Project Resource

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Business Innovation Facility

The road to a water crisis is paved with good, clean water intentions

What is this resource?

This document looks at affordable community drinking water solutions in India, the importance of mapping the right technology to the particular contamination, and building awareness and understanding of the products which are now available.

It is based on insights derived from the Business Innovation Facility's engagement in strategic business model design with Waterlife - a drinking water systems provider for low-income communities in India. The Business Innovation Facility was engaged to explore organic growth strategies for a community drinking-water systems provider across different markets in India.

It was produced by Smita Sharma of Intellecap, who worked on this Business Innovation Facility project from August 2012 to January 2013.

Why is it interesting?

This document looks in detail at the issue of water contamination in India and highlights the problems of using reverse osmosis, a technology that is effective and known, but generates waste water and pollutants. Reasons why organisations use a technology that may not be the most appropriate for the context are also discussed. The importance of raising awareness and trust in new technologies is explored, so as to provide effective and affordable solutions at the base of the pyramid.

Who is it for?

This document will be useful for community drinking water providers and consultants who are providing strategic services in the water and sanitation sector in India and beyond.

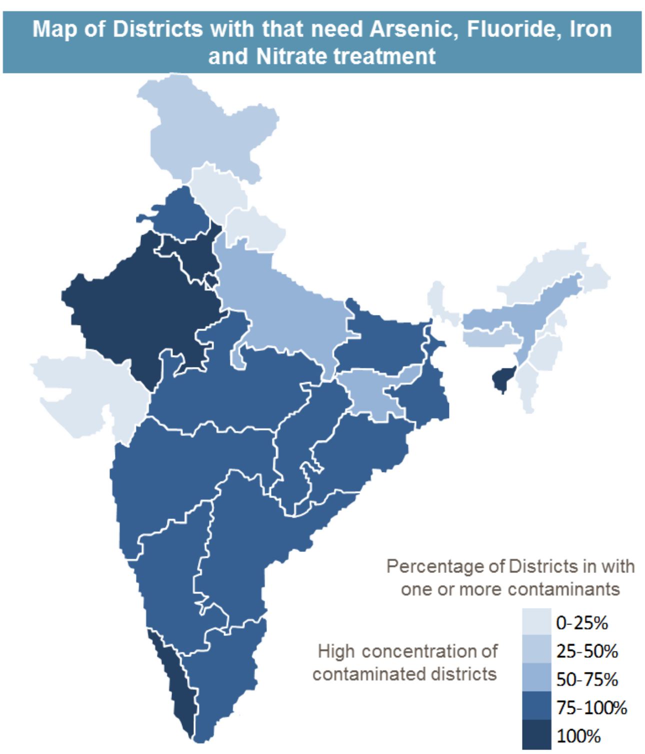
Water contamination in India

Contaminants. The one word that drives the quest for clean drinking water around the world, especially in India. In a country where almost all districts have one or more types of ground water contamination and 70 per cent of surface water sources are polluted with high levels of chemical and bacterial contaminants, there is an all-time high in demand for clean drinking water. Those least resilient to the effects of consuming untreated water are the rural households. Lack of ability to pay, combined with lack of awareness and education, contribute to this segment being the most vulnerable to the dangers of contaminated drinking water, both in terms of affording water treatment systems (filters, other point-of-use systems) as well as medical treatment resulting from unclean water consumption.

Rural India alone accounts for approximately 71 per cent of domestic demand for clean drinking water, translating to a demand of 1,670 million litres per day. The supply situation is desolate: only 35 per cent of rural households have piped water systems that receive treated municipal water. The remaining rural households are in danger of consuming contaminated water. Over 80 per cent of rural inhabitants rely on contaminated groundwater for their drinking water needs.

Major groundwater contaminants in India include fluoride, arsenic, nitrate and iron, that are detrimental to human health above permissible limits (please see table 1). Arsenic contamination affects close to 110 million rural people across 33 districts in India, while fluoride contamination affects 400 million rural inhabitants across 226 Indian districts. **Figure 1** details the incidence of various groundwater contaminants across the states in India.

Figure 1 Map of groundwater contaminants - India



Fluoride affects 226 district s, while Arsenic affects 33 districts across India

This major contamination of groundwater, coupled with lack of availability of municipal treated pipe-water has led to a surge in the number of clean drinking water providers and initiatives, both from the government as well as from the private sector. In rural India, however, municipal solutions are limited to bore-well and hand-pump projects that do not provide treated water. The other option available to rural inhabitants and gaining quick ground is community drinking water systems. Communities are defined as agglomerations of individuals or households in both rural and urban centres (some of the rural community examples include villages, government schools, government hospitals). Water treatment products for communities comprise bulk systems with sizes ranging from 250 to 5000 Litres per Hour (LPH), depending on the size of the community.

India has a current installed base of around 2,000 such community drinking water systems (CDWS), operated by social entrepreneurs that provide clean drinking water at economical rates to rural consumers (ranging from 10 paise to 25 paise per litre). These providers use various technologies for treating contaminants. **Table 1** provides details of available technologies and contaminants treated.

Table 1- Key water treatment technologies and application

Technology	Contaminant treated	Type of input water affected	Geographical area characteristics
Reverse Osmosis	TDS (> 500 parts per million) - ions, aqueous salts), including sodium, chloride, copper	• Groundwater • Surface Water	• Arid/ Semi arid areas with conditions favoring formation of alkaline soils • High industrial areas (especially textiles)

Desalination	Salinity (> 1000 mg/liter)	• Groundwater
		• Surface water (sea)
		• Surface water (river/pond/lake
		• due to intrusion of sea water)
			• Inland salinity:
			  • High industrial areas –typically tanneries
			  • Inland districts close to the coast
			• Coastal areas

Ultra Filtration	Bacterial contamination (Total Coliform, Biological Oxygen Demand), Viruses , Protozoa, chemical contaminants other than TDS	• Surface water • Ground water (due to sewage seepage)	• Locations near polluted rivers • Locations with high population density with untreated sewage (primarily urban)
Arsenic Removal Units	Arsenic (> 0.01 mg/liter)	• Ground water	• High ground water exploited areas which have arsenic in deep aquifers • Run-off areas of river basins that carry arsenic from source
Fluoride Removal Units	Fluoride (> 1.5 mg/liter)	• Ground water	• Industries that use coal for combustion • Agricultural activities that use phosphate based pesticides • Areas prone to volcanic activity (volcanic ash deposition)

During Business Innovation Facility support to identify organic growth strategies for a community drinking water provider, we observed that the most used and highly demanded technology for water purification - Reverse Osmosis (RO) - was, more often than not, unnecessary, given the nature of the impurities. As seen in **Table 1**, RO is only needed to treat high total dissolved solids (TDS), which cannot be removed by other technologies. Given that only 25 per cent of the 646 districts in India are contaminated with high total dissolved solid (TDS) levels, the remaining districts' rural/urban slums community drinking water solutions that continue to employ the reverse osmosis technology cause unnecessary environmental damage.

The RO process results in the highest levels of wasted water and produces a concentrate that, if not disposed of properly, results in further ground and surface water pollution. The treated water is undoubtedly clean (as the technology is all encompassing) but the environmental, social and financial costs of using this "blanket" technology instead of an alternative, targeted method for the particular contaminant, continues to spell a not too distant water crisis.

What's wrong (and right) with Reverse Osmosis?

Reverse Osmosis is a membrane-based water purification technique. The pores of the membrane are tiny, (10^{-7} µm), trap impurities and separate clean water from the total dissolved solids when external pressure is applied. Though necessary when it comes to treating high levels of TDS, it is unacceptable to use RO for other contaminants simply because of the scale of the inherent disadvantages the technology brings to the table. These include:

High wastage of water

The recovery rates for RO is just over 50 per cent - which means it takes 2 litres of contaminated water to produce 1 litre of clean water. With the water table in India becoming depleted at an alarming rate (average yearly loss of 4 meters) and 30 per cent of blocks (administrative units within a district) marked by the Central Ground Water Board as exploited in terms of groundwater extraction, India cannot afford to waste more water. Given the current consumption levels, India is set to be a water-stressed nation with per capita water availability set to decrease by 44 per cent. With an operational technology like RO, especially where it's not required, the future looks thirsty.

High Reverse Osmosis Concentrate pollution

The RO treatment typically produces a waste stream that is many times more concentrated and toxic than the source water. These effluents are often not treated and disposed properly: the reject is either discharged into lakes, ponds or rivers, or simply onto the ground, where further concentrated contamination of the water table takes place. Investing in reject water treatment or "zero-discharge" solutions is expensive, and many organisations turn a blind eye. For households that continue using ground and surface water sources directly for consumption – this spells higher waterborne diseases. Especially for chemicals such as arsenic, nitrate, iron and fluoride, the concentrated contamination due to usage of RO can be easily avoided by alternative technologies such as activated alumina, carbon adsorption and ultra-filtration which produce little or no concentrate.

High Cost

Membrane based water purification systems (such as reverse osmosis and ultra-filtration) are expensive - both in terms of initial capital cost as well as maintenance. The membranes tend to have a short life (5 years) and need constant cleaning and technical upkeep. Organisations operating sustainable community water systems using RO technology have no choice but to pass these costs on to consumers, who end up paying more for clean water than required. Those taking the biggest hit are the rural households and the urban poor, who have no access to clean water and have to bear this cost – unnecessary and completely avoidable if not dealing with high TDS water.

Given the environmental, social and financial costs of using RO where it is not needed, for social enterprises operating in this space, in order to make the most impact it is of paramount importance to map the right contamination to the right technology.

Why do the municipal bodies/state governments and donor organisations keep demanding RO?

Most of the community drinking water systems (CDWS) are either funded by the government (central/state/local governance (Panchayat) level depending on relevant scheme) or donor organisations. These organisations are the primary buyers of the CDWS and mandate the supply. Our field visits and interaction with the key players in the water market (the buyers, the suppliers and the technology providers) revealed three key reasons why RO was considered the de-facto technology regardless of the contaminant found in the source water of the area under research.

1. Lack of buyer awareness

Our interactions with local bodies and organisations that made key requests and decisions regarding the disbursement of funds towards community drinking water treatment plants in their respective districts/blocks demonstrated lack of awareness of:

a) different water contaminants and their linkages to water-borne diseases

b) different technology options available to treat contaminated water. While the urban poor paid hefty prices due to lack of awareness, the rural consumers' lack of awareness permeated to the administrative levels, which commission and paid for RO plants with the ultimate aim of community ownership and maintenance.

How the wrong water treatment technology proved costly to village inhabitants in more ways than one….

A local Panchayat (rural administrative unit) in India commissioned a RO water treatment plant to serve village households with clean drinking water, with the ultimate aim of community ownership. However, the high maintenance costs required for RO could not eventually be borne by the community. Therefore, even after spending lakhs of rupees, the plants lie unused, with the community still drinking contaminated water out of hand pumps. The area had admissible levels of TDS, but high arsenic contamination, which could have been treated with cheap and low-maintenance arsenic removal technology. In this particular case, the lack of awareness cost the government money and rural consumers their right to clean water.

2. Lack of governance and standards on water treatment system configuration

There are no official standards and government regulations on water-treatment plant operations and technology employed. For the most part, barring the administrative red-tape of procuring permission to dig a bore-well /tube-well, there are no regulations on whether the technology used is mapped correctly to the contaminant or not, and no penalties for operating a less sustainable, environmentally harmful or inefficient technology. Both social enterprise and commercial ventures are free to set up water treatment plants using reverse osmosis technology even where the water needs a simple activated carbon adsorption treatment.

3. High supplier margins

The perception that –"if it's RO, it's the cleanest!" ran through our conversations with buyers and consumers of water purification units. The high cost, and therefore price of RO treated water was equated with the perception high quality water and the operators/manufacturers /system integrators earn handsome profits on this technology versus cheaper non-membrane based options. Therefore, there lies a profit incentive in using RO even where not required.

What’s the solution?

Evidently, mapping the right technology to the right contaminant is the prevalent need. The following points are key to ensuring the need is met.

Consumer–level availability and awareness of applicable water testing technology

Though the supply side may be pre-empted by profit potential, empowering the demand side (the consumers) with access to water testing methods and awareness of how the contaminants can be treated will ensure the right technology is used for the right contaminant. Especially for rural consumers, this would drive the community demand for the right water treatment plant that is affordable and appropriate. Water testing currently remains elusive and accessible to a knowledgeable few. Bridging this knowledge gap can make the aspiration of sustainable water treatment well within reach.

Government technology policy and regulation

Most licensed water treatment plants today are only subject to inspection in terms of output water quality. This needs to be extended to regulation on treatment technology and ensuring the contaminants are handled appropriately. In places with RO needs to be necessarily used due to high TDS levels, government oversight and regulations must exist to ensure the concentrated contaminant reject is handled appropriately.

Focused investment in research and development of sustainable water treatment technology

Even for the treatment of TDS, Reverse Osmosis is an inherently inefficient and expensive technology. There needs to be focused investment in research and development activities to investigate and implement design parameters for a more sustainable technology. The government of India has been working on a public-private partnership model with private players on water distribution and monitoring-extending the scope of this collaboration to water treatment research and development could be a the solution to overcoming the impending water crisis.

Additional resources:

You will find more ideas, information and resources on innovation and inclusive business on the **Practitioner Hub (www.businessinnovationfacility.org).**

Our **'know how'** section on other climate-smart solutions can be found at:
http://businessinnovationfacility.org/page/know-how-climate-smart-solutions

To learn more about this project, go to:
http://businessinnovationfacility.org/page/project-profile-waterlife

Further interesting resources on this topic include:

Dynamic Ground Water Resources, India
Central Ground Water Board, Ministry of Water Resource- Government of India, 2012
http://cgwb.gov.in/GW_assessment.html

Joint Monitoring Programme for Water Supply & Sanitation
WHO/Unicef, March 2012
http://www.wssinfo.org/

Water- The India Story
Grail Research, 2009
http://www.grailresearch.com/pdf/ContenPodsPdf/Water-The_India_Story.pdf

This report was written by Smita Sharma of Intellectual Capital Advisory Services Ltd with input from Nisha Dutt and Raghavendra Badaskar**.** Intellecap works at the intersection of the private sector and development. It provides consulting and investment banking services driven by innovative thought processes, to Business and Development communities globally, helping them bring entrepreneurship solutions to development challenges at the Base of the Pyramid and beyond. Intellecap provides India Country Management for the Business Innovation Facility

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For further information and to view other Project Resources, go to:
Practitioner Hub on inclusive business at: **www.businessinnovationfacility.org**

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