Environment

Water Community

Solution Exchange for the Water Community Consolidated Reply

Query: Use of R. O. Systems for Providing Safe Drinking Water - Experiences; Referrals

Compiled by Nitya Jacob, Resource Person and Sunetra Lala, Research Associate
Issue Date: 17 August 2009

From Latha Bhaskar, Ashoka Trust for Research in Ecology and the Environment, Thiruvananthapuram, Kerala

Posted 25 June 2009

I work with the Ashoka Trust for Research in Ecology and the Environment (ATREE), Kerala, on wetland conservation. Currently, I am working on the Vembanad project, concentrating on the area (both land and lake) to the south of Thanneermukkom barrage of the Vembanad wetland system in Kerala. We regularly monitor the water quality of the lake. We have found the presence of large concentrations of microbial pathogens, pesticides and other chemical contaminants in the water. Water borne diseases are prevalent in this area and recently there was a cholera outbreak killing 12 people.

People in the 17 Gram Panchayats surrounding the lake depend on its water for all their domestic purpose, including cooking and drinking. They have no choice, as the piped water supply coverage is just 20%. This water comes from far off places (Tiruvalla) and is unsafe due to the leaks in the pipes, which pass through the lake. During the summer, drinking water is supplied by 35 boats, each carrying 2400 litres of water. Rainwater harvesting units exist in this area, but are not very popular as most households have thatched roofs and little space to construct storage tanks.

To provide potable drinking water to these people, ATREE plans to install a few Reverse Osmosis (R.O.) plants in selected places to filter lake water. However, these should be reliable. If they prove to be successful, they will pave the way for more such local and decentralised units. I want to learn more about R.O. plants to implement this model.

I request Community members to please share their inputs on the following:

- What are the experiences of using R.O. systems? Please share details regarding their cost effectiveness, longevity, O&M costs, safe-guards, technology diversifications, if any
- What area-specific, decentralized approaches can be adopted in places like Kuttanad, Kerala which is a waterlogged area and below the sea level?
- Please provide details of agencies and institutions installing R.O. systems.

Your inputs will help ATREE develop and implement this model for providing drinking water in these Panchayats.

Responses were received, with thanks, from

1. Ramakrishna Nallathiga, Centre for Good Governance, Hyderabad
2. Sree Hari N., Byrraju Foundation, Hyderabad
3. J. Saravanan, DHAN Foundation, Chennai
4. K. D. Bhatt, GSFC Science Foundation, Vadodara
5. Amitangshu Acharya, Arghyam, Bangalore (Response 1) (Response 2)
6. Jim Baldwin, Consultant, Bahrain
7. R. K. Srinivasan, Centre for Science and Environment, New Delhi (Response 1) (Response 2)
8. Latha Bhaskar, Ashoka Trust for Research in Ecology and the Environment, Thiruvananthapuram (Response 1) (Response 2)
9. Sumita Ganguly, Independent Consultant, New Delhi
10. Shibu K. Mani, Division of Disaster Management, Mahatma Gandhi University, Kottayam
11. Sacchidananda Mukherjee, National Institute of Public Finance and Policy (NIPFP), New Delhi
12. Jasveen Jairath, Water Sector Professional, Hyderabad (Response 1) (Response 2) (Response 3) (Response 4) (Response 5)
13. Ajit Seshadri, The Vigyan Vijay Foundation, New Delhi (Response 1) (Response 2)
14. Amitava Basu Sarkar, Himalayan Institute Hospital Trust, Dehradoon
15. Terry Thomas, Wilbur Smith Associates, Bangalore
16. K.A.S. Mani, Andhra Pradesh Farmers Managed Groundwater Systems (APFAMGS), Hyderabad
17. Dinesh Kumar, Institute for Resource Analysis and Policy, Hyderabad (Response 1) (Response 2) (Response 3)
18. Pavitra Singh, People's Science Institute, Dehradoon
19. Nitya Jacob, United Nations Children's Fund (UNICEF), New Delhi
20. Salahuddin Saiphy, Centre for Science and Environment (CSE), New Delhi
21. Salathiel R Nalli, United Nations Children's Fund (UNICEF), Hyderabad
22. Atul Rawat, DMV Business and Market Research Pvt. Ltd., Hyderabad
23. Uday Bhawalkar, Bhawalkar Vermitech Pvt Ltd, Pune
24. Gary Grunder, Association for Needy And Neighbouring Downtrodden, Guntur (Andhra Pradesh)
25. N. C. S Seema, WaterHealth India Pvt. Ltd, Secunderabad
26. R K Srinivasan, Centre for Science and Environment (CSE), New Delhi
27. Avani Mohan Singh, Haritika, Jhansi
28. Jared Buono, Watershed Management Group, Chennai *

**Offline Contribution*

Further contributions are welcome!

Summary of Responses

Reverse Osmosis (RO) is a relatively modern technique for purifying drinking water. The system forces water under pressure through an ultrafine filter (usually a membrane), retaining the impurities on one side while pure water collects on the other. Several organisations have set up RO systems in villages and slums to treat water for drinking, and provide it to communities at 10-15 paise per litre.

A RO system for a group of around 250 households, that can process around 500 litres of water an hour (LPH), costs around Rs 125,000. This uses about 2 kilowatts of power, or around 1200 units, per month. The cost of purifying water from a plant of this scale works out 5 paise per litre; selling it at 10 paise per litre will enable the operator to recover the capital costs as well as some of the running costs.

However, RO plants are a costly option and generate large quantities of wastewater. The concentration of dissolved solids in this wastewater is 50 per cent to 100 per cent higher than the input water, making its disposal a problem. Small RO plants have low efficiency levels, purifying just 5-15 per cent of the water that passes through them; this means they need about 10 litres of raw water to produce just one litre of pure water. Finally, they are power-hungry and in rural areas, where power is short, they may not run to capacity.

The filtration membrane is the plant's most delicate and expensive part. It may be necessary to pre-treat water before putting it through the RO system to prolong the membrane's life. In the area under consideration around Vembanad Lake, the water is brackish and has a high bacterial load. It needs a multi-stage treatment process before it can be safe to drink.

RO systems are supposed to remove all dissolved solids and bacteria, but to make doubly sure, the water being supplied to the RO system can be pre-treated with ultra-violet to first kill the bacteria. In this way, the wastewater from all the RO systems in the 17 gram panchayats (assumed around 100 units) will have a very marginal impact on the ecology of the lake, if it is discharged directly into the lake without treatment. In the Vembanad instance, salt will be the main contaminant of the wastewater. If UV pre-treatment kills the bacteria, they will not add to the pollutant load in the wastewater.

The Byrraju Foundation has set up RO plants in the East Godavari and Krishna districts of **Andhra Pradesh**. Each village has a plant capable of providing 1000 LPH, set up at a cost of Rs 650,000. People get 2-3 litres of drinking water a day for 12.5 paise per litre. The State Government is planning to install RO plants in all villages to provide safe drinking water. The Central Salt and Marine Chemicals Research Institute has installed one RO plant in Bhavnagar, Gujarat. In **Rajasthan**, the Piramal group has launched a programme called Sarvajal to provide drinking water to villages where groundwater is undrinkable.

In the Ramanathpuram district, **Tamil Nadu**, the State Government set up a desalination plant to provide 15 litres of water per day to 296 people. The Rs 35.48 crore venture ran aground over the high cost of changing the membranes. Each of the 168 membranes of the unit costs Rs 50,000. The Naandi Foundation has installed RO plants in several villages of **Punjab** and **Andhra Pradesh** at a cost of Rs 12-18 lakh per piece; they supply water to consumers at 10 paise per litre. Cherukunnu Town in the Kannur district of **Kerala** gets water from a RO plant.

There are several alternatives to RO systems for safe drinking water. The most popular is rainwater harvesting (RWH). The Vembanad lake region gets around 3,000 mm of rainfall per year. Even though most houses have thatched roofs, the people can use plastic sheets to capture enough rainwater to meet their needs for drinking water needs. The BAIF Institute for Rural

Development-Karnataka has set up rooftop RWH systems in several villages in **Karnataka** where groundwater is contaminated with fluoride.

In **Tamil Nadu**, several communities have renovated their traditional water sources, called ooranis (ponds). As the sub-surface water level is high, people can construct shallow clay- or plastic-lined ponds to catch rainwater in the Vembanad region. This will prevent the saline groundwater from mixing with the water in the pond. Several low-cost methods can be used to treat the pond water for drinking.

One such is the slow-sand filter developed by the Centre for Environmental Studies of Anna University, Tamil Nadu. This has reduced the coliform count by 90 percent in six pilot projects of oorani renovation in the Kancheepuram and Ramanathpuram districts of the state. The DHAN Foundation has demonstrated use of these filters with ooranis.

Solar disinfection, sodis, is another inexpensive method to purify water. The Mahatma Gandhi University, Kottayam, **Kerala**, is working on a way to use this way to cleanse water of bacteria and dissolved solids. It is evaluating the method to make pond water safe to drink near Jodhpur. Action for Food Production has designed a horizontal roughing filter to remove suspended particles and bacteria. It also uses plants to fix salts such as nitrates, chlorides and sulphates. However, this phyto-remediation process needs a lot of space.

The Association for Needy and Neighbouring Downtrodden, Guntur, **Andhra Pradesh**, is working on a system that uses a combination of oxidation and reduction using solar powered electrolysis to remove dissolved salts. Others have used a combination of filters and chlorination for water treatment. In **Gujarat**, an NGO advises a group of organizations that work with communities to ensure drinking water security in the Kutch region.

RO systems can be an immediate solution to the drinking water problem for the people in the 17 gram panchayats. However, the communities have to work out a method of maintaining the systems. The pricing of water should be such that they operator can recover the cost of running the plants. A panchayat-appointed committee can oversee the service delivery in terms of both quantity and quality. It will be crucial to maintain equity while providing water; one way to ensure inclusion of the poor is to issue all residents cards that entitle them to a daily quote of water. This will prevent the rich residents from buying more than their entitlement and depriving the poor of theirs.

Before setting up any plants, the agency must assess the pollution load and concentration in the region to determine the best treatment methods. It may be necessary to pre-treat water before RO treatment to get the best results and extend the life of the RO membranes. It will have to educate communities on the advantages of RO systems visavis other sources of water to ensure their adoption and maintenance.

Comparative Experiences

Andhra Pradesh

RO Plants by Byrraju Foundation, East Godavari and Krishna districts *(from Ramakrishna Nallathiga, Centre for Good Governance, Hyderabad)*
Water in several villages in these districts is saline and has a high concentration of dissolved minerals. The Byrraju Foundation installed RO plants in several villages, sharing the costs with the community. It trained two people to operate the plant. It has set up 29 plants in 80 villages

that meet the drinking water needs of 380,000 people. The operator charges Rs 1.5 for 12 litres of water, that is supplied in food grade HDPE bottles. Read more.

Naandi supplies drinking water through RO, *(from Jasveen Jairath, Water Sector Professional, Hyderabad, response 1)*
People in several districts of Andhra Pradesh used to drink water contaminated with pesticides, and suffer from a variety of diseases. Naandi Foundation installed RO plants, along with its technology partner Tata Projects and Water Health International, in selected villages. It has covered 390,000 households in the state over the past several years. People pay 10 paise per litre for the water. Read more.

Oxidation/reduction process to remove dissolved minerals, Guntur *(from Gary Grunder, Association for Needy And Neighbouring Downtrodden)*
Groundwater in the district is heavily laced with minerals. The organisation is developing a process of flocculating these out of the water through a process of both oxidation and reduction using solar-power electrolysis. They have added silver as this has anti-septic properties. Their system treat about 200 litres of water a day in bright sunlight that is free of harmful dissolve minerals, at minimal cost. Read more.

Punjab

Safe Drinking Water Plant completes one year, Gidderbaha, Muktsar district *(from Jasveen Jairath, Water Sector Professional, Hyderabad, response 1)*
People in this region suffered from high rates of cancer caused by water pollution. The Naandi Foundation and its technology partner Tata Projects set up 63 community-based RO in 57 villages throughout the block. The Gidderbaha Safe Drinking Water Project was part of the Public Private Partnership (PPP) between the panchayats, government and the Foundation. Now, more than 150,000 people in the block get water that is safe to drink. Read more.

Kerala

Cherukunnu gets drinking water from RO, Cherukunnu, Kannur district *(from Dinesh Kumar, Institute for Resource Analysis and Policy, Hyderabad, response 2)*
The village of Cherukunnu in the coastal Kannur block of the district was short of drinking water. The gram panchayat installed RO plant to provide residents with safe drinking water. It is managed by the panchayat. The local people have found a way to dispose off the wastewater from the plant. It has solved their drinking water problem. Read more.

Rajasthan

Clean drinking water for all, *(from Jared Buono, Watershed Management Group, Chennai)*
Piramal Water Private Limited was established in mid-2008 to find viable mass-market RO based solutions for drinking water. It operates under the brand "Sarvajal". It is a for-profit business based on the work of the Piramal Foundation. It piloted the Bagar Drinking Water Initiative in the Shekhawati region of Rajasthan, where fluoride contamination in drinking water leads to premature health problems. It has now established 68 rural franchises in the state. Read more.

Solar disinfection of drinking water in an arid zone, Jodhpur *(from Shibu K. Mani, Division of Disaster Management, Mahatma Gandhi University, Kottayam)*

The villages of Tulesar Purohitan and Tulesar Charnan near Jodhpur that depend on their local ponds for water. Under a project to evaluate the efficacy of solar disinfection (sodis) of pond water, 40 families in each village were assigned either to a group using sodis, or to a control group, who were not. The families in the sodis group experienced a 70 percent drop in water borne diseases compared to those in the control group in both villages. Read more.

New Delhi

Horizontal roughing filter and bioremediation for water treatment, *(from Ajit Seshadri, The Vigyan Vijay Foundation, New Delhi, response 1)*
Action for Food Production (Afpro) has developed a horizontal roughing filter, for use in the north-east where there is a need for safe drinking water. This filter, where stones, gravel and sand are arranged horizontally in a bed, removes all suspended impurities. Combined with bio-remediation, it also removes the dissolved salts of heavy metals that can cause diseases. Read more.

Karnataka

From Amitangshu Acharya, Arghyam, Bangalore, response 1)

Rainwater harvesting to address flouride contamination
Over 5,400 habitations in state have fluoride in groundwater. The State government and BIRD-K launched 'Sachetana' to provide a rooftop rainwater harvesting structure for each house for fluoride free water. As many as 60 villages and 5600 families have been already in 4 districts of Karnataka. The project has been successful because of the high degree of community involvement. Read more.

Gujarat

Drought proofing villages in Kutch, Abrasa block
This is an extremely arid part of India that gets scanty and irregular rain. Arid Communities and Technologies (ACT) has provided planning, geo-hydrology and monitoring support to a programme for ensuring drinking water in 165 villages. Over the past 4-5 years, along with partner NGO Sahjeevan, they have ensured adequate drinking water in 60 villages despite a three-year drought. Read more.

Tamil Nadu

From R. K. Srinivasan, Centre for Science and Environment, New Delhi)

Filters remove 90 percent of coliforms, Kancheepuram and Ramanathpuram
Large parts of rural Tamil Nadu depend on ooranis (surface water ponds) for drinking water, but this often has a high coliform count. The horizontal and vertical sand filters developed by Anna University's Centre for Environmental Studies have proved effective in eliminating 90 percent of the coliforms in a pilot undertaken by DHAN Foundation. It will now be scaled up to ponds in all the 12,618 villages in the state. Read more.

RO plant comes a cropper, Ramanathpuram
In Ramanathapuram district, where drinking water is scarce, the State Government tried to solve the problem in 1999 by installing a desalination plant. The aim was to provide the 296 inhabitants of a village 15 litres of water per day. The plant cost Rs 35.48 crore. However, the project failed because of the high cost of the 168 membranes, at Rs 50,000 each. The local people could not afford this and therefore did not take ownership. Read more.

Related Resources

Recommended Documentation

Making the most of a scarce resource: Solar disinfection of drinking water in the arid zone of western Rajasthan (*fromRamakrishna Nallathiga, Centre for Good Governance, Hyderabad)*
Paper; by Rob Reed, Isaac Bright Singh, Shibu Mani, Ranjit Kanjur, Neil Simon and Surekha Mol . Aridlands Newsletter; University of Arizona; Arizona, USA; June 2005; Permission Required: No
Available at http://ag.arizona.edu/OALS/ALN/aln57/reed.html

Paper describes an experiment in Jodhpur district to use solar disinfection of village pond water to make it fit for drinking

Field project to mitigate and prevent salinity ingress on Mangrol coast of Junagadh district, Gujarat (Phase II) (*fromAmitava Basu Sarkar, Himalayan Institute Hospital Trust, Dehra Dun)*
Report on project; Aga Khan Rural Support Programme (India), Ahmedabad; Permission Required: No.
Available at http://www.srtt.org/institutional_grants/rural_livelihoods_communities/kvy_agakhan_rural.htm

Information on field project to mitigate and prevent salinity ingress on Mangrol coast of Junagadh district, Gujarat, including rainwater harvesting

State of India's Environment: Dying Wisdom (*from Dinesh Kumar, Institute for Resource Analysis and Policy (IRAP), Hyderabad, response 2)*
Book; by Centre for Science and Environment; New Delhi; 1997; Permission Required: Yes, priced publication
Available at http://www.cseindia.org/html/extra/twhs.htm

Dying Wisdom documents India's diverse systems of water conservation and management, mostly evolved by communities in keeping with their local environments

Recommended Organizations and Programmes

FromSree Hari N., Byrraju Foundation, Hyderabad

Byrraju Foundation, Hyderabad
Byrraju Foundation, Satyam Enclave, 2-74 Jeedimetla Village, NH-7, Hyderabad 500855, Andhra Pradesh; Tel: 91-40-23191725, Ext: 108; Fax: 91-40-23191726 mailto:sreehari_n@byrrajufoundation.org;www.byrrajufoundation.org; Contact Sree Hari N. Associate Partner

Byrraju Foundation has been setting up RO plants in rural communities where other sources of drinking water are unavailable on a cost-sharing basis with the local people

Dhan Foundation, Madurai
18, Pillaiyar Koil street, S.S. Colony, Madurai, Tamil Nadu - 625 010; Tel: 91-452-2610805; Fax: 91-452-2602247 mailto:dhan@md3.vsnl.net.in; www.dhan.org; Contact A Gurunathan. Executive director

Dhan Foundation works on tank rehabilitation in Tamil Nadu adopting a community-centric approach. It has developed cost-effective water treatment methods

The Central Salt and Marine Chemicals Research Institute, Gujarat*(from K. D. Bhatt, GSFC Science Foundation, Vadodara)*
Gijubhai Badheka Marg, Bhavnagar-364002, Gujarat; Tel: 91-278-2567760; Fax: 91-278-2567562 salt@csmcri.org; http://www.csmcri.org/

The Institute researches more efficient methods of salt production and has set up RO systems near its campus to provide water to villagers

From Amitangshu Acharya, Arghyam, Bangalore, response 1

BAIF-Institute for Rural Development-Karnataka, Karnataka
P. B. No.3 'Kamdhenu', Sharda nagar, Tiptur 572202, Karnataka; Tel: 91-8134-250658, 250659; Fax: 91-8134-251337 birdktpr@gmail.com; www.birdk.org.in

BIRD-K has developed and installed rainwater harvesting systems for individual households in flouride-affected areas of Karnataka

Arid Communities & Technologies, Gujarat
C - 279, Opp. Gunatit Chowk, Mundra Road Relocation Site, Bhuj - 370 001, Kutch, Gujarat; Tel: 91-2832-651531; mail@act-india.org; Contact Dr. Yogesh Jadeja; yogesh@act-india.org

ACT provides technical support, planning and monitoring assistance to NGOs working in Kutch on water management. The provides geo-hydrological inputs for these projects

Centre for Environmental Studies, Anna University, Chennai *(from R. K. Srinivasan, Centre for Science and Environment, New Delhi, response 1)*
Anna University, Chennai 600025, Tamil Nadu; Tel: 91-44-22354296; Fax: 91-44-22354717 dirces@vsnl.com; http://www.annauniv.edu/EnvironmentCentre/

The Centre is involved in researching chemical and biological characteristics of water bodies, treatment and reuse of wastewater by advanced oxidation processes

Indian Institute of Technology, Delhi *(from R. K. Srinivasan, Centre for Science and Environment, New Delhi, response 2)*
IIT, Hauz Khas, New Delhi 110016; Tel: 91-11-26591735; Fax: 91-11-26581471 jeechair@admin.iitd.ac.in; http://www.iitd.ac.in/

Has researched the links between rainwater harvesting and the material used for constructing roofs

Sri Lanka Rainwater Harvesting Association, Sri Lanka
Lanka Rain Water Harvesting Forum, 28/3A, Subadrarama Lane, Nugegoda, Sri Lanka; Tel: 94-11-5524612; Fax: 94-11-2768520; lrwhf@sltnet.lk; http://lankarainwater.org/ Contact Ms. Tanuja Ariyananda; Executive Director; tanuja@sltnet.lk

The Association promotes and fosters R&D, dissemination and sharing of experiences in rain water harvesting, conservation and utilization for solving water problems

Naandi Foundation, Chennai *(from Jasveen Jairath, Water Sector Professional, Hyderabad, response 1*
502, Trendset Towers, Road No 2, Banjara Hills, Hyderabad - 500 034, Andhra Pradesh; Tel: 91-40-23556491/92; Fax: 91-40-23556537 info@naandi.org; www.naandi.org; Contact Mr. Manoj Kumar ; Chief Executive Officer

Naandi Foundation has set up RO plants to meet the drinking water needs of rural communities in four states on a cost-sharing basis with local people

United Nations Children's Fund (UNICEF), New Delhi, *(from Jasveen Jairath, Water Sector Professional, Hyderabad, response 5)*

73 Lodhi Estate, New Delhi 110003; Tel: 91-11-24690401; Fax: 91-11-24627521; newdelhi@unicef.org; http://www.unicef.org/india/children_2357.htm

UN agency which has supported the construction of rooftop rain water harvesting in a few districts of Rajasthan

Action for Food Production, New Delhi*(from Ajit Seshadri, The Vigyan Vijay Foundation, New Delhi, response 1)*

Action For Food Production, 25/1-A Pankha Road, D-Block, Janakpuri, New Delhi-110058; Tel: 91-11-28525452; Fax: 91-11-28520343 ed@afpro.org; www.afpro.org; Contact Dr. D K Manavalan; Executive Director

Afpro is an Indian NGO working for the development of the rural poor through effective natural resource management. It has developed cost-effective water filtration processes

Sir Ratan Tata Trust, Mumbai *(fromAmitava Basu Sarkar, Himalayan Institute Hospital Trust, Dehra Dun)*

Sir Ratan Tata Trust, Bombay House, Homi Mody Street, Mumbai 400 001, Maharashtra; Tel: 91-22-66658282; Fax: 91-22-66658013 srtt@tata.com; www.srtt.org; Contact: The Secretary

This is one of the oldest philanthropic institutions in India. It has promoted access to water in several states, including setting up RO plants for drinking water

Centre for Science and Environment, New Delhi *(from Dinesh Kumar, Institute for Resource Analysis and Policy (IRAP), Hyderabad, response 2)*

41, Tughlakabad Institutional Area, New Delhi, India - 110062; Tel: 91-11-29955124/125; Fax: 91-11-29955870 cse@cseindia.org; www.cseindia.org; Contact Ms. Sunita Narain; Director

CSE has documented traditional water management systems of India and has several publications on the topic

WASMO, Ahmedabad *(from Dinesh Kumar, Institute for Resource Analysis and Policy, Hyderabad, response 3)*

3rd Floor, Jalsewa Bhavan, Sector 10-A, Gandhinagar - 382 010. Gujarat; Tel: 91-79-23247170; Fax: 91-79-23247485 wasmo@wasmo.org; http://www.wasmo.org/

WASMO works towards drinking water security and habitat improvement by empowering communities to manage their local water sources and drinking water supply

Water Health International, Secunderabad *(fromAvani Mohan Singh, Haritika, Jhansi)*

No. 206, Ashoka MyHome Chambers, 1-8-301, S. P. Road, Secunderabad - 500 003, Andhra Pradesh, India; Tel: 91-40-67011709; Fax: 91-40-67011710 infoindia@waterhealth.com; www.waterhealth.com

The company uses a combination of technology and business models to deliver highly affordable, clean water to even the most remote, low-income rural communities

Piramal Water Private Limited, Ahmadabad *(fromJared Buono, Watershed Management Group, Chennai)*

Piramal Water Private Limited, Chandan Bungalow, Near Darpana Academy, Usmanpura, Ahmedabad, Gujarat - 380 13; Tel: 91-79-27560485; http://www.sarvajal.com/contact

Sarvajal is a social enterprise that develops sustainable drinking water solutions. Our commitment is to make purified drinking water accessible and affordable to all

Recommended Portals and Information Bases

Solar Water Disinfection, Department of Water and Sanitation in Developing Countries at the Swiss Federal Institute of Aquatic Science and Technology,

Switzerland *(from Shibu K. Mani, Division of Disaster Management, Mahatma Gandhi University, Kottayam)*
http://www.sodis.ch/; Contact Ms; Regula Meierhofer; Head of the SODIS Reference Center; regula.meierhofer@eawag.ch

The SODIS Reference Center is engaged in providing information, technical support and advice to local institutions to promote the Solar Water Disinfection Process

FromNitya Jacob, UNICEF, New Delhi

All About Water
http://www.allaboutwater.org/filtration.html

Has information on water, including processes to purify it, standards of drinking water, and cost-effective ways to purify water

Wikipedia
http://en.wikipedia.org/wiki/Reverse_osmosis

Page gives an introduction to RO including the technology involved and what the parts of a RO system are. It also has useful links for further reading

Waste to Health, Bhawalkar Vermitech Private Limited, Pune *(fromUday Bhawalkar, Bhawalkar Vermitech Pvt Ltd, Pune)*
http://www.ecochip.org/; Contact Dr; Uday Bhawalkar; Tel: 91-20-24226916; bvpl@vsnl.com
Saline and brackish water when treated through membranes leaves effluents, but biosanitizer uses a natural process to treat water that still has salts, and is palatable

Related Consolidated Replies

Desalination Techniques, from S N Srinivas, TERI, Bangalore (Comparative Experiences). Water Community,
Issued 26 October 2007. Available at http://www.solutionexchange-un.net.in/environment/cr/cr-se-wes-26100501.htm (PDF, 120 Kb)

Provides information and experiences on desalination techniques using solar stills to produce potable water from brackish water

Water Purification Technologies for Flood-Affected Bihar, from G Padmanabhan, UNDP, New Delhi. Water Community and Disaster Management Community,
Issued 1 September 2008. Available at http://www.solutionexchange-un.net.in/drm/cr/cr-se-drm-wes-01090801-fullcr.pdf (PDF,400 Kb)

Recommendations on techniques for purifying water in disaster-affected areas ranging from household remedies, free solutions, to those offered by large companies

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Responses in Full

Ramakrishna Nallathiga, Centre for Good Governance, Hyderabad

It is good to know about such approaches to cater to drinking water needs by treating water from the Vembanad Lake. The preventive approach (through inlet diversion, access control and use management) has been a popular approach to lake water quality management in inland water lakes like that in Hyderabad. However, coastal water lakes have a different setting and it is difficult to manage all of them simultaneously.

While the people in adjoining areas may have already used the lake water, I am not sure of the technology choice. Reverse Osmosis (R.O.) needs to chosen after a thorough examination of the

environmental pollution of lake water and appropriate treatment systems for dealing with the precise problems. RO is effective in removing the salinity and other dissolved minerals in the water. However, it may not be cost-effective to deal with bacteriological contamination of water. In addition, pre-treatment may be required before R.O. treatment depending upon the water quality testing results.

One model that was piloted in select mandals (blocks) of two coastal districts of Andhra Pradesh (East Godavari and Krishna) aimed at providing drinking water to local communities after treatment of the water, which was mostly saline/brackish and laden with some other minerals. It was developed and piloted successfully by Byrraju Foundation (of the erstwhile Satyam Group).

The attached document (shared by a representative of the Byrraju Foundation) gives some technical details and operational arrangements of the project. Please read http://www.solutionexchange-un.net.in/environment/cr/res25060901.doc (DOC; Size: 236KB) for more details. The project not only provided a technical model but also worked out costing and distribution arrangements for continuing the model on a sustainable basis. Further details of the scheme may be available with the Byrraju Foundation, Hyderabad.

Sree Hari N., Byrraju Foundation, Hyderabad

Thank you for bringing up an important aspect of providing clean and safe drinking water to the rural populace.

The Reverse Osmosis (R. O.) plants are very much required wherever the TDS levels are high. You have specified that the source of water is from the lake. As per our experience, the surface water contains turbidity and does not contain much of Total Dissolved Solids (TDS). As reported by you the water contains pesticides and other chemical contaminants, and therefore, it is ideal to go for Reverse Osmosis treatment. As the pathogens are reported in the water, the R. O. System should be equipped with UV Lamp and the treated water should be exposed to UV rays.

We have established 60 water plants in six districts of Andhra Pradesh so far. Depending on the need and quality of the water we have established 25 Reverse Osmosis plants. I will be happy to share our experiences in details. Please contact me at the address given below.

Sree Hari N.,
Associate Partner,
Byrraju Foundation,
Satyam Enclave, 2-74 Jeedimetla Village,
NH-7, Hyderabad 500855
Andhra Pradesh,
Telephone: 91-40-23191725, Ext: 108,
Mobile: 9849484774
Fax: 91-40-23191726,
Website: www.byrrajufoundation.org

J. Saravanan, DHAN Foundation, Chennai

The DHAN Foundation has successfully designed and implemented household level water filters called "bio sand filter" focusing exclusively on bacteriological impurities. However, the system is not for pesticide or chemical removal. The filter is used mainly by the communities to treat pond water before consumption. For more info about the initiative you may refer http://www.dhan.org/vayalagam/biosand.php

K. D. Bhatt, GSFC Science Foundation, Vadodara

Reverse Osmosis (R. O.) is a well-known water treatment technology. However, owing to it's comparatively higher operational and maintenance costs, it is still not widely used.

Further, the R.O. system requires regular maintenance and deputation of manpower for the daily operations of the system, preferably skilled manpower. The other drawback of this system is the problem of disposal of wastewater/discharged water after treatment of raw water, which is highly concentrated effluent water.

The Central Salt and Marine Chemicals Research Institute, CSIR, Bhavnagar had installed one such unit in Kalyanpur village, Vallabhipur Taluka (Bhal area), Bhavnagar district after a few initial technical snags.

You may also consider rainwater harvesting at the community level. We will be happy to share our experiences of community RWH and provide necessary technical guidance, if required.

Amitangshu Acharya, Arghyam, Bangalore *(response 1)*

K.D. Bhatt has listed out the technical difficulties related to R.O. plants quite well. Unfortunately, I am not aware of any research that has taken place on the ecological impacts of converting slightly saline/brackish water into potable water in the hydrological cycle at a micro level. Alternatively, for that matter the impacts of discharging R.O. plants residue in local environments. I would seriously urge you to look into those issues. If members have any literature on these, kindly share them as well.

Thatched roof should not be a bottleneck to rainwater harvesting at the household level. Arghyam supports a project in Karnataka in fluoride-affected districts, which is being implemented by BIRD-K. The innovations and institutional mechanisms that have evolved are worth a look. In these areas, people with thatched roofs are using the space in front of their house as a catchment area, running the rainwater through a sand filter and storing it and using it for drinking purposes. If possible, please contact BIRD-K. Their address and contact details are:

BAIF Institute for Rural Development-Karnataka (BIRD-K),
P. B. No.3 'Kamdhenu', Sharda nagar, Tiptur 572202, Karnataka,
Phone: 91-8134-250658, 250659 Fax: 91-8134-251337,
E-mail: birdktpr@gmail.com
Website: www.birdk.org.in

We are also supporting an initiative in Gujarat called Pani Thiye Panjo. It is being coordinated by an NGO, Sahjeevan. The technical expertise is being provided by an NGO, Arid Communities and Technologies (ACT). ACT has used the knowledge of geo-hydrology to sustain rainwater harvesting through open wells in Kutch district. The TDS in drinking water supplies in this region reaches 20,000 and even more. Yet, using geo-hydrology to mark out potable water pots, a successful model for community-managed drinking water systems is taking shape. Please interact with Dr. Yogesh Jadeja of ACT, he can provide critical input into how sound geo-hydrology can make rainwater harvesting a feasible option in coastal areas. His contact details are:

Arid Communities & Technologies,
C - 279, Opp. Gunatit Chowk,
Mundra Road Relocation Site,

Bhuj - 370 001. Kutch. Gujarat. India.
Phone: 91-2832-651531, 645152,
Emails: mail@act-india.org and act.bhuj@gmail.com

This year we are witnessing the worst possible power cuts. I do not have much clue about the electricity situation in Kerala, but when external power supply fails, how would one run such power guzzling systems? One may suggest solar, but that implies that set up costs will shoot through the roof.

How much is one paying for water now? My concern is that when such external technologies juggernauts into a village, the real sufferers are the poor, who (in case the R.O. water is priced, which I believe will happen) cannot pay for the same.

I would suggest that one looks at possible local options of water harvesting before going for expensive energy intensive systems. There is a trade off between convenience in access and wise resource use. Weighing them would be the best thing to do. RO. systems can perhaps kick in only when no other solution seems likely.

Jim Baldwin, Consultant, Bahrain

After working for many years in the rural water sector in India, I am now working on new development projects in Bahrain. Here a high proportion of water supply comes from desalination sources - many are R.O. based. Experience shows that a high degree of M&E input is required and there can be a high cost for chemicals, for example for neutralisation and mineralisation to make the product more palatable as drinking water.

Trying to provide this technology at village level has always hit the problem of attempting to sustain the system and keep costs at affordable levels for the community.

As an alternative, I would like to elaborate on a solution that was developed during a training course for rural water sector that I had the privilege to run in Andhra Pradesh some years ago. The training was run in high fluoride villages in Nalgonda District of Andhra Pradesh. The engineers in one team came up the following solution:

- Buy a small water tanker
- Drive the tanker to Hyderabad
- Fill up with water from sources in Hyderabad (at the time quoted at Rs. 300)
- Return to the village
- Distribute 3 litres per capita in household containers specially marked and dedicated to the task
- Set up a system of delivery to adjacent villages and sell containers at low cost.

The approach was costed carefully and considered viable, particularly with the capital cost contribution being offered as an incentive to villages from the Central and State Government at the time.

I think the approach needs to be reconsidered in the light of a worsening situation in villages, particularly where high fluoride is causing health problems.

R. K. Srinivasan, Centre for Science and Environment, New Delhi *(response 1)*

Community level rainwater harvesting is proving to be a sustainable option for solving rural drinking problems. The renovation of traditional water sources called “oorani” (meaning ponds) is

providing safe drinking water to several communities in Tamil Nadu. The horizontal and vertical sand filters developed by Anna University's, Centre for Environmental Studies are able to reduce the coliform count by over 90 per cent and thereby provide safe drinking water to the communities. Six pilot projects on renovating the oorani's started in 2005 in Kancheepuram and Ramanathapuram district of Tamil Nadu and now after a successful pilot stage, the state plans to revive ponds in 12,618 villages. The community is involved in all stages including, decision-making, implementing and managing the water sources, which was possible by contact efforts undertaken by the Madurai based NGO, DHAN Foundation.

In the same Ramanathapuram district, previously the State Government tried to solve the problem by installing desalination plant in 1999 to provide 15 LPD to 296 inhabitants at the cost of Rs 35.48 crore. The project did not take up since arrangements to change the 168 membranes, costing Rs 50,000 each could notbe worked out. In this district now under the Oorani Revival pilot project the State Government has taken up the renovation of two ooranis in Mudukulathour block namely the Valandu and Ulaiyur ooranis and in Kadaladi block three ooranis namely Kodarendal, Kandilan and Keelambal ooranis

The combination of technical people and NGOs along with government is reason for the success of this project. For more information regarding this please read http://www.solutionexchange-un.net.in/environment/cr/res25060902.pdf (PDF; Size: 616KB)

Latha Bhaskar, Ashoka Trust for Research in Ecology and the Environment, Thiruvananthapuram *(response 1)*

I would like to thank Amitangshu Acharya for his concerns, which of course is our concern too. In fact, we were also wondering about the disposal of R.O. plant's filtered residue. Considering the costs, only bio treatment is possible and we were considering treating it in tanks filled with water hyacinth, which can absorb the nutrients, heavy metals, etc. This way the treated water can be pumped out to the lake and the plants can be replaced as and when required. The opinion of experts in this aspect is requested.

Rainwater harvesting is done by all people in Kuttanad, though it is not roof water harvesting collected storage tanks. They use indigenous methods to collect fresh rains. Perhaps those living in huts have little space and employ other facilities to do the same.

In such waterlogged areas, which floods in heavy rains, all protected water bodies are contaminated easily. Various technology trials failed to resolve the heavy quantities of pathogenic bacteria present in the water and perhaps the R.O. technology with U.V treatment is identified as the best intervention for providing potable water.

The revenue department and local self-governments spend millions of rupees every year to bring water from farther places in canoes and make it available to the people. This is repeated every year. Loads of complaints and disputes are linked to such supply and still there are no other remedial interventions.

When the cholera deaths were reported, there were high level meetings and the water resource department came into action preparing estimates for water supply through pipe lines, to be brought from other districts. Some 185 crores will be buried this way without solutions. Therefore, we are trying to set up a decentralized m ode of perfect water supply system. One R.O. plant for a cluster of 65 families in a ward will do. In addition, electricity is not a big problem here. Gram panchayths with their decentralised systems have the money and responsibility to take care of the water supply needs of the people. They agreed to provide land, building, electricity and all such supports. They can also subsidize this water supplied to poor families.

Therefore, this is the background and I am not sure whether I mirrored all our problems here. Please do a Google search for the WatSan issues of Kuttanad and Aleppey to read the plight of people. Hence, I request members to tell us about technology choices, R.O. as an option is the one that stands out now.

Sumita Ganguly, Independent Consultant, New Delhi

I request Sree Hari N. to please share with us the cost of installing and operating a rural R.O. system for a standard single village of say 1000 population i.e. 200 households. The source in this case would necessarily be surface water from ponds/lakes, streams, etc as it does not make sense to run groundwater or treated piped water through R.O. What would be the annual per household cost of installing and operating such a system? What kind of pricing has been done to make the system sustainable? Also, please share experiences on maintenance and servicing. Is there any scope for local employment to monitor, test, and service?

It is crucial that all practitioners in this field are fully informed regarding the comparative economics of a range of systems, as also such aspects such as ease of availability of equipments, installation time, availability of skilled persons/contractors, etc and of course the whole issue of cost sharing for sustainability. In order for communities to participate in decision making, and specially women who by and large manage domestic water, it is important that such information is decoded to enable all to understand the basics, which is how much do I have to pay to get safe, clean adequate quantities of water for my family the whole year around. This information should be publicly displayed at all places in a community including schools and health centres to prevent exploitative practices. The discourse on safe water should centre around one theme steadfastly - and that is safe water invariably comes at a price but it costs very little to keep water safe. If only all of us practiced individual and public sanitation uniformly.

Shibu K. Mani, Division of Disaster Management, Mahatma Gandhi University, Kottayam

It is interesting to note that there is continuous monitoring of water quality in the south of the Thannermukham barrage. As part of my PhD work (2000-2006), I observed that certain communities used backwater as their drinking water source which was considered safe water supply. Previous experiences suggest that complicated systems may not be sustainable for long due to many reasons, primarily due to the maintenance cost and the difficulty of follow up works in the marginalized areas. Other reasons such as discontinuity of electricity supply and the geographic peculiarities also act as hurdles. We were working on solar disinfection of the contaminated water (as a point use at the household level) for purification, but only for bacterial removal, not for chemicals. You can get an overview of this by visiting the SODIS website at http://www.sodis.ch/. The work published based on our Rajasthan field study in an online journal is also available. Please read http://ag.arizona.edu/OALS/ALN/aln57/reed.html for the same. If you are interested I can provide more information regarding the same.

Sacchidananda Mukherjee, National Institute of Public Finance and Policy (NIPFP), New Delhi

I believe that identification of sources of pollution of the lake and their pollution transfer characteristics is important. Based on this, taking pollution control measures could provide long-term solutions. However, if there were conflicts of interests among stakeholders, say wetland cultivation and domestic water supply, then it would be difficult to control pollution. For example, nutrients present in wetland water (mostly from sewage and animal wastes) are a major source of fertilizer for the wetland crops but also a good habitat for disease-causing microbes. The

present system of source substitution (draw water from fresh water sources) or alternative system (proposed) of ex-post treatment of polluted water could be a short-term solution. For the long term, we need to protect the lake from all possible sources of pollution.

I would request ATREE to share information on concentrations of pollutants (e.g., microbial pathogens, pesticides and other chemical contaminants), if possible on a monthly basis, to understand the temporal variations of pollution load and documents (if any) on possible sources of pollution of the lake.

Jasveen Jairath, Water Sector Professional, Hyderabad *(response 1)*

I have visited some R.O. plants initiated, operated, and maintained by the NAANDI Foundation in Punjab and Andhra Pradesh. It was a first hand independent visit. My only serious problem with the R.O. plants was the waste disposal and energy dependence, the rest of it was functionally efficient. It had the commitment of the private sector, NGOs, gram panchayats and the local government departments, and hence it was not open to control by any single agency. The monopoly over clean drinking water was pre-empted by selling extra water at higher rates for special one-time events.

If suitable waste collection methods can be coordinated with industries and solar pumps can be used for groundwater, pumping these can become promising decentralized water supply centres that are economically viable.

Jasveen Jairath, Water Sector Professional, Hyderabad *(response 2)*

These are some of my observations based on the R.O. plants I visited in Punjab (which provided much relief to the people there who were dying because of cancer due to surface and groundwater pollution):

- Cost: Water is available to villagers at 10paise per liter and at close proximity to their habitation. This is affordable for most villagers. The very poor who cannot buy the monthly card constitute 5% of the population and are definitely an issue and schemes for cross subsidizing them need to be explored. The cost is of the same order as the water tax to be paid to panchayats/government departments that never deliver satisfactory service.

- Energy intensive: Yes this is an issue. If solar energy can be mobilized it can reduce electricity dependence

- Quality: The water quality is good and well monitored and the agency staff is accountable and can be thrown out of the village by panchayats if they fail to perform

- Equity: Equity is ensured through monthly cards that have to be honoured before yielding to any additional demand by the wealthy/influential. Monopoly of resource is institutionally resisted.

- Maintenance: This aspect is taken care of by agencies, NGOs which have mobile technical staff. They also provide elementary training to local attendants for minor trouble shooting.

- Social response: This has been very positive because it actually delivers what is needed in a systematic, simple, and transparent manner.

- Residue: A serious issue which needs to be addressed. A possible collection mechanism needs to be evolved without adding to cost to user.

- Institutional advantage: NGOs here operate independent of local politics and government departments, hence they can be non-partisan. They are accountable to the village community/panchayat and need their goodwill/sanction to continue its presence in the village.

If the drawbacks can be addressed it is a decentralized model that is worth a try especially in areas where rainwater cannot be stored by scattered users.

Ajit Seshadri, The Vigyan Vijay Foundation, New Delhi *(response 1)*

Based on the suggestions regarding the use of bio-remediation, I suggest that you study AFPRO's design of Horizontal Roughing Filter, which has been used by them in northeast India. It incorporates stones, gravel and fine sand, and you may inter-phase chlorine additives as well. It would be wise to use plants to fix salts such as nitrates, chlorides, sulphates, etc. It is only the metals that are a problem; many common plants are available which carry out the function of fixing metals as well. The plants that will be used will be doing the role of sacrificial plants such as cleaning the water, with the core-function to fix extra salts, metals, etc. The phyto-remediation process i.e. with the use of plants, however, will require a lot of space. Please do apply and arrive at appropriate solutions for remedying raw water for potable purposes.

Amitava Basu Sarkar, Himalayan Institute Hospital Trust, Dehradoon

Please visit the link below regarding a Sir Ratan Tata Trust, initiative in Gujarat. The aim of the initiative is to stop ingress of saline water. In the course of this initiative, SRTT has also used R.O. plants. For more details visit
http://www.srtt.org/institutional_grants/rural_livelihoods_communities/kvy_agakhan_rural.htm.

Ajit Seshadri, The Vigyan Vijay Foundation, New Delhi *(response 2)*

Our NGO has been dealing with water, wastewater, and solid-waste issues. For site specific requirement, due tests need to be conducted for inflow (lake raw water) and also obtain a representative sample and keep a record of test data of outflow water based on the process used, say sand filers, R.O., UV and upon testing we can decide what remediations need to be undertaken. This can then be fine-tuned to get the desired parameters. As we have indicated in previous responses, potable water, water needs to have the following, which is a concept used by us in water-literacy programmes for communities. This is known as CATS, which stands for:

- C-stands for clean and clear,
- A-alkaline as the body systems tend to reach acidity easily, pH - 7.5
- T-tasty to mean good minerals, salts, etc with no pungent taste or odour
- S-sterile to have the water with no pathogens, germs, etc.

We are working in an urban community in Delhi to provide them with potable water. Here similar interventions are being planned, i.e. RO with UV with monitoring of the parameters and fine-tuning the process applied. Since power availability is a problem, we are assessing possibilities of solar powered-PV systems to power the RO and UV and pumping Units. This is expensive, but needed as safe-water comes with some cost involved. Solar electricity may be contemplated in power scarce rural areas as the power requirement is not large. If the system requires only filtration with UV- lamps then the power consumption is also minimal.

Jasveen Jairath, Water Sector Professional, Hyderabad *(response 3)*

Please check the website of NAANDI Foundation for details on R.O. plants. What I recollect is that it costs a one-time investment of Rs. 12 to 18 lakhs per village depending on the population for capital cost. The rest is the only cost to consumer at 10p per liter. The user has to go to the water plant, usually in the village centre to pick up their daily quota in prescribed pots.

Rainwater storage in individual households if possible is probably the best the best option as it is energy independent and nearby. This needs policy support to enable each household to construct such arrangements. In the absence of this R.O. provides an immediate relief but waste management of R.O. is a critical and serious issue, which needs to be addressed. A combination of facilities can be provided for gradual shift over to RWH.

Terry Thomas, Wilbur Smith Associates, Bangalore

At the outset, R.O. for purifying water is a technically viable option. However, issues connected with disposal of brine, electrical needs, and regular replacement of membranes, etc matters much, while considering as community water supply solution. This is particularly true given the water-polluted background of Kuttanad region. Hence, I am replying mainly to your second question.

The basic water issue in Kuttanad is due to excess contaminants as dissolved solids in water. Perhaps this region might have highest surface water per person than any other part of Kerala, and majority of this water present around each community is in non-usable form. Providing water through cross-district water supply pipes attempted through repeated schemes proved to be a failure. Moreover, the volume of fresh water pumped out each year from Kuttanad region itself for enabling paddy cultivation might be much higher than the fresh water demand in the region.

The best option, which ATREE could attempt and make practical, is to establish large clay lined open ponds (2 acres size onwards) which are to be fed by rainwater or from rivers during monsoon period. The team may explore ways to convert few acres of paddy land into permanent fresh water collection body in each village or kara, under similar community management lines adopted in Jalanidhi project. Another option is to further widen the fresh water bodies surrounding the sacred groves in Kuttanad region in the similar lines, which is also a good aquifer well protected by the local flora through phytoremediation. This process of “fresh water farming” may enable to achieve some solace to the ever growing and continually funding water programmes in Kuttanad.

Community management of water supply is a proven concept in Kerala, hence needs no introduction. Households can be provisioned with water through pipes or other options. Hope it adds some value. Please feel free to discuss this further with me if required.

K.A.S. Mani, Andhra Pradesh Farmers Managed Groundwater Systems (APFAMGS), Hyderabad

RO for treating the water for Kuttanad area might not be a sustainable solution. The variation in water quality is huge, depending upon the season and the operation of the shutter preventing seawater ingress. Experience shows that O&M costs for operating RO is enormous and disposal of the sludge is a major issue. Piped water supply is still the best answer. Number of tankers bringing water for the different hotels is only increasing with time. The drinking water economy is huge and needs to be fully assessed for channeling it for a sustainable solution.

Drilling of tube wells is gaining popularity, however contamination of fresh water with poor quality water trapped in the peat and clay layers is limiting the success rate. Contamination of fresh water aquifers (thin) due to faulty design of the tube wells is a major threat. Ideally, ATREE should focus in capacity building of community and elected representatives for managing the problem at household and community level. Harvesting of rainwater at various levels is an option.

Individual household level roof water harvesting needs to be encouraged. Recharging the shallow open dug wells/ponds is an option for flushing of salts from shallow aquifers. Recycling of water for secondary use at household level needs to be studied. The suggestions made by Terry Thomas need to be adopted at community level.

Dinesh Kumar, Institute for Resource Analysis and Policy, Hyderabad *(response 1)*

Rainwater harvesting ponds (with clay lining) in a place like Kuttanad does not seem to be feasible. First, these are low-lying areas. In addition, the groundwater table is very high here and chances of getting saline water and contaminated water (with fertilizer and pesticide residues) from shallow aquifer is high. If ponds are dug, there is no way one can stop inflow of groundwater into these ponds, unless we make thick concrete lining which would be prohibitively expensive and senseless. We should remember that many parts of Kuttanad have problem of sub-surface drainage.

Roof water harvesting is not a bad idea in a high rainfall situation like that in Kuttanad. However, as I wrote several times in this solution exchange, the economic viability of this against the alternatives such as distant pipelines schemes, need to be ascertained first. The most important point, however, is that the people should have good roof and sufficient roof area. I am afraid, the biggest problem that many people who lack access to safe water for drinking is that they are not living under a decent roof! As already pointed out by Latha Bhaskar in her query, most people have thatched roofs there. Hence, the water will be heavily contaminated by organic matter.

Commenting on RO, it is definitely a good idea to think about RO for such areas. While it is pointed out that O & M cost is very high, the total cost of the system including O & M will be still lower than RWHS in the ideal situations, as raw water for RO could be easily made available from the vicinity. I have earlier shared some data on this with the community. Again, changing salinity level of intake water is not a problem as one can design the RO system (membrane) for even brine (normally done in many regions using large-scale RO systems such as Florida in US Saudi Arabia, Kuwait, and Israel).

Disposal of reject water is a non-issue in villages, as the amount is too small to make any negative impact on the ecosystem. A village with a population of 1000 people would need 1,800 m3 of water (at a rate of 5 lpcd for drinking & cooking). The reject water from the system would be around 1,800-2,000 m3 per annum. This is what a hectare of paddy would take for irrigation. If the raw water has a salinity of 3000 ppm, the reject water will have around 6000 ppm (mg/litre) of salinity. If 100 villages of Kuttanad go for RO, then they would together generate 1080 ton of salt every year. This same salt is taken from the lake through the raw water intake. The only difference is that we would be reducing the amount of water in the lake by 0.18 MCM every year. This will perhaps increase the salinity level of the lakes there by just 0.002 per cent! Therefore, in hundred years, the change in salinity level of lake would be 0.2 per cent.

Israel does desalination of seawater to the tune of 100 MCM per year (500 times more than what 100 villages in Kuttanad would eventually generate as waste), and is setting up more plants to generate 350 MCM of water annually. This will meet 25 per cent of the total water demand in that country (which includes irrigation as well). We can find out where they are disposing off the brine.

Pavitra Singh, People's Science Institute, Dehradoon

To purify the surface water i.e., pond water, river water, etc., we do not need RO systems because surface water contains suspended material that can be easily removed by slow sand filters. Otherwise, one can go for some coagulating material followed by filtration. RO is not a suitable treatment option due to the high implementation cost and wastage of water. The other problem associated with surface water is biological contamination that can be removed by chlorination at both the community and household levels. At the household level in south India SODIS (Solar Disinfection) can play an important role to prevent biological contamination because this part of country gets good solar radiation at high temperature. This process is free as all you have to do is to take a good quality PET bottle, paint it half of it black, and then fill it with water. If you keep in the sun for 6-8 hours, the water will be disinfected.

Nitya Jacob, United Nations Children's Fund (UNICEF), New Delhi

This is an interesting discussion, and I thank you for your responses. I feel we have gone a little off-track, though. Please recall below, the original request was for experiences of using RO systems, area specific approaches and agencies implementing them.

Can we please bring the discussion back on course? I agree rainwater harvesting is an alternative in most parts of India, but remember we get 80%-90% of our annual rainfall in just 100 hours (out of 8760 hours in a year). That is a lot rain in a very short time. While we devise location specific rainwater harvesting systems to capture this deluge, we need to provide drinking water to people. Rainwater harvesting is the best in the medium and long term. We need a short-term solution also, and maybe RO systems or other purification systems are the answer.

RO wastes water, uses power and is expensive. However, it may be the only way to provide drinking water in places where water is laced with fluorides, arsenic or other dissolved solids that other filters do not remove. The few organizations that have set up community RO systems say they are working fine and they manage to supply water at 10 paise a litre, affordable to all but the poorest. So we need to cross-subsidise them somehow, an exercise best conducted at the village level based on how many people there are who cannot pay 10 paise a litre for drinking water, and defray the cost of giving them water over the other people in the village. Again, we need to assess whether is inability or unwillingness to pay, and then decide how to deal with this issue.

Domestic RO systems are only 5-15% efficient. In other words, they will waste 10 litres of water to produce 1 litre of drinking water, and this wastewater will be hard to treat. As there is a water shortage, will people in the locality be willing to waste so much water? Is there enough water for running RO systems and other uses to meet the 40 LPCD norms?

Another issue is whether RO systems are the only way to provide drinking water. Alternatively, can ATREE use a combination of other filters, chlorination and U/V treatment to purify water at the community level? Certain filters can chemically adsorb protozoa such as *giardia* and *cryptosporidium* that are resistant to chlorination, and cause gastro-intestinal diseases

(http://www.allaboutwater.org/filtration.html). A community-level treatment unit with a slow sand filter and a chemical treatment device (another filter or ultraviolet light) maybe a more cost-effective option than domestic water treatment options. I believe Vembanad is having floods now, so something like this combined with better hygiene practices (storing water, methods to take it out of storage vessels) in houses may be a viable alternative.

There are more details on RO on Wikipedia (http://en.wikipedia.org/wiki/Reverse_osmosis) and http://www.historyofwaterfilters.com/water-treatment.html.

Salahuddin Saiphy, Centre for Science and Environment (CSE), New Delhi

I totally disagree with people propagating RO over rainwater harvesting. Rainwater harvesting is a time-tested technology practised in India since centuries and its history is as old as 5000 years (examples of rainwater harvesting/flood water harvesting in Dhaula Veera civilization of Indus valley and Sriverangapura near Allahabad). There are variety of rainwater harvesting/water management structures found across the country to suit local climatological, geological, hydrogeological and most importantly social and cultural requirements. Virda system of coastal Gujarat is a similar system used by local tribes to store rainwater in depressions as a layer of fresh water over saline water and used for various purposes. Surangam is another system found on Western Ghats where rainwater, which is absorbed by soil and moves as subsurface water towards ocean, is tapped and used for various water requirements before it is wasted into ocean. The rainwater harvesting implemented on large scale in Tamil Nadu specially Chennai city has helped to increase water levels by 6-7 metres and also improved groundwater quality so much that many wells which have saline water earlier are now yielding sweet water. The country is full of rainwater storage systems found in Gujarat, Rajastahan, North East, etc.

The decentralised sources of water (created through rainwater harvesting systems) have an advantage over centralized systems because it is just one time investment in rainwater harvesting system with minimum maintenance cost whereas the long distant centralized systems require not only huge infrastructural investment but also high running and maintenance cost. It also requires engineering skills to construct and skilled labour to operate it but rainwater harvesting systems can be designed, implemented, and maintained by local communities themselves.

The issue raised regarding non-availability of decent roofs can be tackled easily through cleaning the roof before rainy season or covering it with polyethylene sheets, which may cost just Rs. 50-100 to cover small house, or applying non-toxic paints.

The best part is that it does not have any long-term impact. But the RO system has many disadvantages. One it is expensive, two it requires expensive instruments, three it consumes huge electricity (which is a scarce commodity not only in rural areas but also in many urban areas). Fourth, it is a water waste full technology where the percentage of recovery is around 50% only and disposal of discarded water is a sensitive issue and may have severe impact on hydrological and ecological system if not handled with care. In many parts of Gujarat it has been tried out and the yield of the field have considerably reduced which were getting the discarded water apart from loss of aquatic fauna and flora. Fifth, it requires changing of membrane at regular interval (expensive and imported item). Where as rainwater harvesting uses locally available materials and also provides employment to local people.

Latha Bhaskar, Ashoka Trust for Research in Ecology and the Environment (ATREE), Thiruvananthapuram *(response 2)*

I am thinking in line with the ideas shared by Dinesh Kumar. In fact local self-governments as well as people in Kuttanad have made all other trials except this R.O plants in Kuttanad, to get good water. Some of the models like rainwater harvesting, protected ponds, etc works in some areas but it cannot be duplicated in other places, especially in the places adjacent to the lake and polders raised on the lake, etc where people live an extreme life. They drink the lake water directly.

The southern part of the lake beyond Thannermukkom barrage has fresh water for 8 months a year and saline intrusion takes place only for 4 months of drought season, the bund is closed for preventing it. So as such, salinity is not a big issue here. During this period, the government makes arrangements to supply water in canoes, brought from elsewhere, spending crores of rupees and such expenditures are repeated every year, which is never foolproof and hence there are lot of complaints. The water authority always plans to bring piped water through inter-district transfer arrangements and the water in these pipes, passing through the waterlogged areas, gets contaminated easily.

As such, there is no solution and we want some permanent decentralized models, established to create alternated models and choices to the government and people. Not that ATREE can run such system ever. We can create a model and do community capacity building/panchayat strengthening, etc., to sustain it. And the amount channeled for water supply can be used more wisely, in a decentralized way by setting up institutional frames, capacity building, and sanitation hygiene promotion strategies, cross subsidization, etc. Accordingly, we have developed model plans learning from the experiences of sector reform initiatives in the water and the sanitation sector.

The query posted needs all possibilities and answers in this context and of course some suggestions for disposal of wastes, etc., in a cost effective way.

The answers received so far are helpful. I am waiting for more comments and solutions and I feel very much grateful to the Water Community for facilitating these.

Dinesh Kumar, Institute for Resource Analysis and Policy (IRAP), Hyderabad *(response 2)*

I am responding to Salahuddin Saiphy's comments. Members of this community are perhaps aware of CSE's seminal work on traditional water harvesting systems "Dying Wisdom: Rise, Fall and Potential of Traditional Water Harvesting Systems in India" published by CSE in 1997. I have no disagreement on that they were myriad traditional water systems and they existed for several centuries. But, I do tend to disagree when he says that traditional rainwater harvesting is low cost, and requires little maintenance.

To the best of my knowledge, there is no water harvesting system that requires no maintenance. Most of the traditional water harnessing systems fell into disuse, because they required repair, regular maintenance, and local people and institutions did not care about it. Continuous maintenance through de-silting etc. is necessary for their upkeep. In modern times, when the opportunity cost of maintenance (for labour) of these systems is too high for the little benefits they yield, people simply started waiting for the government to pay for their repair and maintenance year after year. The result is there for everyone to see. A good chunk of the Rs. 44,000 crore spent under NREGA during the last three years was used for earthwork in rehabilitating local water bodies (may be this topic also should attract some debate).

No doubt, **RO systems require maintenance, so are the myriad of modern water supply systems seen around the world**. Any technology, newly introduced, generally pose

challenges from operation and maintenance points of view. These traditional systems were also new at some point of time in history, and some of them had complex designs, and operational principles.So, we should not shy away from it just because of the maintenance needs.

Further, **RO system cannot be labeled as a centralized system (not that centralized system is bad!). It can also be decentralized and operated at the community level also** as many members pointed out**.** There are some examples from south Gujarat and north Gujarat villages. Andhra Pradesh government's decision to install ROs in hundreds of villages in the state is the new move by state establishments for provision of safe water through this technology. One entire towns is supplied water through RO in Kerala (Cherukunnu, in Kannur district), and is managed by the Panchayat. RO does not generate wastewater, but freshwater from a source, which is generally considered as waste. Of course, we need to dispose of the reject water safely.

If one looks at the cost of rain water harvesting systems (per unit volume of water), it will speak volumes of comparative economics. I have earlier shared some data on this with the community on the basis of research, and therefore do not want to repeat it. **It is a false notion that these systems are cheap. It is not the cost of the structure alone, but the amount of water it capture, which in combination decides the "cost effectiveness"**. In addition to the one-time cost, the maintenance cost, which I is discussed below, also should be considered.

Rainwater harvesting for drinking water supply is not just about collecting water in ponds, tanks and lakes, but also about treating it to safe standards and supplying it to the communities. >From that perspective, local rainwater harvesting from natural catchments is not a time-tested technology, as the farming practices, which use chemical fertilizer and pesticides and which cause eutraphication of ponds, tanks, lakes etc., did not exist half a century ago in this country. Protecting common water bodies from this human-induced pollution is not an easy task.

Hope this will help in generating more informed debate about drinking water supply options in hostile environments.

Salathiel R Nalli, United Nations Children's Fund (UNICEF), Hyderabad

I am one of the members of the Technical Committee constituted by the Government of Andhra Pradesh to look at the feasibility of installing RO plants in the water scarce villages. Like many of you, we too had many apprehensions regarding RO water as the technology is quite recent in the country. We have visited the length and breadth of the state to look at hundreds of RO plants installed by the Government, NGOs and private parties. I am jotting down few observations in the context of ATREE's query:

1. RO technology is comparatively very costly and requires proper maintenance and utmost care.
2. There are many technological options available to treat water, but RO is widely used by most private players.
3. RO removes almost all contaminants, except very few elements which are smaller than water molecules like chlorine byproducts, traces of pesticides, herbicides, etc.,
4. RO removes all traces of minerals, including those which are necessary for our body, like iron, calcium, potassium and sodium. So, the filtered water needs to be blended with RO water to gain TDS of up to 150 ppm.
5. RO filters only 5% - 40% (depending on TDS) of water and more than 60% goes out as reject water. The reject water contains increased levels of contaminants which need further treatment before discharge.

6. The costliest item is the most sensitive RO membrane. To increase the life of the membrane, water needs to be pre-treated through water softening, activated carbon treatment and micro filtration. The RO water then can be processed through UV and Ozone treatment before distribution.
7. The average manufacturing cost of RO water is around 5 paisa per liter. However, considering all other O&M costs, the water can be supplied at 10 paisa per liter with profit.
8. The doorstep delivery needs to be part of the supply cost. This will ensure equity between people who are near and far away from the plant. Also, it can minimize social barriers, if any exist.
9. The average cost of a RO plant of 500 liter per hour is 1.25 lakh which is sufficient for up to 250 families (only for drinking purposes). There are cases where the plant was installed with Rs. 70,000 also.
10. 2 KW of power is needed for a 500 lph plant, which totals up to 1200 units of electricity per month.
11. To be successful, the project needs to begin with participatory assessment and planning with the community. A perennial source with least contamination needs to be selected and the communities need to be properly oriented regarding the system. Two qualified plant operators need to be selected and be given proper training.
12. Water jars (food grade) of 20 liters for individual families also need to be part of planning, so that safe storage and withdrawal of water can be ensured.

Finally, RO is one of the most effective technologies available as on today. RO is recommended only for specific contamination problems that other filters can't remove in a cost effective manner. RO can to be installed when there is high TDS, presence of nitrates, arsenic, and brackishness.

Amitangshu Acharya, Arghyam, Bangalore *(response 2)*

I guess the main purpose of this discussion has significantly deviated. We can easily label this as a discussion on traditional versus new technologies in safe drinking water provision. That would not serve Latha's purpose. I would suggest that ATREE does a rapid scoping study of possible water provision in Kuttenad and a rigorous cost benefit of technologies available and then go ahead accordingly. This may seem as a delay to meeting immediate water needs, but then as the old saying goes, better safe than sorry. As I said earlier, very little research seems to exist in India on effects of RO plants on local ecology and health, etc., though cost-benefit studies as Dinesh suggests perhaps do. Can we use this opportunity to engage in a constructive and holistic study that weighs all equity and ecological aspects of RO? ATREE can be a forerunner with their expertise in ecosystem research and management. Perhaps based on the scoping study a potpourri of interventions can be designed, including/excluding R.O.

However, just as claims that centralized systems are bad as compared to decentralized systems are sweeping generalizations, I feel the same goes for "Most of the traditional water harnessing systems went into disuse, because they required repair, regular maintenance, and local people and institutions did not care about it". This statement assumes that State policy and agencies are neutral agents, which have had no impact on systems of community ownership and management. My recent visit to Uttarakhand clearly shows how a simple thing like lining earthen irrigation channels (*kuhls*) with cement by the minor irrigation department has upset community norms of water sharing and most importantly groundwater recharge mechanisms. As long as it was earthen, people could fix a breach in minutes. Now they inform the irrigation department and wait for a week and sometimes months until action is taken; by that time most of the harvestable water required for cropping is lost. If we are blind to these realities, we will always end up blaming the victims.

In Kachchh, piped water was welcomed by all and pushed vigorously by the State. People lost interest in managing *virdas* immediately. However, when the piped water supply started getting erratic and TDS values started to surge people went back to *virdas*. Now WASMO, a government agency, is promoting decentralized drinking water in a big way. Somewhere, the pendulum swung back to traditional water harvesting when piped water supply faced its ecological limits.

How we look at this live examples and technological failures and interpret the results is up to us. The best way out would be pitch interventions based on serious field studies and understanding of local equity issues.

Best wishes to ATREE for this exercise. It is not going to be easy, but that is what is makes the work worth it.

Jasveen Jairath, Water Sector Professional, Hyderabad *(response 3)*

Solar disinfection is an effective method for treating water contaminated with pathogens but it cannot handle chemical and other dissolved impurities. Rainwater harvesting is a more cost-effective way, however, to obtain water that is free of pollution from surface and sub-surface sources, than RO.

RO systems in conjunction with ultraviolet purification systems have been used for immediate relief in congested urban areas such as slums since it takes time and space to set up RWH systems. There are also numerous bureaucratic, legal and institutional bottlenecks in setting up urban RWH systems. RO systems can be explored in certain contexts, rather than being a blanket solution.

If all households have impervious roofs, the area available for RWH will increase dramatically. This could solve two problems at once.

Atul Rawat, DMV Business and Market Research Pvt. Ltd., Hyderabad

I have spent 25 years in Dehradun and currently am working in Hyderabad. In Dehradun, the water supplied to households contains high levels of calcium salts, which causes several diseases. Adoption of ROs helped us to decrease the threat of diseases. RO filters are able to remove both chemical and particulate (microbes for example) contaminants. RO systems are even used by the military to make poor quality water drinkable. However, RO systems should not be used on water that is contaminated by wastewater. If you are using the RO unit on rural water sources, (individual wells, etc.) a good way to test for such contamination is to measure E. coli and coliforms before the water is chlorinated. Chlorination may kill the coliforms, but not other disease-causing microbes and such water should not be used for consumption even with an RO unit.

Uday Bhawalkar, Bhawalkar Vermitech Pvt Ltd, Pune

I am giving below an ecological technique of water treatment, based on 36 years of research 'in collaboration with Nature' involving keeping biosanitizer ecochip crystals in contact with polluted water. There are no recurring costs involved and decentralization is possible. There is no waste stream produced either. This method can handle both toxic organic and inorganic pollution as well as bio-pollutants. Salts are converted into minerals; this is how the coconut plant produces tasty coconut water from the saline water. Please see www.ecochip.org for details.

Gary Grunder, Association for Needy And Neighbouring Downtrodden, Guntur (Andhra Pradesh)

Over the past few years, I have been developing a way of altering the oxidation states of dissolved materials in water to precipitate them out of solution. What I have found is that the generation and saturation of reduction-oxidation reactions in water using solar powered electrolysis is an excellent way of producing flocculation. As the dissolved particles in water react with hydrogen and oxygen, they are reduced or oxidized, and flocculate. This renders previously harmful reactants into innocuous salts that precipitate out of solution and may be filtered out (with inexpensive plant fibre materials). One such unit can treat around 50 gallons of water a day in bright sunlight.

The addition of some saltwater into the reduction-oxidation reaction chambers may be rendered into hypochlorite for water sanitation purposes. In addition, I have found that the use of small amount of silver in the reaction chambers produces silver anions and silver chloride, and these are useful for their antiseptic properties.

Now, there is some upfront cost to building the flow through reaction chambers, but once they are built, there are no further expensive membranes to purchase. In addition, by designing the reaction chambers to maximize the reaction surface areas and spacing them closely, the reaction chambers operate quite well from energy received from photovoltaics. To minimize the cost of solar cells, then one must design the system to reflect more light onto fewer solar cells, such as with a parabolic dish.

Anyway, I was compelled to tell you about what I am discovering in my workshop and how I see it fitting into water sanitation for drinking purposes.

N. C. S Seema, WaterHealth India Pvt. Ltd, Secunderabad

Wherever there is surface water, the community needs to be educated on the importance of protecting it. The government should ban use of RO in these areas and promote alternate UV and filtration methods to eliminate microorganisms. In that way we will protect the environment and provide safe drinking water to the community.

RO wastewater contains four times higher TDS which needs to be addressed immediately or else as Saiphy has said, there will be a loss of aquatic fauna and flora, as has happened in Gujarat.

Jasveen Jairath, Water Sector Professional, Hyderabad *(response 5)*

All water supply systems need maintenance though at different levels. Each has a different cost implication that must be proportional to the number of users. The cost of maintenance will influence to what extent users control their assets, or if an external agency is needed to do so. Thus, political independence and control over technology may be more critical in evaluating its long-term utility to the community.

We must understand that the choice of technology is driven as much by political as by technical factors. Many times, this lack of understanding creates illusions about the technological potential of a particular system. For example, sprinkler irrigation has not taken off despite heavy subsidies. Alternatively, why do we have such a poor record of providing drinking water inspite of technical knowledge and investing huge resources. What is the guarantee that new technologies will actually deliver?

The social/economic conditions of acceptance of RO and RWH storage need to be evaluated. Both systems have had their share of successes and failures that need to brought out.

What is needed is a socially contextual approach where the user community is provided similar opportunities to adopt either technical option. Backing one of the two techniques will contribute to forced choices that may serve vested interests of the suppliers of that particular technology.

Therefore, let us not get caught in a debate on which is better, RO or RWH but examine their contextual viability along with other systems in different social/economic/cultural settings.

I feel UNICEF in Andhra Pradesh must consider certain issues, including the cost, treatment of wastewater, maintenance, delivery of RO treated water, power consumption, water storage vessels and adding trace elements back into RO treated water. These issues have to be considered before inviting tenders from manufacturers of RO plants under BOOT terms for installation in water-scarce villages in Andhra Pradesh. If needed, the process can be extended to give ample time to consider these issues.

These issues can only be addressed through extensive social and technical preparation before commissioning the RO plants in areas that may be required. A question to ask is if the RO manufacturers can handle the social issues of dealing with user communities – equity, distribution, access, quality monitoring by users independent of the supplier? Can they handle the government-related issues?

If this is not possible, then it will be advisable to extend the process of finalizing the tenders beyond 1 August, and delay the launch of the scheme beyond August 15. I suggest holding a national consultation on the issue rather than limiting the discussions to a small committee. This could be held in Hyderabad to take into account diverse viewpoints that can suggest how to put in place checks and balances to make sure that the RO plants function under public surveillance.

If the private sector/NGOs are installing RO plants, I feel it would be good to put in place a system of regulation/monitoring/accountability of such ventures by local communities.

R K Srinivasan, Centre for Science and Environment (CSE), New Delhi *(response 2)*

Rainwater harvesting is possible in thatched roofs also. This issue was discussed in detail while Tamil Nadu went for large scale roof top rainwater harvesting in 2003 in the entire state. The state government has come out with cost-effective solutions like using plastic sheets to capture water from roofs. Roof top rainwater harvesting is done by using locally available materials and it only a minimal capital cost while the operation maintenance cost is negligible.

The large scale roof top rainwater harvesting scheme implemented by Water Crusaders, a Kolkata-based NGO in Sahedanga village, stands out as typical example how rainwater harvesting can solve the water problem in water quality affected areas. The rainwater quality studies done by IIT Delhi from various types roofs have shown positive results and rainwater quality studies done by Ms Tanuja from the Sri Lanka Rainwater Harvesting Association shows the type of roof is not a issue as much as the mind set of people.

Rainwater harvesting should not be compared to RO system since RO is not eco-friendly and has high capital and running costs. RO systems will be hard to maintain in rural India of so high because of high maintenance costs. For example, in Naripiyur village, Ramanathapuram district, Tamil Nadu, the membranes are not changed since 1991 due to their high cost.

Avani Mohan Singh, Haritika, Jhansi

There are two organisations we know working on R O systems. These are the Hyderabad-based Water Health International and Naandi Foundation. You see further details at www.waterhealth.com. For providing 21,000 litres of safe water per day, you have to invest Rs 8 lakh.

Dinesh Kumar, Institute for Resource Analysis and Policy, Hyderabad *(response 3)*

Kuttanand lake water is saline, and while ordinary filters cannot remove this salinity, RO filters can. Other sources of surface water are contaminated with bio-chemical agents that call for mixed treatment (sediment removal, BOD/COD removal, etc).

Therefore, we need to carry out systematic studies before we zero onto RO systems. The same applies to decentralized water harvesting systems as well. These are also not benign technologies. We need to do decent studies to analyze the ecological and environmental impacts of the interventions (be it in Kuttanad or Kachchh).

My point about the collapse of traditional water harvesting was that "Most of them went into disuse when local people and institutions did not care about their repair, and maintenance". Here, I am using "local institutions" in the broad sense of the term, which include the Panchayats, the minor irrigation department, etc.

WASMO never did any cost benefit calculations not ecological studies for the decentralized interventions they are now promoting, including building check dams, RWHS, ponds, etc. GWSSB or SSNL did not undertake a detailed social cost benefit analysis of the pipeline scheme for drinking water supply based on SSP.

Also, there is no comparison between the traditional "virdas" and the modern water harvesting structure made of concrete and cement which WASMO supports.

Jared Buono, Watershed Management Group, Chennai *

If RO is your chosen technology then I would recommend contacting Sarvajal (http://www.sarvajal.com/). They are a social enterprise using RO, in conjunction with other methods of treatment, to provide safe drinking water in rural areas. I just visited one of their locations Rajasthan, it seems they have done a lot of experimentation and have developed several innovations. For example, to reduce costs and foster small enterprise they utilize a franchise approach with standardized equipment and regional maintenance teams. Their approach has many other benefits (they just won a Ripple Effect award for it), but I will let them explain more.

Many thanks to all who contributed to this query!

If you have further information to share on this topic, please send it to Solution Exchange for the Water Community in India at se-wes@solutionexchange-un.net.in with the subject heading "Re: [se-watr] Query: Use of R. O. Systems for Providing Safe Drinking Water - Experiences; Referrals. Additional Reply."

transmit the information contained in these messages should be aware that they are relying on their own judgment.

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