management which is the exposure to modern systems and process driven approach. The water project connects the formal financial markets with community thus becoming a working evidence for link between social capital and financial intermediation. The economics of operation, which is result of improvement over the years, is depicted below:

No	Item	Non-RO	RO
1	Capital Expenditure (including building US$ 10000)	17500	20000
2	Production of water per day in liters (average)	7000	7000
3	Distribution of water per day in liters (average)	6000	6000
4	User Charges @ US$ 0.035 for 12-liter can per year	6400	6400
5	Annual Recurring costs in US$:		
	- Manpower (3 persons)	2700	2700
	- Power, Consumables, Maintenance, Depreciation and miscellaneous expenses	1900	2900
	TOTAL expenditure per year US$	4600	5600
6	SURPLUS per year in US$	1800	800

BF facilitates the economic sustainability of community in poorer sections so that the social leadership can implement holistic transformation programs effectively. Water Plant is a profit-oriented enterprise, a part of the surplus generated is ploughed back for implementing various activities to benefit the community. It can also be run as an enterprise, which breaks even at distribution of 4000-4500 liters daily. Unemployed youth from village are provided training for operating the plant. One helper is engaged, for delivering 120-150 water cans, by rickshaw at the door-step of consumer, charging additional amount of 1-3 US Cents per can, depending on the distance. A van is deployed for carrying water cans to little far away places, say beyond 4-5 km from the plant. In all, employment for 5-6 persons is ensured per each plant.

Impact

Access to clean drinking water has transformed the village landscape in many ways as its consumption has improved health leading to reduced expenditure incurred otherwise towards treatment of water borne diseases, reportedly accounting for 80% of ailments, thereby enlarging productive time. The impact is quite perceptible among the children, in regards to the reduction in absenteeism in attending school due to sickness leading to improved learning, as water from these plants is supplied free of cost to the schools and health center. The initiative benefited the community in the following aspects:

- 52 water plants in BF villages and 12 plants in other places were set up (as on February 2008)
- Access to safe drinking water provided to nearly 800,000 people in BF's 160 villages and about 100,000 people in other places
- About 46% of people on regular basis and 5-10% people on and off consume BF water
- Over 300 million liters of safe water distributed to the poorer sections of the society, covering old age pensioners, destitutes, Orphanages, Anganwadi (nursery) Centres, Schools, etc.
- Number of patients visiting BF health clinics in the villages with access to BF water dropped by 15-30% and the expenditure on medicines declined by 10-22% after consumption of BF water, leading to improved quality of life, attributed due to relief from water borne diseases
- Provided livelihood opportunities to nearly 250 youth within villages

Lessons Learned and Challenges

Initially, the pilot plant at Gollalakoderu did not foresee high levels of suspended matter. These impurities increased during monsoon period and also summer months when canals feeding fresh water are closed for 6-8 weeks for repairs and also due to reduced water in the reservoir. A small scale coagulation unit to remove most of suspended solids was set up thus reducing load on sand filter and micron filters. Further, ozonation was also introduced to improve shelf life and quality of product water. In some villages, which distribute higher quantity of water, a diesel generator has been installed to meet the requirement of electric power.

Though BF desires that the poorest of the poor can afford to consume safe water, the main challenge is to reach them effectively. Although BF is creating awareness and educating the community by demonstrating the contamination levels in present water systems, their mind set is something very difficult to change in a short span of time. Added to it is the cost element, as vast majority in the community want drinking water at no cost and at or very near to their doorstep. Despite realizing the importance of consuming safe drinking water, the common practice of drinking from available sources for years inhibit them from wanting to pay for product water, no matter how safe it may be. But the reality that the naturally available resource is polluted does not strike them immediately. Continuous and constant persuasion can only motivate them to switch over to safe water.

Distribution of product water is another issue. While those in close vicinity of the plant collect the water, people living far from it need to put in extra effort or spend on transport. The poor condition of roads, more so in monsoon time, distracts transporter to carry the water for door delivery. To improve distribution system, mobile units to process water at different locations, including hamlets, which are far from main water source, are another option for ensuring higher levels of penetration. However, the realization and need for safe options is increasingly felt and the trend is towards searching for better sources.

Replication

Based on the experienced gained, BF is confident of setting up of small community-based water purification systems for a cluster of 2-3 villages/locations, having 8000-10000 population, as a sustainable enterprise. The concept and technology have been proved to make the community to operate the Water Plant on their own because (a) The technical design of the plant, the process and the choice of equipment are very sound (b) The recurring cost of running the plant is not a burden on the donor/sponsor, and (c) Willing participation of the community is possible. Appropriate treatment processes have been put in place to suit different situations and the model, with incipient potential of generating income, is replicable across other regions/countries in a sustainable manner. BF guided and assisted quite a few organizations agencies in implementing the scheme. United Nations-Human Settlement Program (UN-HABITAT), under Water for Asian Cities Program, signed a Cooperation Agreement with BF in setting up one plant each in Indore (installed in Dec 2007), Jabalpur (both in Indian State of MP), Laos, Nepal and Uganda.

Environmental Issues

BF’s water initiative addresses environmental issues through treatment of contaminated water thus providing safe water for drinking purpose. The refuse and wash water, after purification (usually 4% of total production in case of conventional process and up to 50% in case of RO system), is recycled to charge the ground water table or used for irrigation purpose or in its absence let into drain. In case of Kandlakoyya Plant, the reject water is used to irrigate kitchen garden and lawns in an old age home thereby following the practice of conserving the water. The product water is distributed in food-grade HDPE cans safe for storing water. These cans last a year and can be recycled without posing problem of degrading the environment. BF developed a low cost H2S vial, costing 20% of market cost, for testing bacteria and the glassware used for this is recycled thus reducing generation of more waste. In summer months, effective micro-organism solution, made locally in the Laboratory, is sprayed for controlling growth algae, which increases due to intense sunlight and also restricted supply of fresh water, in the pond instead of other chemicals thus following environmental friendly practice. The yarn of used/discarded micron filters, is used to making products, like door mat, swing, muffler, cushion cover, floor mopper, thus not wasting this material either.

Quality Assurance and Control

Quality of product water is tested everyday at plant for key parameters, like, bacteria, TDS, residual chlorine, pH, etc. Elaborate tests are carried out in a well-equipped Laboratory in a Degree College for these as well as other chemical and physical parameters on weekly/fortnightly basis. In addition, the presence of crucial parameters, like fluorides and nitrates, which require costly and sophisticated apparatus with high level of skill, is analyzed in other laboratories accredited by National Board of Accreditation for Laboratories and Test Houses(NABL) on six-monthly basis. Based on these test results, it has been observed that the water samples passed quality tests, 99.8% times across all the plants, during the last one year, against the a set target of 99.5%.

Recognition

The experience gained, technological and social outcomes obtained through this intervention, are widely disseminated through presentation/publication of papers (listed below), consultation/guidance extended to other NGOs, etc. Process Document, listing out treatment processes, operation and maintenance, and management issues in running the Plant, has been developed and distributed amongst interested agencies.

BF has been rated ‘Best Water NGO-Water Quality’ in India by Water Digest (A global magazine for water solutions) and UNESCO for the successive years 2006-07 and 2007-08. Global Development Network, conferred Japanese Award for ‘Most Innovative Development Project-2007 (2nd prize) for the water scheme. The project (working model), exhibited during the 95th Indian Science Congress held at Visakhapatnam during January 3-7, 2008, has been rated Outstanding Display by the delegates. The work has been reported in a few publications and a couple of them are mentioned below:

1. “The Byrraju Foundation’s 4P model of Quality Drinking Water in Villages” published in ‘India Infrastructure Report-2008: Business Models of Future' by Oxford University Press (Edited by 3i Network: Indian Institute of Management-Ahmedabad, Indian Institute of Technology-Kanpur, and Infrastructure Development Finance Company Limited), February 2008, pp 183-185.
2. “Pro-poor Water Purification and Bottling” published in ‘Local Actions for Sustainable Development: Water and Sanitation in Asia-Pacific Region’ by UN-HABITAT, Asian Development Bank and Asia-Pacific Water Forum, December 2007, pp 99-102.

The Greatest Barrier to Clean Water Access

Though many issues concerning water distribution have been receiving attention of governments, the real problems in supplying safe water are not addressed to adequately. High levels of contamination and unsanitary conditions make water non-potable causing water borne diseases. Growing scarcity and rapid degradation of the water bodies will pose a greater threat for well-being of people. Grant of heavy subsidy on consumption of electrically operated pump sets not only results in wasteful use depleting water table but also contaminates due to leached pesticides, fertilizers, etc. The conflicts on sharing of waters in flowing rivers, between neighboring states, are flaring up often, leading to many habitations in the down stream opting for drawl of sub-surface water from deeper levels having higher amounts of undesirable impurities.

Ineffective distribution system driven by heavily subsidy driven system of water supply is another cause for not meeting the demand. A proper pricing mechanism for supply and distribution of clean water needs to be evolved which can prevent its misuse to a large extent. Like energy security, which is well recognized by the policy makers, water security needs greater attention which encourages industry to recycle used water and reduce waste in the domestic front. A policy that encourages conservation, efficient use of existing resources, minimum level of wastage, prevention of leakages, proper purification, strict compliance of quality standards, and enforcement of regulatory measures will go a long way in minimizing the water scarcity to a great extent. Privatization or corporatization of water purification and its effective distribution needs to be seriously considered to prevent the above situation. Creation of greater awareness and an informed public opinion can make a huge difference for proper and efficient use of water.

Testing of water and the infrastructure required thereof is inadequate, especially in village situations. A proper system, with the involvement of community, local institutions and health agency, for water testing at habitation level needs to be advocated. A reliable, user friendly and simple to use kits to test water samples in rural areas should be made available.

Future Goals of Byrraju Foundation

In addition to 52 plants in operation, 9 more plants are under various stages of construction and the same will be commissioned (in stages) within next 2 months. With this, all the 185 villages will have access to purified water. This proposition means one water plant for every 3 villages, each with a total population of 5000.

Due to various reasons, attributed mainly to lack of awareness, affordability and accessibility, about 45-50% of the people are only consuming BF water, with the remaining continuing to depend on the existing sources, how unsafe it may be. With continuous and constant efforts in educating the community on ill-effects of drinking un-safe water, it is expected that more and more people will switch over to safer options, leading to increased levels of penetration of BF water. In such a scenario, BF would like to eventually have one plant for every two villages or of every village to have a plant in the long run. This allows cutting down the costs on transportation of BF water besides resolving the issues related to distribution, especially in summer months, when demand goes up. This will also lead to possible reduction in the user charges and also generation of higher amounts of surplus. To meet the demand, BF intends to set up 30-35 more plants, in public-private partnership mode, within the next few years.

BF would also like to continue extending help to other NGOs and Corporate Social Responsibility arms of organizations in establishing such units in villages and also slum locations within urban areas. BF would also like to play an active role in advocacy to influence the government and policy makers in opting for most reliable and effective safe drinking water schemes on sustainable basis. BF strongly believes that consumption of safe water will lead to children growing in a healthy environment and community contributes to the well being of its own people.

Chapter Five

A Case Study of Three Villages under the 'Pani Thiye Panjo' Programme: A Multi-Institutional Decentralized Solution to Drinking Water Scarcity in Abdasa Taluka, Gujarat

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Profile of the Programme and Partners

"Pani thiye panjo", (loosely translated from Kachhchi means 'let this water be ours!') is a multi institutional programme that attempts to address issues of water scarcity through local water source augmentation in Abdasa taluka, Kachchh district, Gujarat. The project was conceived by Sahjeevan and is being implemented by a group of NGOs, namely Vivekanand Research and Training Institute (VRTI), Kutch Fodder Fruit & Forest Trust (KFFFT), Manav Kalyan Trust (MKT) and Abdasa Mahila Vikas Sangathan

(AMVS). It aims to ensure adequate[1], safe drinking water[2] access[3] to 80%[4] of the population of the taluka through the development of sustainable water resources at village level over a period of five years. The meta objective is to reverse the dependency of water from unreliable centralized rural water supply schemes to community managed wells.

The multi institutional framework helps to create and tap into a dynamic knowledge pool. In a classic example of community-public & civil society partnership, WASMO (Water and Sanitation Management Organisation), an autonomous organisation established by the Government of Gujarat in 2002, joined hands and committed funds to support the hardware costs (also some administrative ones) involved in programme implementation.

The programme is anchored in communitarian processes. Pani Samitis (i.e. Village Water Management Committees, a subgroup of the village Panchayat[5]) is capacitated by implementing NGOs, prepares a project proposal, the quality of which is assessed by ACT[6]. The final proposal is submitted to WASMO, which extends support through hardware financing.

Arghyam provides financial assistance to cover all soft costs of implementing NGOs. Sahjeevan being the nodal agency coordinates activities of the consortium.

Sahjeevan, (literally sah i.e together & jeevan- living) was set up in 1991 and has over a decade's experience in working on action research and developing models with the women collectives. Sahjeevan is an active member of the Kutch Nav Nirman Abhiyan[7] a civil society network and provides leadership to the Drought Proofing Program in the district, coordinated by the same people. Working in tandem with the other partners,

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[1] 70 liter per person per day

[2] The quality parameters will be concomitant to WHO standards, http://www.who.int/water_sanitation_health/dwq/guidelines/en/

[3] 'Access' will mean a distance of not more than 200m from individual households

[4] 135 out of 166 villages, as they were categorized earlier, and 80% required urgent intervention, the remaining had assured supply but work was required at management levels.

[5] Village level constitutionally approved (73rd Amendment of the Indian Constitution) governance and administrative units.

[6] Arid Community and Technologies, an NGO with expertise in geo hydrology

[7] Rebuild Kachchh Movement, which began after the devastating earthquake of 2001

the network has now gone on to support several villages in protecting their water, land, grasslands and mangroves.

Arghyam[8] is a public charitable foundation and has been working in the water sector since 2005. Guided by its mission “Enough water, safe wate … always and for all”. Arghyam supports strategic and sustainable projects and programmes in the water sector that enhance equity in access to water for all citizens. Its key interest areas are Integrated Domestic & Waste Water Management, Rainwater Harvesting, Groundwater Management and Sanitation. Till 2007-2008 Arghyam has supported 29 projects on water and sanitation in 9 States of India, spread across 30 Districts and more than 700 villages.

Types of Water issues in the Region

Kachchh (previously Kutch) is geo climatically one of the harshest regions of India. It forms a contiguous land mass with the Arid and Semi Arid regions of Thar Desert in Rajasthan. Kachchh experiences the highest air temperature in the month of May with temperatures ranging from 40°C-45°C. An average annual rainfall of 312 mm[9] coupled with 2-3 droughts in every five years make it a water stressed zone, The project area, namely Abdasa taluka[10] is located in this dry zone. Abdasa is one of largest talukas of the district[11] with 8 small towns and 165 villages. A large number of people, 73,633 (49%) do not have access to safe and adequate drinking water[12]. Water quality issues further compound the scarcity factor. Preliminary analysis of drinking water quality of 130 samples of water sources revealed 35 with high levels of fluoride and 54 samples had high salinity and was undrinkable. Overall, 58 villages are consuming saline water[13], way above the permissible limits of 1500 parts per million[14].

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[8] ‘Arghyam’ is a Sanskrit word meaning ‘*Offering*’.

[9] Gujarat Water Supply and Sanitation Board (GWSSB)

[10] Generally, a taluka consists of a city or town that serves as its headquarters, possibly additional towns, and a number of villages. As an entity of local government, it exercises certain fiscal and administrative power over the villages and municipalities within its jurisdiction. It is the ultimate executive agency for land records and related administrative matters. Its chief official is called the talukdar or tehsildar.

[11] The second largest in India, first being Ladakh

[12] The baseline scenario of Abdasa taluka was determined in a joint study conducted by Sahjeevan, ACT, WASMO and the four NGO’s of Abdasa.

[13] ibid

[14] ibid

Traditional coping mechanisms to such conditions had generally been migration in peak summers and manual construction of shallow dug wells known as virda. However, well construction technology (especially masonry) never really shaped up in Kachchh unlike its neighboring low rainfall areas of Rajasthan. Still, communities possess excellent traditional knowledge on marking out sweet potable water spots. Such knowledge systems are also under threat as over the years salinity ingress has affected such sources, putting otherwise vulnerable communities in a tighter spot. Also, traditional techniques are unable to mitigate fluoride contamination.

Efforts have been ongoing to address water scarcity issues in Abdasa taluka. On paper, it's the last taluka which will receive water from Narmada dam. Given the present controversy and public debates on the project and progress of construction, communities will have to wait for long till the "benefits" of such large developmental projects reaches its parched lands. In Gujarat, the last couple of decades, there has been an overemphasis on the Narmada dam solving the problem of drinking water for the State. But as the canals and pipelines started getting laid out the enormity and the difficulty of the task became apparent.

Making a choice between water for life and that of livelihoods is an everyday experience in these parts. Wells and lakes are and has always been the only way. "Virda" or shallow dug wells tap potable water at upper reaches of an aquifer (1-4 metres) as deeper down (<4m) one hits saline/brackish water. Rainwater harvesting through ponds and lakes has been a traditional process. Usually well off individuals in earlier times constructed such catchment structures out of charity. They served a key purpose in attending to livestock water requirement. Since livestock rearing is a key occupation in these parts, rising animal populations translates into higher water demand[15]. Traditional structures no longer hold ground in a fast changing demand supply regime. Hence augmenting water sources for both humans and livestock is a critical need of the taluka.

Challenges and Solutions to Pani Thiye Panjo Programme in Three Villages in Abdasa Taluka

Addressing the water scarcity challenge in villages in Abdasa has been attempted from two paradigms. The dominant one is that of a centralized techno bureaucratic approach in the form of transporting Narmada waters through large-scale engineering

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[15] For rural areas 30 lpcd for each adult cattle unit is recommended by the GWSSB.

and construction related activities. The other is of decentralized community led water management and augmentation. Of the two, the second seemed more feasible as it enables communities to seek solutions by enhancing their adaptive capacities, especially in the larger context of global climate change. The goal of this programme is to influence the state by setting an example, on a reasonable scale, which demonstrates that source development and the governance of safe drinking water can be technically and administratively devolved to the village/town level. It will also demolish the myth that arid, drought prone areas cannot be self-dependant for their domestic water needs.

Nimanivandh, Karamta and Sadhiravandh are three villages in the programme area. The following figure provides a brief profile of each village:

Details	Sadhiravandh	Nimanivandh	Karamta
Population	300	200	169
No of Households	54	35	52
Households below poverty line (BPL)	38 (70.4%)	20 (57.1%)	40 (77%)
Communities	Jat Muslim (100%)	Jat Muslim (100%)	Rabari 100%
Primary Occupation	Animal Husbandry	Animal Husbandry	Animal Husbandry
Name of Panchayat	Butta Juth Panchayat	Charopadi Juth Panchayat	Akari Juth Panchayat
Secondary Occupation	Labour Work	Dry Farming, Fishing, Labour Work	Dry Farming, Mava Making (Milk Product), Handicraft , Labour Work
Geo Hydrology (types of rock, soil)	Vinzan Series clay Formation	Recent Pleistocene Deposition	Vinzan Series clay Formation
Existing Water Structures (Traditional i.e. virda)	0 (traditionally both humans and livestock drank water from a nearby pond)	5 (2 in disuse)	3 (all in disuse)
No of lakes/ponds	2	1	3
Water Quality of Ponds	TDS and Bacteriological impurity	TDS and Bacteriological impurity	TDS and Bacteriological impurity

Use pattern of Ponds	Livestock Water	Groundwater recharge	Livestock Water
Existing Water Structures (Panchayati Wells)	0	3 (1 for livestock and 2 for drinking water)	0
Existing Piped Water Supply	From District Rural Water Supply and Sanitation Scheme (RWSS)	None	Sanghi Industry (CSR) & R.W.S.S
No of overhead tanks	1	0	1

The challenges faced by the Pani Thiye Panjo programme in these villages were the following:

1. Physical Water scarcity: In all three villages, there is acute water scarcity especially in summers, when the average annual rainfall is only 314 mm. In Nimanivandh and Sadhiravandh, virda's or traditional shallow dug wells (without masonry) usually cave in during monsoons, as mud and sand chokes the well. Locating the right spot for virda's is also not precise and many a times, such wells choke immediately on construction or produce brackish rather than sweet water.
2. Unreliability of Centralized Supply: In two villages, drinking water is sourced through a rural water supply scheme from an adjoining taluk. However, such systems are energy dependant and given erratic electricity supply in the taluk, villagers get to see water in overhead tanks only once in week. Water is also supplied through tankers, as in Sadhiravandh but again, its infrequent. Hence, 6 days in a week communities have to resort to traditional coping measures. Operations and maintenance (O&M) is also a major issue, as ownership of fixing pipelines and other peripheral equipments lies with the Panchayat. However, being technologically incapacitated, the Panchayat has to redirect the issue to the local water supply engineer, and this entire process is painstakingly slow. The village of Nimanivandh refused to lay out pipelines in their habitation, being aware of failure of piped water supply in neighboring areas.
3. Water Quality: Fecal coliform has been detected in ponds in each village, and health risks are high in Karamta where the existing pond provides drinking water to humans and livestock both during peak summer. As regards chemical impurities such as fluoride, water test results are awaited.

4. High opportunity cost in water collection: In all three villages, when assured sources of water (such as piped water) fail, women and children have to travel a distance of 3-4 kilometres on an average, to collect water from a distant source. Water is not only collected for domestic needs but also for livestock, implying greater demand and hence time taken and drudgery increases proportionately.
5. Low Masonry Skills: Though communities are adept in identifying sweet water spots and digging shallow wells, being pastoralists and migrants, there was never an effort to develop masonry skills. Hence, well construction know-how remains in a basic stage.
6. Institutional and Intra Community Conflicts: Formation of village level institutions, in the form of Pani Samiti's is a mandatory project process. This is primarily to strengthen decentralized management through users. Since Panchayat's are de jure management units of developmental intervention in a village, Pani Samiti's may be perceived as an existential threat. As witnessed in Karamta, there was noticeable conflict between the Pani Samiti and the Akari Juth Panchayat on these very lines as the Sarpanch wanted to wield political clout and demanded to be made president of Karamta Pani Samiti. In Sadhiravandh, individual farmers got on the wrong end of Pani Samiti by attempting to put in bore wells in revived ponds for irrigation. Also, there is confusion about legitimacy and association of Pani Samiti's unlike that of Panchayats
7. Willingness to Pay: Generating contributions at the village level are mandatory under WASMO project support guidelines. Ideally, communities have to show intent by paying 10% of the project cost in advance. Poverty being rampant in all three villages, getting communities to commit to such financial contribution was extremely difficult.
8. Involving women: Socio cultural and religious contexts are at times bottlenecks to ensuring women's participation in project processes. Though in random cases women have spearheaded projects in their village, gendered participation is still a much desired programme objective.
9. Inaccessibility: Two of the three villages are located in interior areas and are not accessible by road. This has adversely affected communities' ability to access developmental benefits such as education and health. Mostly pastoralist societies, Government progammes are unable to keep them in its ambit.
10. Changing Desert Ecology: Prosopis juliflora, an invasive with known negative impacts on soil moisture and groundwater, has proliferated over the years in Kachchh. Recent policy measures to check its spread was to sanction free logging of the same for charcoal making. However, a well meaning policy has backfired. Charcoal making being financially remunerative, there has been excessive logging of all local

varieties as well. This has intensified desertification and the impact of this entire phenomenon on infiltration is yet to be studied. Yet, current literature suggest that subsequent reduction of water infiltrating the soil due to lack of vegetative cover may result in a lowering of the water table and a potential reduction in the amount of groundwater

Response to such challenges requires deeper understanding of communities, local water issues, policies and institutional processes. The in house capacities of all stakeholders, especially the implementing organizations proved crucial for smooth project implementation at the village level. Solutions to challenges listed above originated mostly at the village level and was anchored in collective decision making. External support was leveraged mostly on technical fronts. However traditional knowledge of communities was integrated in such processes wherever possible. The following chart out key processes that allowed positive outcomes to the overall programme in the documented villages.

1. Promoting local wise use of water: Through the programme 3 new wells in each of the three villages have been successfully constructed. Well construction was the final output of a detailed planning exercise, which was 'ground truthed' by ACT and WASMO. In each village, communities helped with the preparatory work of testing and deciding the location. The formation of Pani Samiti's in each village, before construction paved the way for setting up of rules and norms of use. In Nimanivandh, the community preferred their "virados[16]" to any modern construction and consecutive deepening and strengthening of a virado has brought in greater relief to the community. There are strict norms on water use. It's mandatory for all to take off their shoes before getting on the platform of the virado. The old virado is now being used for domestic needs such as washing and drinking water for livestock and the newly constructed one solely for drinking water. The success of the well has been such that villagers from neighbouring Mohadi (which already has a piped water supply scheme) use the same virado to cater to their drinking water needs. The Pani Samiti allows such use, a decision which is based on mutual understanding and empathy as Mohadi, due to inadequate and irregular electricity supply gets piped water only once in a week. The other forms of wise use being witnessed in the villages include social fencing of drinking water source for villagers from livestock, source augmentation by deepening ponds, building earthen check dams surrounding the well, digging series of shallow dug wells and using them in rotation and clearing the feeder channels to the catchment areas

[16] Virda's in the local 'jati' dialect

2. Training “Barefoot Engineers” to plug knowledge gaps: Providing appropriate and timely technical services to Panchayats, Pani Samities, NGOs, CBOs and individuals, was critical to success of Pani Thiye Panjo. Hence, a service centre for drinking water, titled “Parab[17]” was established in Abdasa taluka of Kachchh to train and develop para water engineers. These ‘barefoot engineers’ are capacitated to tackle basic technical issues related with augmentation and management of drinking water. Since well construction is a relatively new phenomenon in these villages, developing technical expertise in rural youth has borne fruit. In the village of Karamta, quality control by para engineers resulted in better materials and technique being used for construction of the only well in the village under the programme. Parab technicians are trained to conduct technical geo-hydrological surveys, prepare estimates etc, and these services would be offered to Panchayat and other line departments for implementing other water related schemes in the region
3. Leveraging on and assisting local champions: Noormahmamad Sarfuddin Jat (Secretary, Sadhiravandh Pani Samiti), Mr. Sakurbhai Bhachal Jat (Panchayat Member, Sadhiravandh), Ibrahimbhai from Nimanibandh and the articulate Ms. Hansabai, (Ex Sarpanch[18] and Secretary Karamta Pani Samiti) are unsung heroes of rural Gujarat. Their roles in bringing communities together for collective action, has freed respective villages from acute water stress. Hansabai went around talking of community contribution when the very idea was perceived as attempted humour in Karamta. Refusal to give up has now ensured a community contribution of Rs 86000[19]/- for constructing an open well. Now, there is a further add on, as a solar pump is being set up which will directly bring water to each household. Convincing the community to opt for such technology was difficult, but Hansabai had a strong logical approach. She convinced her community of the system’s sustainability and since input costs were being reduced through programme intervention, it would be an opportunity which if missed will make successive generations suffer the same drudgery being experienced now. In Sadhiravandh, Sakurbhai, used his presence in the Panchayat to ensure greater coordination between the Pani Samiti and Butta Juth Panchayat
4. Nesting and linking institutions: The need to nest Pani Samiti’s within Panchayats is critical for sustainability of the intervention. Pani Samiti’s are community endorsed but have no constitutional validity. Panchayats issue a No Objection Certificate

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[17] In Kachchhi parlance Parabs are the water points meant for distributing drinking water to the people without any monetary charges, especially during the summer

[18] Elected head of the Panchayat

[19] Approximately $ 2263 in current valuation

(NOC) to Pani Samiti's but has powers to revoke it. Hence, the programme envisaged greater sensitization of Panchayat's for need of Pani Samiti's as being user oriented; they are capacitated to meet local needs more efficiently. To bring about this desired synthesis, capacity building trainings, workshops and visits were organized at the village level involving both PRI's and Pani Samiti functionaries. One of the major outcomes of Pani Thiye Panjo programme was streamlining Pani Samiti formation in each village. Previously, the Panchayat also initiated pani Samiti's alongside WASMO. Hence often in one village, there were multiple Pani Samiti's resulting in an institutional chaos. This was sorted out through multi stakeholder dialogues, involving district and block administration, WASMO officials, Panchyati Raj Institutions (PRIs), Pani Samiti functionaries and NGO partners. It was agreed that hence onwards there would be only one Pani Samiti in a village, which will be recognized by WASMO and the village Panchayat. The talati[20] will facilitate the process and the Panchayat will issue a No Objection Certificate.

5. Strengthening institutions to manage conflicts: In Sadhiravandh, when a powerful farmer attempted to use a bore well to irrigate his agricultural land in a rejuvenated recharge structure (i.e. pond), the entire village, led by the Pani Samiti, filed a First Information Report (FIR)[21] in the local police station. When this failed to work, they appealed to the District Collector in Bhuj who responded favourably and threat to the resource was mitigated. Similarly when the Sarpanch of Akari Juth Panchayat demanded de facto leadership of Karamta Pani Samiti, there was stiff resistance, as members realized this would lead to political capture of the institution. Threats to villagers of dire consequences, jeopardizing project funding, et al didn't leave a dent and the Pani Samiti was formed with the help of the Talati, who realized that such institutions actually enable him to work more efficiently.
6. Flexible systems to ensure contribution: WASMO guidelines clearly spell out advance contribution of 10% of the total project cost from the community. Only on satisfying such a condition does WASMO release 90% of the rest of the funds to the Pani Samiti for implementation. However, in areas where 77% of the population are below poverty lines, such contributions are hard to come by. And yet, a flexible system of payment of either cash or kind (i.e. through labour) sped up such a process. Continuous dialogue with WASMO officials allowed villagers of Nimanivandh to build a well by pooling in only human labour. Labour went into site clearance and other maintenance costs. Also payment in instalments for those unable to other-

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[20] Village level revenue official

[21] According to Section 154 of Code of Criminal Procedure (1862) whenever a citizen informs the police, or the police learn otherwise about the occurrence of a cognizable crime the station house officer [SHO] institutes a First Information Report [FIR] which initiates the criminal investigation.

wise, facilitated well construction in Sadhiravandh and Karamta, as villagers, finding it easier to contribute, pitched in.

Access Barriers to Clean Drinking Water

Availability of clean drinking water in Kachchh is bottlenecked by several institutional and economic factors. Perhaps the biggest of them all is the dominant worldview that water needs centralized, techno-bureaucratic management. Such thoughts find their way through to policy and subsequent planning and implementation. Each of these processes fails to factor in actual water demand, existing local management practices and regimes, and often there is a mismatch between real needs and created demand. Also such systems are heavily dependant on non-renewable energy sources, and in principle unsustainable and given the nature of erratic supply, in practice, untenable.

Communities in Abdasa Taluka have for centuries managed to adapt to their environments by developing local coping mechanisms. Such mechanisms are anchored in source sustainability and are flexible. Augmenting such local knowledge systems with modern technical know-how is ipso facto, a best practice.

If water is best managed locally, then institutions at micro, meso and macro levels need to interweave, leaving decision making at the grassroots to users. However such decision-making also needs to be vetted with current scientific knowledge systems. Community based knowledge systems can no longer operate in isolation and in its interactions with the outside world, requires additional external inputs.

Interlinking of institutions is critical for sound water management. Absence of the same has resulted in lacunae in delivery schemes. An inter-institutional dialogic process is a pre-requisite for smooth, efficient and practical implementation of water management programmes in India.

Future Goals and Initiatives of Pani Thiye Panjo Programme

The programme expects that successful outcomes will provide it with greater credibility to continue to get more work in the region (including 3-4 talukas of western Kachchh). This will ensure up scaling of local water management projects across Kachchh, proving once again the practicality of low scale, locally viable management systems.

With structures in place, the next logical step is to look into water quality issues. Tests of drinking water from both traditional and new sources on various parameters have been initiated. On the basis of its results awareness on drinking water quality and safeguards will take place. Strengthening institutional processes such as regular collection of water charges and facilitating women's leadership in water governance is another objective. The programmes will also concentrate on developing and augmenting knowledge at the grassroots. The para engineers (parabs) will play a critical role expanding and strengthening the programmes' work in Abdasa.

The final push of the programme at the village level would be to transforming local sources as the primary source with the external sources only functioning as backup. It also envisages evolving a system of water prices and taxes that will help in the financial sustainability of managing local sources in a competitive manner. Improving the local governance and management of water systems such as efficient tax collection, proper operation and maintenance, and protection of sources with active community participation are the probable end milestones.

Chapter Six

Water Security in Thar

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The Thar Desert region occupies 60% of land in the state of Rajasthan and houses a population of over 22 million people. This region has earned the distinction of being the most densely populated desert in the world. It is the ingenuity of the communities living here which has made it possible for them to survive and proliferate even in the extreme inhospitable conditions.

Scarce water access and availability is an indispensable aspect of the desert, which creates a drought situation every three years. Water availability is becoming an increasingly difficult issue in the rural areas of Thar. Ground water at most places in the desert is saline and is unfit for human consumption. Its level continues to fall due to various unsustainable practices such as mining and extraction of groundwater due to agribusiness. These practices have, in turn, led to the loss of the natural watersheds worsening the availability of water. The groundwater at certain places is as low as 1,000 ft.

Over the years, the indigenous communities of Thar have used their knowledge and experience to combat water scarcity issues. This experience has evolved into exemplary technologies for water conservation. Some of these innovative technologies include the man made village ponds locally know as “naadis”, shallow percolation wells called “beri” and small underground systems called “taankas.” These structures have a symbiotic relation with the local environmental conditions and have thus been sustainable for over centuries. These local technologies are still being used as the main water source in some rural areas of the desert. However, over the past few years GRAVIS has been successful in introducing better designs for these traditional structures.

Organisational Profile

The foundation for GRAVIS's strategy and approach to work has been influenced by two Gandhian philosophies. The first, sarvodaya, entails upward mobility across society with an emphasis on marginalized communities. The second principle places importance on swarajya, or empowering local governments beginning at the village level.

Gramin Vikas Vigyan Samiti (GRAVIS) or Center of People's Science for Rural Development was founded by a group of Gandhian development activists led by late Shri L.C.Tyagi and Smt. Shashi Tyagi in the small village of Jelu- Gagadi in 1983. The organisation was formed with the aim of implementing rural development activities in remote regions of the Thar Desert. At the beginning, GRAVIS worked with a mere cluster of 20 villages in the Jodhpur district of Rajasthan. Presently, GRAVIS works in more than 850 villages in 5 districts of Rajasthan.

GRAVIS's work extends to the Jodhpur, Bikaner, Barmer, Jaisalmer and Nagaur districts of western Rajasthan. The GRAVIS organization also includes an advocacy unit and a Health Environment Development Consortium (HEDCON) in Jaipur.

GRAVIS Interventions

Taanka

Taanka is a cylindrical, underground water storage tank with a capacity of approximately 20,000 litres. Some of these tanks have a built-in natural or artificial catchment that can be used for harvesting rainwater. When filled to capacity, the water in these tanks can be sufficient to sustain the drinking water needs of a family of up to six people for a period between five to six months.
Access to a taanka has been shown to have a positive impact on the health and hygiene of a family. The availability of taanka water significantly improves the condition of women in relation to household activities. Access to a taanka decreases the difficulty of women carrying water over long distances. It also increases the chances of girl children, who would otherwise have to help in fetching water, being enrolled in school.
The taankas constructed by GRAVIS are 10 ft x 10ft in size which provides a larger capacity of water than the traditional ones. To decrease the silt load they have also been provided with silt catchers and wire meshes. These new taankas are being built with an outlet to prevent the collapse of the superstructure in case of heavy rainfall.

Khadin

Is a low mound like structure, approximately 1.2 to 1.9 mts high, built on the lower three sides of an agricultural field. The low barrier collects water and allows it to spread on the agricultural filed. The percolation of water increases the soil moisture. This, in turn, increases the average crop yield.

Khadins constructed by the government are typically 8 ft in height and several mts in length and are only benefical to bug and owners. Khadins designed by GRAVIS specifically benefit mardinal farmers with small land holdings. The smaller khadins are 3.5-5 ft tall and 500-1500 ft in length. A built-in wastewier allows for an equitable distribution of water.

Beri

Beris are shallow, low diameter percolation wells. Beris act as a water source and a storage structure. Gravis helps in renovating old beris. This process involves a desiltation of the well and a construction of a concrete superstructure. The superstructures also feature silt catchers and covers, which decrease the silt load into the beri. Interventions have also been made to reduce the pressure of water on the walls, which prevents the beri from collapsing.

Naadis

Naadis are village ponds. The naadi or village pond is the most important waster source that serves the drinking needs of humans, lifestock, and wildlife in the Thar Desert. It comprises of a large size catchment, the down slope of which is dug into a big pit to store the runoff. The excavated earth is piled up as a semicircular bund along the edge of the pit in order to check the water flowing out of the pit. The dimensions of a naadi vary a great deal. Bigger naadis have a catchment of 100 to 500 hectares and its collecting pit is usually 200 meters across with its deepest point ranging from 4-6 meters. These bigger sized naadis have a capacity of 20,000 to 40,000 kiloliters or cubic meters. Smaller naadis may have a capacity of just 700 cubic meters and a catchment of a few hectares. A rainfall spell of 75 to 100 mm is sufficient to fill this kind of a naadi. GRAVIS helps in the desiltation processes as well as construction of naadis.

Sustainability and Replicability

These structures are simple, low cost and can be constructed by material available in the local market. They hardly require special skills, which enables local masons to construct them. The management of these assets lies fully with the community that uses them. Since these communities on a daily basis use these water contraptions, the people are vigilant in managing its upkeep and repair.

Chapter Seven

Providing Potable Water to Millions of India’s Rural Poor: Creating Models for Sustainable Development

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Mrs. Bala Theresa Gingras who hails from Reddypalem, a remote village in Warangal district of Andhra Pradesh, founded Bala Vikasa Social Service Society in 1991. After marrying a French Canadian, Mr. Andre Gingras, and settling in Canada, Mrs. Bala Theresa Gingras wanted to do something for her motherland, as she was very much aware of different problems faced by rural communities in India.

Supported by her husband and family members, Mrs. Bala Theresa started SOPAR (Society for Partnership/sharing) a registered society in Canada during 1977. She initially supported her Indian village Reddypalem with housing, water, education etc. In a very short period of time, the activities of SOPAR spread from Reddypalem to neighboring villages, to district and to the state level. Mrs. Bala Theresa Gingras makes three to four trips a year and lives in India for more than six months to monitor and support the program. As the activities of the organization grew, Mrs. Bala Theresa Gingras felt the need to have a local office for effective monitoring of the projects and as a result, founded Bala Vikasa Social Service Society in 1991 with its head quarters in Warangal, Andhra Pradesh.

Bala Vikasa is a voluntary, secular and non-political organization working with the motto of “Help the people to help themselves.” Bala Vikasa is playing the dual roles of fund provider and an implementer. Bala Vikasa established a strong network of more than 40 NGOs in Andhra Pradesh and implementing different development programs reaching approximately 2000 villages every year.

Bala Vikasa is very much involved in the following activities:

- A Women Integrated Development program in about 1400 villages with 1,750,000 women membership in 20 districts of Andhra Pradesh
- Providing drinking water through 500 overhead tanks, 5000 bore wells, 100-water purification reaching more than 1 million rural poor
- The renovation of 420 traditional irrigation tanks by silt excavation
- Organizing farmers' cooperatives in 5 districts of Andhra Pradesh
- Providing capacity building program to the grass root CBOs, NGOs, GOs and also for the NGOs from national and international communities
- Rehabilitation of Tsunami victims
- Education for the orphans, semi-orphans, poor etc.
- Implementation of youth development programs
- Issuing support to rural public schools by providing water and sanitation facilities
- Research, documentation and consultancy

Bala Vikasa is supported by International NGOs from Canada, Europe, and Hong Kong and also by local donors.

Regional Issues

The following are some of the issues related to water that are faced in the region of Andhra Pradesh:

- Presence of excess Fluoride in Water: Andhra Pradesh estimates more than 4000 habitations are consuming water with excess fluoride. The most affected districts are Nalgonda, Warangal, Ananthapur, Mahabubnagar and Prakasham. The people living in these regions suffer from colored and decayed teeth, crippled bones, joint pains, spinal cord pains, etc. Continuous drought and over exploitation of the ground water resources is one major cause for the increase in the fluoride concentration. As the people of these regions do not have any other options of procuring drinking water, they are forced to drink this highly fluorinated water. People affected by this problem are mostly poor because they cannot afford to get nutritious food and drinking water. People suffering from these crippling diseases are also becoming unproductive.

- Contamination of Water:

  Urban Areas: 70% of the contagious diseases are due to the consumption of contaminated water. Industrial pollution plays a major role in the contamination of water. Due to increased industrialization in Hyderabad and surroundings, industrial effluents are freely mixed in the rivers and lakes. The other reason for contamination of water is the sewage problem. Most of the cities like Hyderabad do not have proper drainage facilities. The sewage and the industrial effluents are directly merged in the Musi river which flows through the district of Nalgonda. Musi river, which was once a source of drinking water in the regions of Hyderabad, Nalgonda no longer serves this purpose because it is highly contaminated. People suffer from diseases like diarrhea, cholera, measles, malaria, etc. after consuming this contaminated water.

  Rural Areas: The use of chemical pesticides in agriculture, the misuse of water resources, and lack of hygienic conditions are the main causes of water contamination in rural areas.

- Decrease in Ground Water Levels: The causes of decreasing groundwater levels are irregular monsoons, droughts and deforestation. Most of the regions of Andhra Pradesh depend solely on rainfalls, which are very irregular. Farmers are unable to store the rainwater because of various reasons such as lack of storage facilities like lakes and ponds due to the presence of excess silt in the wells and lakes.

  With the hope of unearthing water for the crops, the farmers drill bore wells. Every year there is a 50% increase in the number of bore wells drilled. But the pity is that nearly 50% of them fail, which leaves poor farmers debt ridden.

  Due to tremendous urbanization there is a rapid imbalance in the eco-system, which also results in the decrease of ground water levels. Due to irregular rainfalls, there is an imbalance between the available quantity of water and the required quantity of water. People in these regions are economically backward and therefore depend solely on government and NGO’s to help them. Government has initiated many water development projects but most of them have failed because they could not sustain for long periods and the government failed in encouraging community participation in these projects.

- Work Load: As per tradition in the rural communities, it is the responsibility of the women in many families to fetch the water for domestic purposes. Since the water sources are located at far distance, the women and the children walk very far every day to fetch the water. In doing this, the women and children are spending lot of time and energy. On an average the women spend about two to three hours per day fetching water.

Providing Potable Water to Millions of India's Rural Poor: Creating Models for Sustainable Development

Water is life…but unfortunately many rural communities in the state of Andhra Pradesh still do not have access to this basic need. Women and children walking long distances just to fetch a pot of water is still a common sight in most of the villages of Andhra Pradesh. Many of the drinking water sources in the rural areas are contaminated. Consuming contaminated water is affecting the health of the rural communities.

To help the rural communities, Bala Vikasa during the past 27 years has supported more than one million rural population in about 3,500 villages to have easy access to potable water by constructing 500 overhead tanks and 5000 bore wells with manually operated hand pumps in Andhra Pradesh. Bala Vikasa is one of the leading voluntary organizations in providing potable water to rural communities. Bala Vikasa implements these programs all over the state of Andhra Pradesh with its strong network of more than 20 partner NGOs spread over all the districts. The programs are implemented in the most economical, effective and sustainable manner with active participation of the beneficiary communities.

Bala Vikasa's three drinking water supply projects

1. Water Purification Project
Bala Vikasa initiated community owned and managed de-fluoridation projects during the year 2004 as millions of rural people in the state of Andhra Pradesh suffered from dental and skeletal Fluorosis, which is caused by the consumption of water containing excess fluoride. Since Fluorosis is a slow effect and is not a necessary concern for either the victims or the government. Due to this negligence, the victims become crippled and unproductive. Generally levels below 1 PPM of Fluoride in water are desirable for human consumption as per WHO standards. Unfortunately, it is alarming that few villages in Nalgonda district of Andhra Pradesh have the highest concentration of Fluo-

ride (25 PPM). About 4000 villages in 10 districts of Andhra Pradesh are consuming water with more than 1 PPM fluoride and suffer from Fluorosis.

70% of the diseases are caused due to consumption of contaminated water. Statistics indicate constant increase in the fluorosis-affected population in the state of Andhra Pradesh. Due to increased awareness on health issues, many people tend to purchase canned water from the micro-commercial water purification companies. These commercial companies sell 20 litres of purified water between Rs. 10 and Rs. 15 depending on the market situation. Unfortunately, the majority of the rural poor who live on daily wages earn between Rs. 40 and Rs. 60 per day cannot afford to spend Rs. 10-15 everyday on drinking water. Therefore, the poor still go without clean water.

To help fluoride affected communities in rural areas, Bala Vikasa initiated a de-fluoridation project adopting “Reverse Osmosis” technology which not only removes excess fluoride, but also all other unwanted impurities such as Chlorine, Lead, Sodium, hardness etc. Thus the villagers are able to get safe drinking water as per the standards of World Health Organization.

As the de-fluoridation projects are owned and managed by the communities, they are able to produce safe water at an affordable cost of Rs. 1 per 20 litres can. The projects are self-sustainable, as the members are paying the user fee for present and future maintenance of the project. These projects create a visible impact on the health of the affected people within a period of two months after project installation.

Participation is essential for the sustainability of any development program. With a strong belief in this concept, Bala Vikasa will motivate and organize the villagers who come forward by themselves to solve their Fluoride problem.

By March, 2008 Bala Vikasa will have completed 100 projects in 100 villages benefiting more than one lakh (300,000) population in the fluoride affected villages to include Nalgonda, Prakasham, Warangal, Guntur, Mahabubnagar, Rangareddy and Karimnagar.

Criteria for selection of the village:

- Having more than 2 PPM fluoride in the public water supplying source
- A Willingness to implement the project with participation from the whole village without discrimination against caste, religion, or political view
- Beneficiaries willing to contribute 30% of machine cost

- Cooperation between the Gram Panchayats and community to provide raw water supply and existing or new room in the village for installing the machine
- A willingness to unite and work under the committee specially organized for the purpose of project maintenance
- A willingness to contribute a user fee for the supply of water

Water testing: Water samples are collected from the major drinking water sources in each village for testing. Village elders bring the samples to the authorized laboratories for testing. If the results indicate that Fluoride levels are above 2 PPM fluoride they apply to Bala Vikasa.

Organizing and motivation: In every applicant village, Bala Vikasa conducts a series of village informational meetings to explain the process and benefits of the project. This motivates the villagers to unite while solving their community problems. Bala Vikasa has the village elders collect the required data and than assesses the villages' needs, and designs each project jointly.

Local contributions: The villagers to contribute 30% of the water purification machine cost. This will be accrued by way of membership fee from the beneficiary families. Each family will pay between Rs. 150 and Rs. 200 as membership fee to meet the 30% of the machine cost. To ensure the equal share among beneficiaries, contributions from single donors, rich class, government share, MLAs, etc. are not accepted. Apart from 30% cash contribution for the machine, the villagers also provide an existing or new room and raw water source for installing the machine. "Gram Panchaayat", the village administrative bodies, generally provides these facilities. With these contributions the share of the beneficiaries will be more than 50% of the project cost.

Organizing a committee: the beneficiaries who take care of the project maintenance form a committee consisting of five to seven members.

Role and responsibility of the committees:

- Organize the villagers and conduct meetings
- Collect contributions from the beneficiaries
- Support Bala Vikasa in implementing the project
- Hire necessary staff for operating the machine and maintaining water supply
- Monitor the functioning of the program
- Conduct meetings

Reverse Osmosis Technology: This is one of the best technologies available in the world for water purification. Commercial companies like Coke and Pepsi also use the same technology for their bottled water business. This technology is effective and manageable in rural communities.

Operational system: The project committee hires a person for operating the machine. The machine supplier provides training to the person. This person is actually responsible for operating the machine and producing a sufficient quantity of purified water every day as per the requirements of the members. He is also responsible for machine maintenance.

Water supply system: The purified water is supplied in 20 litre cans to every member. The members come with their cans to the machine, which is generally located in the center of the village at a convenient place. The members purchase the pre-paid cards for 10 cans, 15, cans, 30 cans etc. as per their monthly consumption and economic abilities. Each time they come to the machine and collect the water the operator punches on the prepaid card. This process ensures effective accounting system and economic stability.

Pricing the water: The cost of producing 20 litres of purified water is less than Re.1. In addition to production costs, the committee requires maintenance funds to take care of the repairs. Therefore, the committee fixes the rate at Rs. 2 or 3 per 20 liter tin in the initial year. The machine supplier guarantees the first year's maintenance and therefore eliminates repair costs from the committee in the first year. Therefore, the committee can save all their profits. Once the committee feels that they have enough funds to take care of the project repairs they will reduce the cost of the water from Rs. 3 to Rs. 2, or Rs. 2 to Rs.1.

Village meetings: The Village committee meets every month to discuss monthly activities, revenue, expenses, profits, services etc. Bala Vikasa technical staff will attend these meetings to support committee in organizing effective meetings and monitoring the projects.

General body meetings are conducted for all members involved in the project. During these meetings the annual report is presented and approved along with the financial statements. The annual budget is prepared, committee members are elected, policy is approved, and future plans are made during the annual general body meetings. Bala Vikasa supports the villagers to organize effective meetings.

Maintenance of the project: The companies that supply the machines take care of the first year maintenance. From the second year on, the villagers are responsible. Bala Vikasa is planning to make a federation of the project villages to setup a maintenance unit, which will be cost effective.

Impacts of the water purification projects:

- Improved access to safe drinking water for the poorest of the poor in the rural communities
- Water available at 70 to 80% less price compared with local market
- Improved health among the rural communities
- Increased unity and leadership in the village
- Project committees inspired to take up other development activities in the village

2. Over-head tanks supplying water to the doorsteps of beneficiaries
Bala Vikasa supported 500 overhead tank projects in Andhra Pradesh within the past 25 years. Through this project, the water is pumped from a tube well to the overhead reservoir and then distributed with gravity through pipeline to individual houses in the village.

Criteria for the selection of villages:

- Beneficiaries contribute 15% of the construction cost from their pockets
- Villagers unite without discrimination against caste, religion, political views etc.
- Village administration allocates place for construction of the project
- Villagers elect a committee to organize, mobilize, implement, monitor, and manage the project

Project designing and budget allocations: Bala Vikasa is constructing four different size tanks, which are determined by the village's population size. Standard designs are prepared and budget estimates are made as per the current market prices.

Cost sharing: To ensure genuine need and to create a sense of ownership, community participation is required. Bala Vikasa asks that the beneficiary community contribute 15% of the projects cost while the remaining 85% Bala Vikasa pays in the form of a grant. Donations by Gram Panchaayat, politicians, business people, individual donors etc. are not accepted.

Implementation Method: The committees are actively involved in planning, mobilizing, implementing and monitoring the project. Committee members share responsibilities and take part in procurement of material and implementation. The affiliated NGO will provide all necessary technical support for construction and do the monitoring for Bala Vikasa.

3. Bore Wells with manual pump
Bala Vikasa constructed about 5000 bore wells in more than 3000 villages with manually operated hand pumps in the state of Andhra Pradesh. These bore wells are constructed in small communities.

Criteria for approving the support for bore well:

- A minimum of 30 families in need of water facilities.
- Beneficiaries unite without discrimination against caste, religion, political views etc.
- A minimum 150 meters distance from the existing bore well.
- Beneficiaries contribute 15 % of the project cost.
- Committees formed for project maintenance.
- Bore location should be on the roadside in a public land where every one can have the access.

Implementation: Bala Vikasa implements these projects with the support of its network spread in all the districts of Andhra Pradesh. The committees take active role in the actual implementation making the projects more effective and economical.

Impact of overhead tanks and bore wells:

- Increased access to potable water for the rural communities.
- Increase in unity and leadership.
- Improved health among the poor communities.
- Time and energy saved for the women in fetching the water is utilized for productive purposes.
- Improved vegetation in the village with availability of water.
- Increased kitchen gardens increase family nutrition.
- Improved personal hygiene

The water committees do not limit their role to maintenance of the water project alone. With this experience and strong leadership they initiate other development aspects in the village and contribute to the integrated development of the village. After Bala Vikasa's help, the "Gangadevipally" Village in Warangal district has received best village award at national level.

The Barriers for Access to Clean Water

Contamination of existing resources: Ground water is the major source of drinking water in rural India. The water has been drawn from open wells for centuries. Due to ignorance and negligent practices the water in the wells is becoming contaminated and unsafe for human consumption. Therefore, the scarcity for water is increasing.

Over exploitation of the ground water source: Agriculture continues to be the major activity in Andhra Pradesh, and the success depends on the availability of water sources. Unfortunately the state of Andhra Pradesh depends mostly on either rains or bore wells for crop cultivation. As drought in the area continues for more than a decade now, the ultimate source is to exploit groundwater. Farmers are drilling bore well after bore well with a hope to find a good source. Unfortunately more than 50% of the bore wells are fail in Andhra Pradesh. The number of bore wells dug is doubling year after year. This is causing a negative affect on the quality of water. As the water level decreases, the concentration of the minerals in the ground water increases such as fluoride etc. This is very bad for human consumption.

Lack of public participation in resource maintenance: The government and NGOs have implemented many water projects, but their sustainability is limited due to ineffective maintenance practices. When there is no participation of the beneficiaries, there is no sense of ownership, when there is no ownership feeling there is no maintenance, and when there is no maintenance there is no sustainability. When we notice government sponsored bore wells in villages and school many are not functioning, as they are not maintained regularly.

Lack of budget allocations by the government: The government does not provide a sufficient budget allocation to improve drinking water facilities because allocations are not increasing in proportion to the increase in need. There is no balance between the needs and available resources. If the government can design projects with community participation the expense can be reduced and more projects can be completed.

Bala Vikasa's Future Plans

Bala Vikasa is content with the impact of its three different types of water projects, which are implemented for the benefit of the rural poor communities in the state of Andhra Pradesh. As the projects are ensuring genuine participation of the people at planning, mobilization of resources, implementing, monitoring and maintenance, the scope for program sustainability is very high.

Though Bala Vikasa is successful in its programs it could not reach all the deserving communities due to financial and other limitations. But effective models are created in designing and implementing the water projects especially the water purification and overhead tank systems. Therefore, Bala Vikasa is in a position to help other NGOs and government bodies so that their projects can also be effective.

To share the knowledge and experience of Bala Vikasa, we are planning to make videos in the form of case studies, training material etc so that many will understand the concepts. Bala Vikasa is also planning to organize exposure visits to the field for interested NGOs from around the world.

One of the major expenses for the water purification maintenance is the power bill. Therefore, Bala Vikasa is preparing the water purification project committees to represent their demand for free power supply to the water purification projects which are owned and managed by the village communities.

We are also planning to unite all the water purification villages and make a federation so that they can set up their own sales and service unit. This would provide sustainable, effective, and economical project maintenance.

The water purification project is very effective, economical and provides instant relief to the fluoride-affected communities. Many political representatives are also aware of the projects' impact and have started to allocate small budgets for them. But this is not enough as the need is very big. Therefore, Bala Vikasa is planning to promote the concept through workshops, media cooperation, and publications to influence the government in taking up such projects.

We cannot produce new water even if we have money. Therefore, the society has to conserve water resources and use them in a very prudent manner. The general public tends to waste the water even in the villages where it is scarce. There is no discipline and responsibility among the villagers. Therefore, the general public must be made aware of all the consequences they will have to face if they continue to neglect water conservation. If necessary, strict disciplinary actions will be imposed in the villages.

Water saving is like water generating. Therefore, the government must provide incentives for the communities putting efforts in saving the water through effective management systems of the projects and economical utilization of the water.

People must feel responsible for the protection of water resources as they often feel it is the responsibility of government to provide them funds. One blaming the other is not justifiable as both are culprits. Both the governments and the general public are responsible for the present situation. Therefore, both should work hand in hand performing their responsibilities in providing and protecting the water resources.

A Success Story on Water Purification

Mulkanooru is a village with a population of around 1400 families. The main source of income for the villagers was agriculture and related jobs. Most of them are seasonal daily wage laborers. Though there were two bore wells, two open wells and 10 hand pumps for the purpose of drinking water, villagers were scared to use them because the water in them contained heavy fluorosis. Villagers frequently complained of colored and decayed teeth, crippled bones, joint pains, spinal cord pains, joint pains, crippled bones, and spinal cord problems. Many young people were unable to work because of severe bone deformalities and nervous problems. The villagers had to spend most of their earnings for the medical expenses incurred due to these problems.

Only 400 families were economically sound enough to purchase the purified water from commercial water plants. They used to spend Rs 10 for a 20 litre water can. The rest were forced to drink the impure water from the bore wells and open wells. They requested the help of the government to solve their problem, but no action was taken.

In the year 2006, a water purifying plant was started in a nearby “Kandugula” village and local media publicized the success of this village. The Mulkanoor villagers have visited this village and learned about its procedures. Optimistic about solving their persisting drinking water problem, the villagers approached Bala Vikasa during October 2006 and explained their problem.

To assess the project need, unity among the villagers, their willingness to participate in the project, Bala Vikasa asked the villagers to mobilize at least 80% of the village population for a initial motivation meeting. As it is a need of every family about 1300 people participated in the initial meeting and proved their unity, leadership and expressed their willingness to follow the rules and regulations of Bala Vikasa.

During this meeting Bala Vikasa team explained in detail about the water purification plant, the process, technology, its benefits, role and responsibilities of the villagers, leaders, Bala Vikasa etc. The village was divided into 20 groups and each group elected their leader. The committee was responsible for mobilization of contributions in the form of membership fee, which is Rs. 200 as decided at the village meeting. As the need was genuine and there is good leadership and unity the committee was able to mobilize contributions from 800 families within a period of just one week and the remaining have joined in the following weeks.

The village administration provided required room to install the machine and also sufficient water source to supply water to the machine. Within three weeks of the initial meeting the villagers got ready with their room, water source and the 30% contribution. After paying 30% contribution for the project, the villagers have a balance of Rs. 30,000 left over fund, which they turned, into maintenance fund of the project. Looking at the activeness of the villagers, Bala Vikasa installed the machine and the project was inaugurated within one-month time from the initial meeting.

The committee hired 3 staff to operate the project and supply the water to the members. As soon as the project was inaugurated the total villagers started to purchase the water at just Rs. 3 for 20 liters can. Within a period of one year the committee was able to show a net profit of Rs. 2,25, 000 after taking out all the maintenance expenses. This is a big success for the villagers.

The committee members used to meet every month on regular date, time and place to monitor the project. Accounts are updated and a print statement is pasted on the notice board at the plant. The committee gained the confidence of the villagers, as they were committed, transparent and effective.

There were some families who did not join the project in the first year due to their economical backwardness. Therefore, villagers during the annual general body meeting decided to allow the members to pay the membership fee in installment.

As the project was able to build Rs. 2.25,000 maintenance fund the members felt it is sufficient to take care of any maintenance of the machinery. Therefore, during the annual general body meeting the members decided to reduce the cost of water from Rs. 3 to 2 per 20 liters tin. This reduction will help the poorest families to buy more water regularly as it will not cost them more than one-day wage per month.

Chapter Eight

Clean Water by Riverbank Filtration

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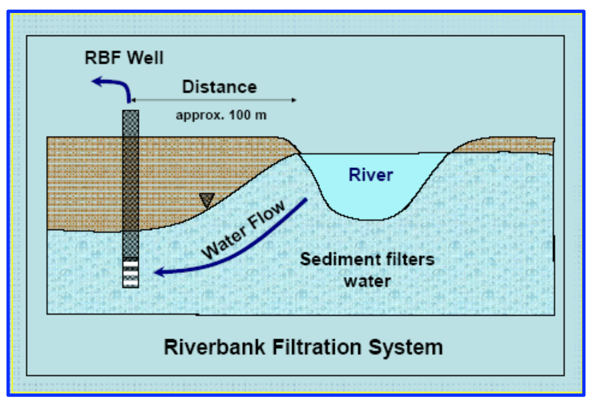
Riverbank filtration (RBF) is a low-cost water treatment technology with a history of use dating back to ancient Egypt. RBF involves extracted water from one or more wells located near rivers (Figure 1) and using the physical, chemical, and biological processes of the riverbank to purify the river water and to provide a buffer against rapid changes in river stage or water quality. The principal benefits of RFB are (1) predictable removal efficiency for bacteria, parasites, and viruses, (2) efficient removal of particles and turbidity, (3) biodegradation of trihalomethane (THM) precursors and micro-pollutants, (4) smoothing of variations in temperature and concentration of pollutants and (5) compensation for peak and shock loads.



The RBF technology has been successfully implemented in dry to wet climates and at scales ranging from small community treatment systems to supplying drinking water to large industrial cities in Europe and the US. Ideally, RBF systems are installed in the inner bend of a river meander where hydraulic conductivity of the riverbank deposits are >10m/d. The distance of a RBF well to the river should be at least 100 m to ensure a travel time from the river to the well of at least 20 days. Although simple in concept, the performance of a RBF system is strongly dependent on local conditions, i.e. sedimentation, filtration, sorption, ion-exchange capacity of the local riverbed materials and the red/ox reactions and (bio) degradation conditions prevalent along the flowpath from the river to the well. Sites not well suited for RBF are along rivers with high concentrations of clay (turbidity > 100) or with high levels of organic particulate matter and algae, including high levels of biodegradable substances ($BOD > O_{2\ river}$), especially in combination with pH> 7 and low red/ox conditions.

It is recommended to consult with a hydro geologist to determine the suitability of a prospective RBF site. Once a suitable site has been identified and land ownership issues have been addressed, setting up a RBF system requires at minimum the drilling of a 6 to 8 inch shallow well (about 20 m, depending on local hydrogeology) and installation of an adequately sized pump. Pumps can either be run off the electrical grid, if available, or powered by generators or possibly by (expensive) solar energy systems. Depending on the distance to the consumer, pipelines and/or storage tanks, including water taps or household connections, have to be constructed. Outfitting storage tanks with disinfection capabilities ensures a safe water supply. Also, water meters are required to recover capital and operation costs from individual consumers. Total cost varies from country to country, but a small, self-sustaining community RBF system can be installed for around $15,000. This estimate includes operator wages and business costs.

For more information about RBF projects in India and assistance with implementation, contact the Joint Center for Water Quality and Aquifer Remediation in Coastal Areas, Dr. Boving (boving@uri.edu) or TERI - Western Regional Centre, Vasudha Housing Colony in Alto Santa Cruz, Goa-403 004, INDIA (+91 832-245-9338, bchoudri@teri.res.in).

Chapter Nine

Household Water Treatment: A Summary of Methods and Techniques

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The Need for Household Water Treatment

People in many parts of the world are exposed to disease causing pathogens on a daily basis due to the consumption of unclean water. Drinking water is prone to contamination at the source, within the distribution system, and during collection. Additionally, the unhygienic handling of water during transport and within the home can also contaminate water which was previously safe. Therefore, it is often the case that people with access to improved water supplies through piped connections, protected wells, or other improved sources are, in fact, exposed to contaminated water as well. (WHO, 2007).

Research indicates that household water treatment (HWT) can have a significant impact on improving the health of its users. For example, diarrhoeal episodes are reduced by 25% through an improved water supply, 32% by improved sanitation, 45% through hand washing, and 39% because of HWT and safe storage. (Fewtrell. et al., 2005).

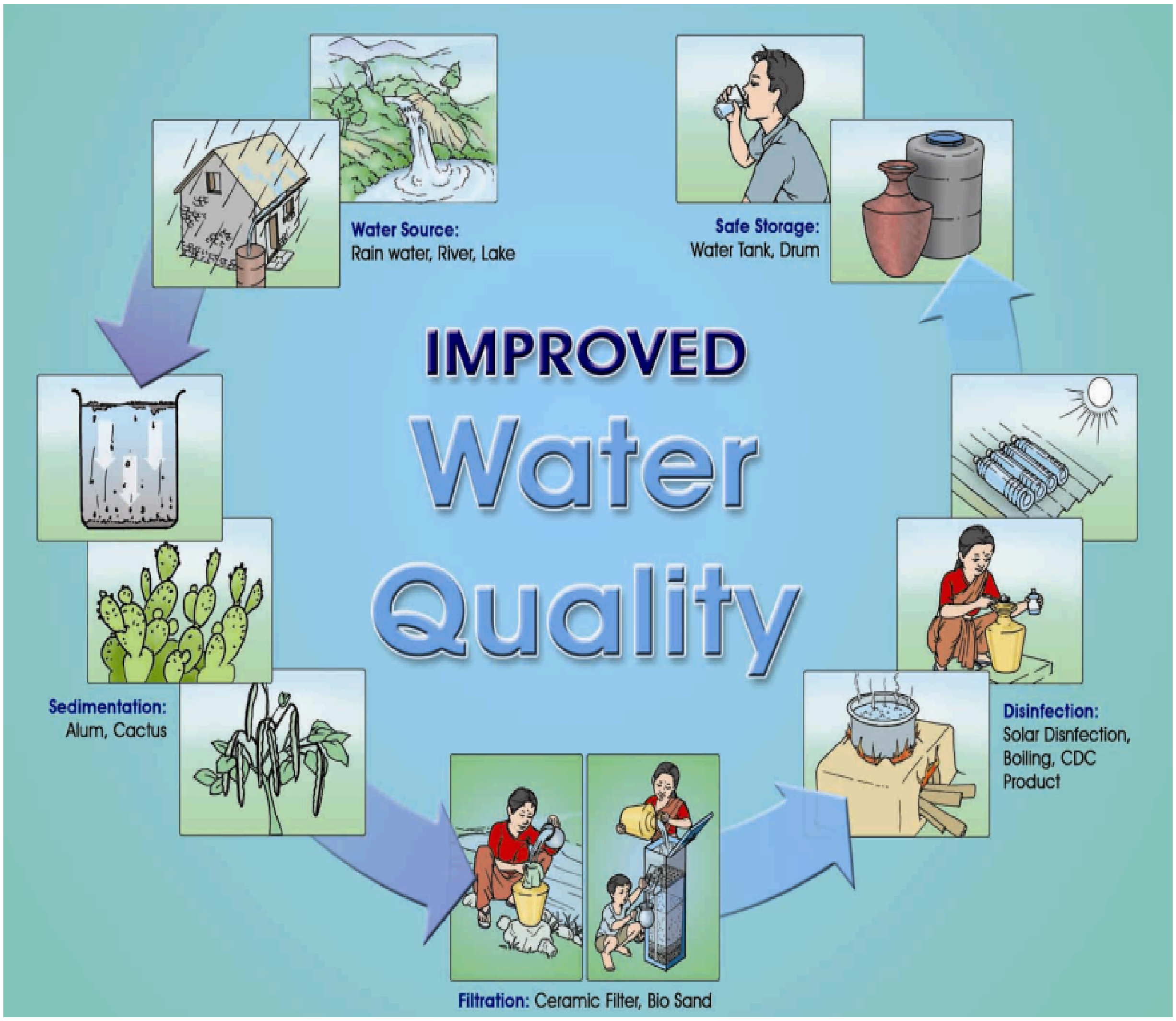
Step 1	Sedimentation/Settling Suspended materials in water, such as particles of sand, clay, and other materials can be substantially removed simply by allowing the water to settle naturally. Bacteria and viruses are often attached to particles; therefore, sedimentation will also reduce bacterial concentrations. Assisted sedimentation speeds the settling process through the use of coagulants and flocculants. These are natural and synthetic chemicals that cause suspended particles to clump together, thereby increasing the speed with which they settle.
Step 2	Filtration Filters can remove pathogens in a variety of ways, to include straining, adsorption, and biological processes.
Step 3	Disinfection The destruction of organism cell walls by oxidation is known as disinfection. Disinfection typically involves the addition of chemicals such as chlorine. It can also be induced by ultraviolet radiation, such as natural sunlight or artificial UV rays.

The Multi-barrier Approach to Safe Water

The multi-barrier approach reduces the risk of drinking unsafe water, by upholding the following initiatives:

- The protection of water sources
- The use of an appropriate pre-treatment storage container
- The correct operation of a series of treatment steps
- The hygienic storage and use of treated water

This process is depicted in the diagram.



Similar to a community or municipal water treatment system; household water treatment processes follow 3 major steps.

Step One: Sedimentation

Natural Settling

The process of natural settling allows turbid water to stand undisturbed so that the suspended particles settle out. Methods that make use of this simple process include 3-pot settling, large container settling and surface collection from lakes or ponds. Simple settling, however, can only partially reduce the amount of suspended particles and pathogens in the water. The time required to achieve acceptable results depends on the nature of the water and the size of suspended particles. The process will take anywhere between one hour to two days, but alternative methods should be considered for lengths exceeding two days.

Advantages	Disadvantages
• Low cost: free if a container is already available. • Simple and easy to do.	• Time required is variable, depending on initial and desired water quality. • Does not remove all turbidity.

The 3-Pot System

The 3-pot system combines natural settling with a 24-hour period of water storage. If contaminated water is stored for a period of time, some bacteria and viruses will die off.

Advantages	Disadvantages
• Simple, easy to do. • Due to the 24-hour storage period, some pathogens are removed.	• Time consuming. • Labour intensive.

Assisted Sedimentation Using Coagulants

Assisted sedimentation is the practice of adding coagulants to turbid water in order to accelerate the settling of suspended particles. A coagulant is a substance, which reacts and combines with particles in the water forming larger clumps of particles, which are more easily removed by settling and/or filtration. Examples of coagulant agents include aluminium, iron salts, and natural plants to include as specific types of cactus and the seeds of the moringa tree.

The following procedure is commonly used to prepare seeds for use as a coagulant:

- Dry and grind the seeds to a fine powder.
- Mix the powder with the water to be treated; the quantity of powder and volume of water depends on the type of seed used:
    - In the case of Moringa Oleifera, add 50-150mg/litre.

    - For peach or bean seeds, add 300-500mg/litre of water.
- Mix for 5 to 10 minutes.
- Leave to stand until the particles settle, then decant the treated water.

Advantages	Disadvantages
• Coagulants are widely available. • Natural coagulants are often of low cost and sometimes free. • Removes some turbidity, bacteria, and chemical contaminants. • Simple and easy. • Widely used in many parts of the world.	• Recurring costs can be high depending on the type of coagulant used. • Time consuming to process and prepare natural coagulants.

Step Two: Filtration

Water filtration technologies such as the biosand filter, Kanchan arsenic filter, ceramic filter, and the ceramic candle filter will remove most solid matter and a large portion of micro-organisms. Many of these are commercially produced filters, which are costly, but some filters can be made using locally available material. Straining can also be considered a form of filtration.

Straining

A cloth fabric can be used to strain particles out of water. Typically, a sari cloth that is folded 8-10 times is used as a cloth filter. Water is poured through the folded cloth to strain particles out of the water.

Advantages	Disadvantages
• Low cost: Rps.0 if old sari cloth is available. • Time required is minimal. • Simple and easy to do. • Removes some turbidity and bacteria (particularly cholera when it is associated with copepods present in the aquatic environment).	• Requires washing of cloth or sari after use.

The Biosand Filter

The biosand filter is an adaptation of a traditional slow sand filter, which allows it to be built on a smaller scale and to be operated intermittently. These modifications make the filter suitable for use at the household level.

As water passes through the filter there are four processes, which simultaneously occur to remove pathogens and particles from the water.

1. Mechanical trapping: Mechanical trapping of particles and micro-organisms occurs in the small pore spaces between the sand grains.
2. Predation: As in a conventional slow sand filter, a biological layer forms at the surface of the sand bed. This bio-layer houses micro-organisms that prey on other organisms and pathogens in the water and consume organic matter as food.
3. Adsorption: Adsorption is a process where micro-organisms, particles and some compounds stick to the surface of the sand grains due to dispersive, polar or ionic physical forces. Sand grains will adsorb viruses, iron and other small particles; adsorbed micro-organisms die off or are inactivated.
4. Natural death: Many pathogens will be killed or inactivated as a result of the relatively hostile environment within the filter's sand bed where there is no light, little oxygen, and few nutrients. Furthermore, the lifespan of many micro-organisms is quite short, so the number of pathogens will be reduced due to the natural die off rate.

A bucket of contaminated water can be poured into the top of the biosand filter as required. The water flows through the filter and is collected in another storage container.

The biosand filter is comprised of six distinct regions: 1) influent reservoir, 2) supernatant, 3) biolayer, 4) biological zone, 5) sand zone, and 6) gravel zone.

Plastic commercially produced filters are available in several countries.

Advantages	Disadvantages
• Functional, durable and affordable. • User-friendly. • Produces good quality water.	• Cannot remove some dissolved substances (e.g. salt, hardness), some organic chemicals (e.g. pesticides and fertilizers) or color. • Cannot guarantee pathogen-free water.

The Kanchan Arsenic Filter

The Kanchan Arsenic Filter (KAF) was developed at Massachusetts Institute of Technology (MIT), in collaboration with the Environment and Public Health Organization (ENPHO) of Nepal. The KAF is a household slow-sand filter with the capacity to remove both microbial and arsenic contamination. The design of this filter is similar to the biosand filter, but, here, the diffuser plate is replaced by a deep diffuser basin filled with 5 kg (11lbs) of non-galvanized iron nails and a layer of brick chips. In addition to the concrete version of the filter, the MIT-ENPHO team has developed a small plastic version using off-the-shelf plastic water buckets available in Nepal.

After coming in contact with water and air, the iron nails in the diffuser basin quickly rust. Iron rust (ferric hydroxide) is an excellent adsorbent for arsenic. When arsenic-contaminated water is poured into the filter, arsenic may stay in the diffuser box (i.e. adsorbed to the surface of the rusted nails in the box), or the arsenic-loaded iron particles are flushed down and trapped on top of the fine sand. The purpose of the brick chips is to protect the iron nails from being disturbed by the force of the incoming water.

The KAF can remove 85% to 95% arsenic in the raw water. The iron nails will lose their capacity in three to five years if the raw water has up to 500 ug/L of arsenic, and, at that time, replacement of the iron nails is necessary.

Advantages	Disadvantages
• Removes 85 – 95% of arsenic from water. • Functional, durable and affordable. • User-friendly. • Produces acceptable water quality.	• Can not remove some dissolved substances (eg. salt, hardness), some organic chemicals (pesticides and fertilizers) or color. • Can not guarantee that water is completely pathogen free.

Ceramic Filters

Carefully prepared clay is moulded into the required shape for the filter and then fired in a kiln. Pores in the body of the filter allow water to pass through but retain particles and pathogens. If properly constructed and operated, a ceramic filter can produce good quality water.

Frequently, colloidal silver is applied to the ceramic surface. Silver in its ionic colloidal state has antibacterial properties that help reduce the bacteria content in the water.

Advantages	Disadvantages
• Removes 99 – 100% of fecal coliforms. • Some removal of turbidity and iron. • Low cost: one new model projected at US $3.50 for the two-container system. • User friendly.	• The flow rate is 1.5-3 litres per hour or approximately 15-30 litres of water per day. • Filters are fragile and commonly do not last more than two years. • Turbid water can result if the filter becomes plugged. • Limited removal of viruses and arsenic.

Ceramic Candle Filters

The ceramic candle filter has one or more porous hollow cylindrical ‘candles’ made of kiln-fired clay, which may be coated, with colloidal silver. It can filter particles as small as 0.2 microns, removing all disease-causing bacteria and protozoa. Because the ceramic filter can be cleaned many times, more water can be filtered at a fraction of the price of a unit with a non-recoverable filter.

A typical filter unit includes a raw water reservoir, a closed storage reservoir for the filtered water and a tap to dispense the filtered water.

Advantages	Disadvantages
• Removes bacteria, protozoa, helminths, and turbidity. • Easy to use. • Costs $2-10 US for filter, $7-20 US for system.	• Produces 1.5-3 litres of water per hour, up to approximately 18 litres of water per day. • Filters are fragile and commonly do not last more than two years. • Turbid water can result if the filter becomes plugged. • Rigorous quality control during manufacturing is essential for effective filters.

Step Three: Disinfection

Disinfection processes include the use of chemicals such as chlorine and also the effects of ultraviolet radiation.

Pathogens and other micro-organisms can be concealed by organic and inorganic matter in the water and can thus be protected from contact with the disinfecting agents. Doses of chemical disinfectants can be increased up to a point to resolve this dilemma, but the best solution is to reduce turbidity via one of the processes mentioned in Step 1 and/or Step 2.

Chlorination

Chemical disinfection is commonly done using chlorine; it is relatively affordable, widely available and effective. Chlorine is an oxidizing agent, which reacts with organic matter, killing bacteria and viruses, but does not inactivate pathogenic parasites such as Giardia, cryptosporidium and helminth eggs. Chlorine also oxidizes manganese, iron and hydrogen sulphide.

Chlorine products suitable for household level water disinfection are available in liquid, powder and granular form. Household bleach (sodium hypochlorite) is the most common chlorine product that is appropriate for household water treatment.

The following table lists common chlorine generating products and their typical chlorine content or percentage strength.

Product	Strength	Remarks
HTH - High Test Hypochlorite (calcium hypochlorite)	65% - 70%	Usually in granular form. Stable: approximately 2% active chlorine loss per year.
Chlorinated Lime, (bleaching powder)	30%	Usually in powder form. Not stable.
Household Bleach (sodium hypochlorite)	2.5% - 10%	Liquid form. Not stable: only use if stored away from heat and light and manufactured within three months of use.
NaDCC (sodium dichloro-isocyanurate): used in products such as "Aquatabs"	50% - 60% as granules. (5mg to >5g active chlorine per tablet)	Usually in tablet form, also available in granular form. Tablets are pre-dosed for water treatment and/or disinfection uses. Very stable: shelf life of approximately five years.

In some markets, chlorine solutions specifically produced for household water treatment are readily available. For example, in Nepal, the brand Piyush is available in a 0.5% chlorine solution in a 60mL bottle.

Advantages	Disadvantages
• The chlorine chemical destroys the cells of biological contaminants and kills them. • Inexpensive: \$0.40 to \$0.80 US per family per month. • Removes bacteria and viruses effectively. • Easy to use at a household level.	• Not effective at removing protozoa or turbidity. • Requires a minimum of 30 minutes contact time. • Requires clear water to be most effective. • Taste unacceptable to some users. • Requires the continual purchase of chlorine.

PuR - Combined Coagulant and Disinfectant

Proctor and Gamble Health Sciences Institute developed the PuR water treatment product, which is composed of coagulants and chlorine. When mixed with water, it coagulates and speeds up the settlement of solid particles while disinfecting the water. The water is then strained or decanted to remove the suspended particles.

The product is promoted as an affordable and simple-to-use household water purification product. It clarifies the water and effectively reduces microbial pathogens.

Advantages	Disadvantages
• Some removal of microbial, chemical, and physical contaminants. • Current price of about $US 0.01 per litre of treated water.	• Requires outside supply of chemicals. • Educational efforts including product demonstrations are necessary to encourage a consumer habit change. • Requires a 20 minute wait time.

Solar Water Disinfection (SODIS)

SODIS is a simple water treatment method using solar radiation (UV-A light and temperature) to destroy pathogenic bacteria and viruses in the water. Its efficiency in killing protozoa depends upon the water temperature reached during solar exposure and on the climatic and weather conditions. Microbial contaminated water is poured into transparent containers and exposed to full sunlight for a minimum of six hours. Various types of transparent plastic materials are good transmitters of light in the UV and visible range of the solar spectrum.

Plastic bottles made from PET (PolyEthylene Terephtalate) are preferred because they contain fewer UV-stabilizers than PVC (PolyVinylChloride) bottles. Glass bottles can also be used for SODIS.

Water with a turbidity of more than 30 NTU cannot be used for SODIS. Sunlight treats the contaminated water through two synergetic mechanisms: radiation in the spectrum of UV-A (wavelength 320-400nm) and increased water temperature. If the water temperature rises above 50°C, the disinfection process is three times faster.

Advantages	Disadvantages
• Kills most biological contaminants. • Relies on local resources and renewable energy. • Ideal to treat small quantities of water. • Costs are minimal; the system only requires plastic bottles, which can be reused. • Simple and affordable.	• Does not remove chemical contaminants or turbidity. • Does not improve taste or odour of the water. • The container needs to be exposed to the sun for six hours if the sky is clear or up to 50% cloudy. • The container needs to be exposed to the sun for two consecutive days if the sky is 100% cloudy. • During days of continuous rainfall, SODIS does not perform. • SODIS is not useful for treating large quantities of water.

Source: SANDEC (Water & Sanitation in Developing Countries) at EAWAG (Swiss Federal Institute for Environmental Science and Technology), CH-8600 Dübendorf, Switzerland.

Water Pasteurization

Pasteurization is the process of disinfecting water by heat or radiation. Water pasteurization achieves the same effect as boiling, but at a lower temperature of 70-75° C. A simple method of pasteurizing water is to simply put blackened containers of water in a solar box cooker, an insulator box made of wood, cardboard, plastic, or woven straw. Common solar box cookers can pasteurize water at a rate of about 1 litre per hour.

A thermometer or indicator is needed to tell when the pasteurization temperature is reached regardless of the type of solar cooker. Solar Cookers International's reusable Water Pasteurization Indicator (WAPI) is a simple device that contains a special soy wax that melts after the water has been pasteurized (Solar Cookers International, nd).

Safe Water Systems also manufactures Solar Water Pasteurizer household units that disinfect water by combining heat pasteurization with UV radiation (Safe Water Systems, nd).

Advantages	Disadvantages
• Removes over 99% of the bacteria, viruses, helminths, and protozoa. • Can be built with local materials or purchased commercially.	• Does not remove salts, chemicals, or turbidity. • Weather dependant.

UV Disinfection

The use of ultraviolet light to disinfect water is not a new technology. However, the availability of small scale, energy efficient, affordable and low-maintenance devices is a recent development.

The UV light interferes with the DNA of the micro-organisms in the water, rendering them incapable of replication. A typical unit will treat 5 litres/minute, which can supply sufficient treated water for between 200 and 500 people. UV disinfection offers the first practical means of providing many communities in developing nations with adequate quantities of disinfected drinking water.

Advantages	Disadvantages
• Effective on all water-borne bacteria and diseases. • Disinfects quickly at about five minutes per litre.	• No chemical or physical contaminant removal. • Initial costs: \$50-\$150 US. • Operating costs: \$10-\$25 US per year for bulb replacement. • Requires electricity. • Does not improve taste or odour.

Boiling Water

Boiling water kills viral, parasitic and bacterial pathogens. The recommended boiling time is not defined in minutes but rather as the amount of time necessary to reach the first bubbling point.

The main disadvantage of boiling water is the large amount of energy required, making it economically and environmentally unsustainable.

Advantages	Disadvantages
• Kills all biological contaminants. • Simple and widely accepted. • Locally available.	• Does not remove suspended solids or dissolved compounds. • High costs for fuel. • Contributes to indoor air pollution and deforestation.

Comparison Based on a Broad Range of Household Water Treatment Technologies

Technology Types		Biological Removal	Turbidity Removal	Amount of Water		Cost ($US)	Ease of Use	
				Flow rate	Lifespan	Unit	Set-up	Maintenance
Moringa Seeds		Y	Y	N/A	Variable	$ 0	Easy	N/A
Sari Cloth		Y	Y	Variable	Limited	$ 0	Easy	None
Sand Filter		Y	Y	200 L/day	Variable	$50	Easy	Weekly
Biosand Filter		Y	Y	36 L/hr	Indefinite	$12-$30	Easy	Sporadic
Ceramic Filter	Disk	Y	Y	1-10 L/hr	5 years	$3.5	Easy	Monthly
	Candle	Y	Y	1 L/hr	6-12 mths	$2.25	Easy	Monthly
Chemical	SHS*	Y	N	N/A	Variable	Variable	Easy	None
	PUR	Y	Y	10 L/pack.	N/A	10 c/pack.	Easy	None
UV Radiation	SODIS	Y	N	1 L/bottle	1-2 years	$0	Easy	Regularly
	Lamps	Y	N	> 1 L/min	1 yr/bulb	$ 10 - $100	Mod.	Regularly

Source: jalmandir.com; cawst.org

HWT – Advantages & Disadvantages

In many parts of the world, the individual household is often responsible for treating its own drinking water. Where community utility water treatment and distribution systems do not exist, it is frequently the only viable option to treat drinking water.

Advantages	Disadvantages
Relatively cheap.	Need for knowledge and capacity for operation and maintenance.
Fast implementation.	Need to motivate users to operate and maintain correctly.
Appropriate for treating small volumes of water.	Most technologies cannot remove chemical contamination.
Creates an entry-point for hygiene and sanitation improvements.	

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Whitman Direct Action