



Arsenic Knowledge and Action Network

February 2018

Interventions for Safe Drinking Water

Case Studies addressing Arsenic Contamination

Case Study Four

Promoting Community Health and Preventing Waterborne Diseases with the Jalkalp Water Filter

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Myriad efforts aimed at achieving the millennium development goal of providing safe drinking water to half of the world's population have not proved to be adequate, as a large bracket of the world's population continues to lack sufficient availability of good-quality water. Microbes, iron, arsenic, and turbidity are present individually or coexist in drinking water across numerous states in India.

The World Health Organization noted (WHO 2007) that "Lack of safe water perpetuates a cycle whereby poor populations become further disadvantaged, and poverty becomes entrenched." The lack of safe drinking water contributes to poor household economy due to loss of livelihood income during illness and increased financial stress from treatment costs.

Physical, chemical, and biological forms of contamination make the water unfit for drinking. Diarrhoeal and other waterborne diseases are caused by pathogens present in water. The geographical spread of such biological contamination is observed throughout India, with no estimates available on the number of districts affected (Shankar et al. 2011).

Consumption of contaminated water has particularly adverse health impacts on children and women. In India, the single largest cause of ill health and death among children is diarrhoea, which kills nearly half-million children (Pacific Institute 2010). Exposure to waterborne diseases is the foremost causal link behind inequalities in child mortality and poor nutritional status (Khurana & Sen 2006). The duration of illness due to diarrhoeal diseases and its severity are found to be higher among malnourished children where repeated exposure to diarrhoea results in weight loss, stunted growth, and vitamin deficiency. Morbidity due to waterborne diseases

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increases the chances of children performing poorly or dropping out of school, and the prevalence of bacterial contamination in water increases the health risks for women especially during pregnancy.

Evidence suggests that prolonged consumption of water contaminated with arsenic is associated with development of cancer, particularly skin, lung, and bladder cancer (WHO 2004). Arsenic contamination above permissible limits is found across alluvial plains of Ganges, and is more recently been detected in the north-eastern regions of India (Saurav et al. 2015).

Excess iron in the body leads to health hazards like haemochromatosis. Drinking water with high iron content gives rise to iron bacteria—tiny creatures that feed off iron and leave behind iron waste deposits. They cause unpleasant stains, tastes, and odours; leave behind slime that sticks to pipes and fixtures, and can introduce other harmful bacteria.

Arsenic contamination, so far considered endemic to north-eastern parts of India, has now spread to a large part of Bihar state. With nearly twenty districts in Bihar in the grip of arsenic contamination, the situation has worsened for masses exposed to this slow and consistent toxin. The presence of arsenic in the region was first noticed in Bangladesh in 1991, and in Nepal, adjoining Bihar, in 2001. Arsenic was first found in Bihar in 2002, and extensive testing has since been carried out. The map below shows that eighteen districts of Bihar had arsenic pollution in the groundwater in 2014. In most of these areas, the groundwater also contains high levels of iron and biological contamination. In these mostly flood prone areas, drinking water remains the biggest challenge during flood periods. But contamination in the drinking water and associated risks remain a big challenge even beyond flood periods.



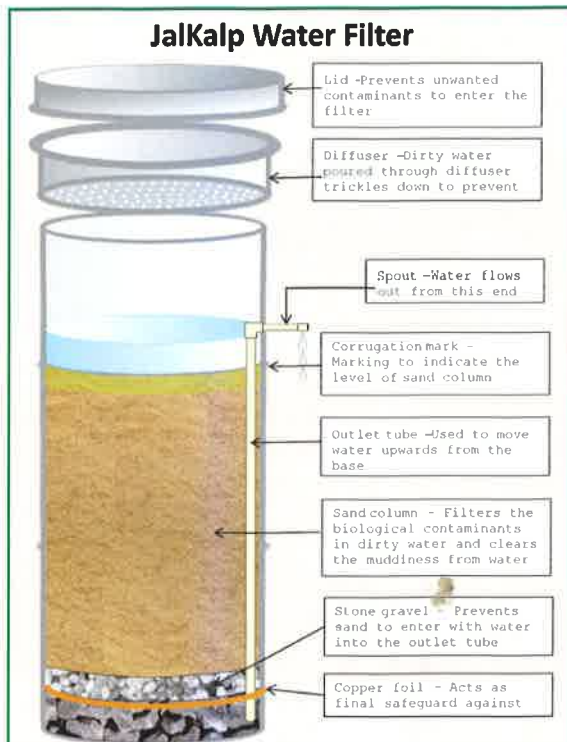
Source: DR A K Ghosh, professor-in-charge, Department of environment and water management, A N College, Patna

Most of the rural population does not currently use any method for purifying water, or have any other adequate solution. Widespread occurrence of these contaminants and the lack of awareness have created a public health crisis that calls for immediate attention. A solution that can facilitate the elimination of these frequently occurring contaminants simultaneously is an urgent requirement.

Though there have been efforts to put water treatment plants to address arsenic and iron in some villages, most were not sustained for various reasons such as:

- Technological limitations of the plants
- Plants not serviced and maintained timely and/or properly
- Communities not trained, mobilized, and motivated to undertake the maintenance
- Lack of community participation
- Lack of education and awareness among communities
- Poor community dynamics and socioeconomic conditions

Household water treatment technologies have the potential to avoid 122.2 million DALYs (disability adjusted life years) throughout the world (Pacific Institute 2010). JalKalp water filter is one such technology that removes biological contaminants, iron, arsenic, and turbidity from water, making it suitable for drinking. JalKalp works under the force of gravity without using any form of energy or on-line pressure.



SM Sehgal Foundation Promotes Safe Drinking Water

Through a project supported by Water Technology Initiative of Department of Science and Technology, Government of India, SM Sehgal Foundation is promoting the adoption of the low-cost sustainable JalKalp water filter in selected villages of Bihar. Sensitizing communities about the presence of contaminants, their impact on health, and need of safe drinking water is the key component of the project. The project goal is to benefit poor rural communities who are unaware of the importance of safe drinking water and those who cannot access the prevalent high-tech water treatment systems due to lack of affordability or erratic power and/or water supplies.

Working & maintenance of JalKalp water filter

(A) JalKalp water filters remove pathogens with four processes—

- Predation: A bio-layer that forms on top of the sand contains bacteria that consume harmful bacteria and parasites as new water enters the filter.
- Adsorption: Viruses adhere to the surface of specially prepared sand, which has a slight electrostatic charge, and die there.
- Anaerobic Die-off: As there is no oxygen, light, or air further down in the filter, any remaining microbes die off.
- Mechanical Filtration: Fine-grain sand prevents the passage of bacteria, parasites, and worms, which are relatively large.

(B) The technology of arsenic removal in the filter is based on generating Fe^{2+} by contacting water with zero valent iron (ZVI) and efficiently using the iron (Fe^{2+} present in the groundwater and Fe^{2+} produced by corrosion of ZVI) for removal of arsenic. Fe^{2+} forms hydrous ferric oxide (HFO-adsorbent for arsenic) on oxidation of Fe^{2+} during subsequent filtration; HFO is an effective adsorbent for arsenic. The process is so designed that efficient oxidation of As(III) to As(V) is achieved; and As(V), thus formed, is adsorbed on HFO.

© The iron-contaminated water passes through the diffuser, drips down in the form of droplets, and the surface area of the water increases. With the increased surface area, the oxygen absorption of the water also increases and thereby iron in the water is oxidized. The compound formed by oxidation is insoluble in water, so it is trapped on the top surface of the sand column and the iron is removed from the water.

As there are no moving parts, JalKalp filter does not require any replacements. With time, the flow rate of filtered water may reduce due to an accumulation of silt (came with water) over the sand top layer. When the flow rate slows down, the maintenance to be conducted is simple: lift off the lid, pour water into the filter, take out the diffuser box, and do a "swirl and dump," gently swirling the water above the top layer of sand. The deposition is suspended in the water over the sand, and that cloudy water can be removed. This may be repeated once or twice more if the flow rate is not recovered.

Innovations at three levels promote adoption of a low-cost, zero-maintenance JalKalp water filter to address arsenic, iron, biological water contaminations, and turbidity:

a. Approach innovation

Household water treatment technologies hold an edge over community-level technology as they minimize the chances of secondary infections.

b. Product innovation

JalKalp is a low-tech, low-cost, and easy-to-maintain water filter with a more innovative design than conventional biosand filters. It works under gravity without any external energy/on-line pressure, and has no parts that require replacement. Features include:

- Integration of germicidal properties of copper increases coliform-removal efficiency to 100%.
- Integration of Zero Valent Iron Technology removes arsenic.
- Filtration rate of 0.6 litres per minute is increased over the 0.4 in conventional design.
- Stainless steel cell design weighs only 4.5 Kg vs. the original concrete design weighing 70 Kg.
- Portability and quality control is better than conventional biosand filters.
- Operation and maintenance do not require any special skills.



c. Process innovation

The key to sustainability is ownership and active participation by beneficiaries. Therefore, major emphasis is placed on sensitizing communities about issues of water quality and waterborne diseases. This process triggers the demand for a solution. When communities are sensitized and demand a solution, JalKalp is offered as a safe and affordable solution.

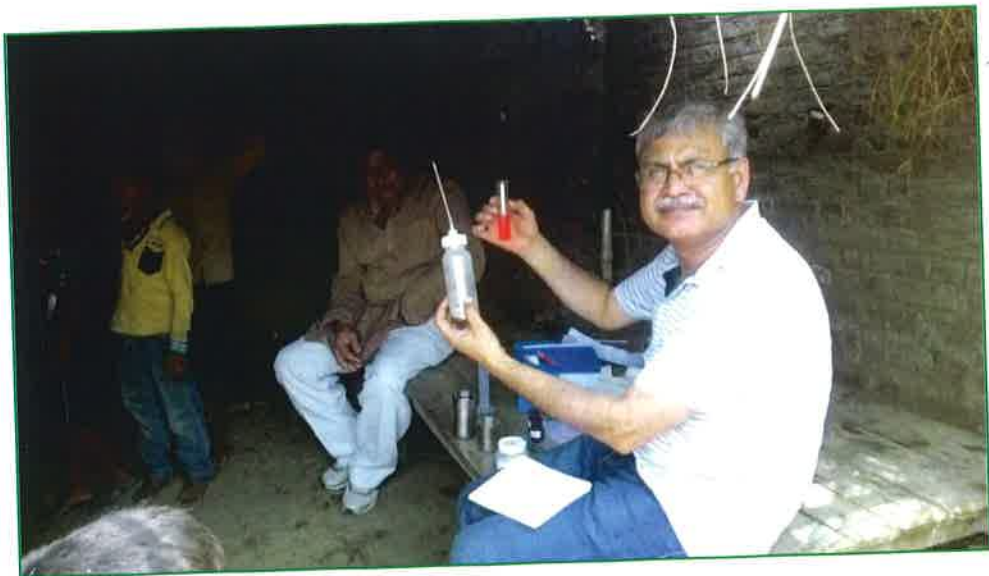
Mr. Prince of district Vaishali, a fan of JalKalp

Mr. Prince Singh, age 22 lives with his family (2 male and 4 female) in village Kharika of block Bidupur, Vaishali district (Bihar). Most hand pumps in his village are marked RED by related departments, forbidding people to use the water from these pumps. Many cases of skin cancer are found in the village, causing many deaths. Mr. Prince's grandmother died of skin cancer after a long medical treatment.

People in the village know how dangerous the water is, so most of them buy water to drink, but for cooking they use the hand pump water, which allows consumption of arsenic through food. So buying water for drinking was not a complete solution. Mr. Prince used to buy water for drinking—before he met Mr. Dharmendra Singh from Sehgal Foundation. Mr. Singh told him about the JalKalp water filter and proposed that he try it. Mr. Prince immediately agreed. Mr. Singh first tested the water from the hand pump using a field kit, which showed arsenic contamination over 250 PPB (parts per billion), iron over 3 PPM (parts per million), and the presence of coliform indicating biological contamination. (Permissible limits are arsenic: 10 PPB, iron: 0.3 PPM, and no presence of coliform.)

A JalKalp water filter was installed at Mr. Prince's house and the contamination in water was monitored after a week. The JalKalp water filter had brought down arsenic, iron, and coliform to not-detectable levels.

Mr. Prince was amazed with the results. He said he saw changes in his water. Earlier when he used to prepare tea using hand pump water, its color was almost black; but now the JalKalp filter's water shows the true colour of tea. The family no longer purchases water to drink. They use JalKalp for drinking water and for cooking. They not only notice better water colour, but also better taste of their food. He said he is also very happy that, since the day he started using the JalKalp, his digestion problems (acidity, constipation, etc.) have disappeared.



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