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მეცნიერების აქტუალური პრობლემები Actual Problems of Science

Sustainable Water Management - A Review of the Drinking Water Situation in Bangladesh

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Abstract. All citizens around every country in the world have the right of access to clean and sanitized drinking water. Bangladesh largely depends on groundwater resources for drinking. Much of this groundwater is contaminated with probably naturally occurring arsenic. It is generally agreed that arsenic occurs naturally in the alluvial sediments of the region, but there is considerable debate as to how the arsenic is released into the groundwater, and whether the problem is manmade or not. The impact on the health of the rural population due to the use of this water is evident, and it is imperative that solutions urgently need to be found on a communal and dwelling basis to manage this crisis. Arsenic removal technologies need to be monitored to ensure that arsenic is consistently removed to below permissible limits currently 0.05mg/l in both India and Bangladesh. Unfortunately, this presence of arsenic in groundwater is not readily apparent to users as it does not alter the physical water quality, taste, smell, color, etc., and the symptoms of arsenic poisoning are undetectable in their early stages. The major challenge is how to rapidly reduce and monitor the arsenic consumption of millions of people scattered over a huge area. This paper refers to current situation and addresses possible solutions that can be researched or implemented without delays.

1. **Introduction.** The contamination of groundwater by arsenic in Bangladesh is the largest poisoning of a population in history, where one quarter of the population are exposed. In Bangladesh alone, 28 to 77 million people drink arsenic-laden water from shallow tubewells, the majority of which were installed within the past forty years as an alternative to drinking biologically contaminated surface waters (Ahmad

et al. 2003). According to the Bulletin of the World Health Organization, arsenic in the well water could be responsible for as many as 43,000 deaths per year in the country. Having studied the arsenic issue of Bangladesh, and by quickly reviewing the attempt to control arsenic for the last thirty years by various foreign and local experts, investigating the household-level arsenic removal systems, have not gained popularity in Bangladesh. This is primarily because of poor "user-acceptance" of the systems. People have the tendency to compare such systems with the ease with which they used to get "tube well water" for potable use. Sometimes they would prefer to drink highly arsenic polluted water in comparison to slightly coloured water that contains iron because it looks clearer. Besides, at many localities, some sources of arsenic-free water (e.g., from deeper arsenic-free wells) are available in the vicinity; this also discourages people to use systems that require regular treatment. Long-term chronic exposure leads to a variety of very serious health problems, notably diabetes mellitus and cancer of the skin, bladder, kidney, and lung (Chen and Ahsan 2004; Chowdhury 2004). Unawareness about the serious adverse impacts of arsenic and the absence of evidence of the immediate health effects may also contribute to the low popularity of arsenic removal units.

In conclusion community-scale arsenic removal systems also have hardly succeeded because of serious operation and management issues as stated above. This paper briefly describes the recommends intervention strategies and related concerns of implementation linked with arsenic management in Bangladesh.

2. Water sector scenario in Bangladesh. Water supply in Bangladesh started during the early stage of the development of water supply. The water supply in Dhaka city was first started with the establishment of Dhaka Water Works (DWW) by the Nawab Sir Abdul Gani in 1874. Major water works in the sub-continent and even in the developed world started around that time. Although the first water supply in Bangladesh was surface water based, groundwater received priority in the subsequent development of water supply in the country. The surface water treatment plants operated by Dhaka Water Supply and Sewerage Authority (DWASA) in Dhaka and Narayanganj produce about 40 million litres per day (DWASA, 2000). The Mohora surface water treatment plant in Chittagong is the largest surface water treatment plants in Bangladesh producing about 90 MLD of water. There are few small surface water treatment plants and quite a large number of Pond Sand Filters for treatment of mainly pond water in the country but the total quantity of water produced by these units is very small as compared to demand. It is well documented that Bangladesh's water sources suffer from geogenic, bacteriological, and industrial pollution. Two prime sources of geogenic pollution have been identified as the naturally occurring inorganic arsenic contamination and salinity posing concerns over domestic and agricultural water use (Hasan et al 2019).

About a quarter of structurally improved drinking water sources, primarily shallow tubewells, contain arsenic levels by greater than WHO safe water guidelines (10 parts per billion) (Figure 1 **Error! Reference source not found.**).

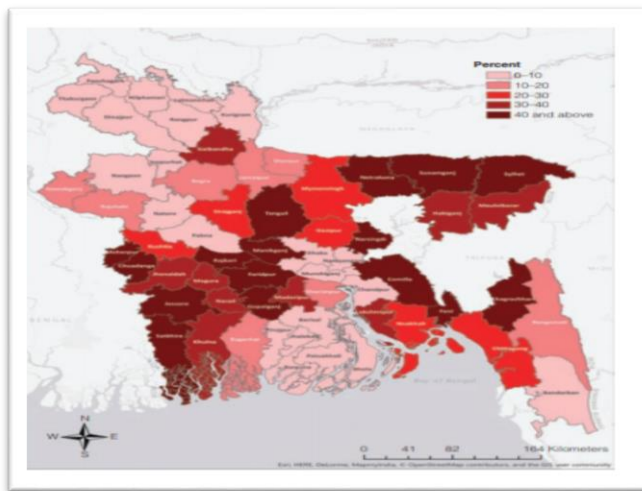


Figure 1: Proportion of Water Sources Contaminated with Arsenic. Source: Joseph et al (2019)

To manage and regulate water-related challenges, the government of Bangladesh has undertaken several national policies. The National Water Policy has been formulated in 1992 with the aim of guiding public and private actions ensuring optimal management and development of water resources which would benefit individuals and society as a whole. The National Adaptation Programme of Action (NAPA) has been prepared in 2005 by the Ministry of Environment and Forest (MOEF) and Government of the People's Republic of Bangladesh. The NAPA was prepared to identify the key adaptation measures to respond to immediate and impending climatic anomalies. Furthermore, the National Strategy for Water Supply and Sanitation has been formulated in 2014, aiming at ensuring universal access to sustainable and safe water supply, sanitation and hygiene services through an uniform strategic guideline. Most recently, Bangladesh Delta Plan 2100 (BDP 2100) has been initiated as the long-term strategic plan for land and water resources management plan for the next several decades. The delta plan vision states 'Ensure long-term water and food security, economic growth and environmental sustainability while effectively coping with natural disasters, climate change and other delta issues through robust, adaptive and integrated and equitable water governance' (Hadi, 2019).

3. Recommendations and concerns. An extensive study for the World Bank, Ahmad et al. (2003) found that 72% of villagers surveyed would choose a

community-based technology over a household filter. This may result from other preferences held by villagers. For instance, several studies have found that villagers listed convenience as the most important attribute of a water treatment system (Ahmad et al. 2003; Caldwell et al. 2003). Community-scale systems, especially those maintained by a trained technician, are more convenient than household filters in terms of individual time spent using and maintaining the system. Several studies report household filters being abandoned because they required too much attention and maintenance (Ahmad et al. 2003; Hoque et al. 2004).

It is evident that the permanent solution to the arsenic issue is the use of arsenic-free water available through any alternative supplies, namely surface waters-ponds, rainwater harvesting, desalination etc.

4.1 Surface water. Surface water is abundant in the wet season in Bangladesh. An estimated 795,000 million cubic meter (Mm^3) of surface water is discharged through the Ganges-Brahmaputra system, in the downstream of the confluence of the Ganges and the Brahmaputra. This is equivalent to 5.52 m deep water over a land area of 144,000 km^2 . There are other rivers discharging surface water into the Bay of Bengal.

Traditionally, before and during the early stages of tubewells installation, rural water supply was largely based on protected ponds. Most of the region's rural population got its drinking water from surface ponds, but these sources were often polluted, and more than a quarter of a million children died every year from water-borne diseases (World Bank 1999). There are about 1,288,222 ponds in Bangladesh having an area of 0.114 ha per pond and 21.5 pond per mauza (BBS, 1997). About 17% of these ponds are derelict and probably dry up in the dry season. The biological quality of water in these ponds is extremely poor due to unhygienic sanitary practices and absence of any sanitary protection. Many of these ponds are chemically and bio-chemically contaminated for fish culture. If one pond per mauza could be protected from contamination, it would provide a source of drinking water with minimal treatment and water for other domestic uses without treatment.

Surface waters receive pollutants from agricultural, industrial, domestic and municipal sources. Concentration of silt content in turbulent water in the monsoon is high. Similarly algal growth in stagnant water bodies in the dry season is also very high. Insanitary practices of people have greatly contributed to the deterioration of quality of surface water sources. The faecal coliform concentration in most surface water sources lies in the range of 500 to several thousand per 100ml. The rivers and surface water sources around densely populated urban areas depending on water quality parameters are four to ten times more polluted than the similar water sources in the countryside. The deterioration of water quality is directly related to population density and industrial activities due to poor management of domestic and industrial wastewater. The use of surface water for drinking purpose requires

clarification and disinfection by elaborate treatment processes. The availability of surface water in the dry season is also a constraint for the development of dependable small and large scale surface water treatment plants for water supply.

4.2 Rainwater Management. Heavy rainfall is characteristic of Bangladesh. With the exception of the relatively dry western region of Rajshahi, where the annual rainfall is about 1600 mm, most parts of the country receive at least 2000 mm of rainfall per year. This rainfall however is not evenly distributed throughout the year. If managed correctly this supply can provide superior quality water, that can enrich surface waters, or be collected by households.

The availability of rainwater is limited by the rainfall intensity, distribution over the year and availability of suitable catchment area. The distribution of monthly rainfall over the year shows that the 75% of the rainfall occurs during May to September and the excess rain in wet season is required to be stored in large tanks for consumption in the dry season. In Bangladesh 48% of the households have sheet roofs, tiles and pucca roofs suitable for the collection of rainwater (BBS, 1999). However, the poorer section of the people is in disadvantageous position in respect of utilization of rainwater as a source of water supply. This section of people has smaller size thatched roof or no roof at all, to be used as catchment for rainwater collection. The main problems of rainwater harvesting are easy access to surface and groundwater sources, lack of initiatives and management. Storage and maintenance issues of quality water from the bacteriological perspective are also significant problems in Bangladesh.

4.3. Desalination:

Southwest coastal Bangladesh has an acute scarcity of safe drinking water. Both the government and non-government organizations are now promoting reverse osmosis based small scale desalination plants (SSDPs) to ensure safe drinking water.

Compliance of product water with the WHO and Bangladesh drinking water standards for chloride, bicarbonate and sodium were found in respectively 80%, 90% and 70% of the tested samples, although their concentrations in all the feed water samples were higher than both of the standards. About one-third of the DPs did not meet the drinking water standard for sodium, which may be an important health concern for the people consuming this water. Apart from one of the DPs, all of them complied with the standard for faecal coliform and *Escherichia coli*. Results suggest that proper maintenance of the desalination plants is necessary to ensure safe drinking water for the coastal population of southwest Bangladesh.

Concluding Remarks.

Surface water treatment facilities are necessary to operate in order to provide piped water to housing areas. If not to all houses, at least identify distribution points where people can collect SAFE drinking water. Water trucks could also provide safe

drinking water for domestic use to rural or remoted areas. In order to minimize initial investments, simpler sand filtration and chlorination methods can be initially employed. Planning sustainably should be absolutely necessary in all tasks (Novak, Keil, Fimml, 2011).

Referring to already operating treatment plants, the aim then will be in optimizing the energy, that is; to improve energy efficiency, to maximize the energy extracted from untreated water and eventually from sludge, and to recover other renewable energies.

The following suggestions are provided for sustainable water resource management in Bangladesh:

- Energy recovered from sludge could be above 60% of the total energy needs of a sewage treatment plant.

- innovative technologies in digester design, and sludge pre-treatment before digestion

- Use of power generation and combined heat from digester gases electricity for various treatment needs.

- Direct use of gas after purification to the gas grid.

- Use of the biosolids in agriculture, and as a solid fuel in industry.

Improving treatment technological practices and following 'best practice' suggestions for low energy consumption can produce savings about 20 %. (Lazarova, Choo and Cornel ,2012).

Energy recovered from wastewater flows, improved topography designs to reduce pumping needs, as well as using other innovative technologies such as photovoltaic-thermal systems, wind turbines and others can produce considerable savings in energy to an additional 20%.

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