



**THE GROWING
ARSENIC-CONTAMINATED
WATER CRISIS IN BANGLADESH
(AsIII AND AsV)**

**BANGLADESH,
WATER AND SANITATION**

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Over the past few decades, arsenic contamination has emerged as a major health issue across the globe. Excessive amounts of arsenic in drinking water have been reported in various countries, including Argentina, Chile, China, Hungary, India, Mexico, Nepal, Taiwan, and the USA (WHO). According to the World Health Organization, at least 140 million people in 50 countries are exposed to arsenic through arsenic-contaminated groundwater at levels above 10 µg/L. Chronic exposure to arsenic through the consumption of contaminated water can result in arsenicosis: a chronic condition arising from prolonged ingestion of arsenic above national health standards for at least 6 months (WHO). Arsenicosis has been found to increase the likelihood of cancer development, adverse pregnancy outcomes, and intelligence deficiency among children (NIH). Currently, a higher proportion of people are still consuming arsenic-contaminated water due to the lack of sustainable and safe water supplies (WHO).

Recently, however, arsenic contamination has been recognized as a major public threat in Bangladesh, Asia's largest and the world's most populated delta. Since arsenic was first identified in tube well water in 1993 in a northern district of Bangladesh, the country has been classified as the worst arsenic-affected country in the world in terms of population exposure to arsenic-contaminated water (NIH). At present, 59 of the 64 districts in Bangladesh have arsenic contamination levels above the nationally accepted limit of 50 µg/L (IWA). Threatening the population, an estimated 50 million people are at risk of exposure (WHO). Without proper and timely contamination management, arsenic-contaminated water will continue to be consumed leaving Bangladesh's population and water supply poisoned.

Bangladesh, located in South Asia, is home to 75 ethnic groups. Spanning 148,460 square kilometers, Bangladesh has a diverse climate ranging from tropical, mild winters to hot, humid summers. As of 2022, Bangladesh is the 8th most populated country in the world, with a population of 165,000,000 people (The World Factbook: Bangladesh). Bangladesh continues to operate under the Parliamentary Republic under current prime minister Sheikh Hasina. Since 2005, Bangladesh's economy has grown roughly 6% per year, sparking improvements in foreign exchange and energy infrastructure. After gaining independence from their neighboring country, Pakistan, Bangladesh has reduced its poverty rate from over half the population to less than a third and maintained an average of a 6% increase in GDP per capita per year (WorldBank). Though Bangladesh has seen quick growth, the average GDP per capita remains similar to other developing countries at 456,000 takas (approx. USD \$4,800) and an estimated 22 million people are still living in poverty (WorldBank).

Not only is Bangladesh changing economically, but also socially. 39.7% of Bangladesh's total population is living in urban areas, with a 2.88% annual increase in the rate of urbanization (The WorldFactbook: Bangladesh). In search of jobs, younger generations are increasingly leaving rural farming locations, where the only source of income is through agriculture, to work in big cities such as Dhaka and Chittagong. While there are stark differences in the lives of those living in urban and rural areas, the same familial values hold for most Bangladeshi families. The most common family unit in Bangladesh is called a 'barhi' and the typical Bangladeshi household consists of five people (CulturalAtlas). Additionally, 74.9% of the population is literate with the average schooling time spanning 12 years (The World Factbook: Bangladesh).

The typical Bangladeshi meal is eaten family-style consisting of rice, with various meat and vegetable dishes to eat alongside the main starch. Accompanying each meal is a glass of water. This glass of water is most commonly obtained from groundwater sources such as hand-operated tube wells. Not only is water a basic need, but it also carries a religious significance in Bangladesh. Water is considered a social good by the 153,000,000 Muslims living in Bangladesh (World Population Review). It is regarded as a blessing that gives and sustains all life in this world and it is common for Bangladeshis to drink water to break their fasts during special occasions and holidays such as Ramadan and Eid (Wiley Online Library).

Most Bangladeshi families will shop at local markets to buy fresh produce and meat every day to cook at home. About 70% of Bangladesh's total land area is used for agricultural farming. Unlike the United States, Bangladesh does not have major farming companies that account for a majority of food production. Instead, "small-scale food producers, farmers, forest producers, fishers and herders produce 80% of the region's food" (Food and Agriculture Organization of the United Nations).

As the socioeconomic status of Bangladesh continues to change, the demand for access to clean drinking water will change with it. Since 2010, 8 million Bangladeshis have moved out of poverty, increasing the need for arsenic-free water as incomes increase in urban and rural areas. Despite this accelerating growth, Bangladesh has also had an increase in arsenicosis cases. In 2012, a total of 65,910 arsenicosis cases had been identified in arsenic-contaminated areas of the country (Directorate General of Health Services of Bangladesh). According to a report by the Journal of Water and Health, the average Bangladeshi citizen drinks up to 73.04 mL of contaminated water daily. To meet the Bangladeshi demand for clean drinking water, technological advancements imported from countries such as the United States and Canada are heavily relied on.

However, increasing clean water production to fit the growing needs of Bangladesh is not possible without proper arsenic-contamination prevention methods. Currently, the contamination of clean drinking water is already increasing the price of 1 unit (1000 L) by 31% for residential use and 13% for commercial use, threatening citizens living in rural areas with lower incomes (English). As more tube wells become contaminated, the demand for clean water from non-contaminated districts increases, resulting in economic pressures. Water not only serves as a human need, but it also serves as an agricultural component for thousands of small family farms in rural areas. Arsenic contamination is now putting the lives and incomes of Bangladesh's most vulnerable, rural citizens at stake.

Under current conditions, stopping the arsenic contamination of water will be an enormous challenge due to the current conditions of tube well groundwater and the complexity of underground water systems. To effectively prevent the further contamination of water in Bangladesh, arsenic-contaminated water itself must be thoroughly understood.

Compared to surface water sources, the groundwater in Bangladesh contains a higher concentration of arsenic than surface water. The groundwater contains both As(III) and As(V), forms of inorganic arsenic. As(III) is more commonly found in arsenic-contaminated water and is known to be more toxic, however, both forms are commonly found in tube wells around

depths of 15-50 m (The International Water Association). Arsenic (As) itself is a ubiquitous element found in all environmental media and is also present at very low concentrations in the human body.

However, for Bangladeshis, exposure to arsenic is a daily occurrence, whether citizens are using water for cooking or drinking purposes. According to the National Library of Medicine, “on a daily basis, a male living in arsenic-contaminated areas on average ingests 1.734 mg of arsenic through drinking water, while a female ingests 1.321 mg of arsenic.” Additionally, agricultural products that come from arsenic-contaminated locations pose a threat to Bangladesh’s food market. Vegetables such as potatoes, pumpkins, amaranth leaves, and kalmi leaves have been found to contain high concentrations of arsenic. 27.9% of the arsenic found in these vegetables is reported to be inorganic—more toxic to human health (NIH). This has led to a majority of Bangladeshis living in rural areas, especially the young adults, to develop arsenicosis. Most arsenicosis patients in Bangladesh are in mild and moderate stages. Additionally, 5.6% of deaths in Bangladesh are due to arsenic exposure at levels above the national health standard (NIH). Unfortunately, there are no simple treatment methods for this disease. The current solution is to avoid further exposure to arsenic by stopping the consumption of arsenic-contaminated water.

Bangladesh’s government has taken several initiatives since arsenic was identified in the tube well water in 1993, however, the problem is still at large. Initially, the government formed a committee, “Committee for Reviewing the Situation of Arsenic in Drinking Water in Bangladesh” which focused on extracting and analyzing data with the intent to explore the effect of arsenic contamination. In 1996, the government declared arsenic contamination in groundwater as a national problem and formed three additional committees: “National Steering Committee,” “Arsenic Technical Committee,” and “Scientific Research Committee” (CiNii Research). In 2004, the United Nations gave Bangladesh a budget of \$1,282,727 to target arsenic contamination in the Hajiganj and Shahrasti districts. The United Nations Industrial Development Organization implemented new technologies capable of eliminating arsenic from drinking water, increased water storage tank capacity for local institutions, and raised awareness of arsenic-related health issues (United Nations). Despite the improvements made over the years, Bangladesh remains the global leader in arsenic contaminated well water.

My plan of action is to combine efforts through three initiatives: (1) increasing education and public awareness of arsenicosis, (2) improving arsenic-removal processes through the development of point-of-use water treatment devices, and (3) offering government-funded incentives to farmers that use non-contaminated water for their crops.

The Bangladeshi government needs to extensively work with the Food and Agriculture Organization (FAO) of the United Nations and reinstate a greater Trust Fund for Human Security to successfully eliminate arsenic-contaminated water as quickly and effectively as possible.

An arsenic education program intended to increase arsenicosis awareness offers great potential to spread awareness and be implemented in Bangladesh due to the country’s increased usage of social media and smartphone pervasiveness. In June of 2021, Facebook reported that they had more than 47.2 million active users in Bangladesh—around 30% of the population (Statista). This number is bound to increase as Bangladesh becomes more technologically advanced and more

resources become available to rural families as well. Arsenic contamination safety manuals such as, “Health Impact of Arsenic Exposure” and “Occurrence of Arsenic in Groundwater and Surface Water” have already been created by the United Nations Children’s Fund and can easily be translated to Bengali with the help of the existing Bangladeshi branch of the FAO. Printed out pamphlets and manuals can help reach more rural areas, making Bangladeshi citizens aware of the toxic side effects of drinking arsenic-contaminated water. Educating farmers about the arsenic contamination of water and how to spot the early signs of arsenic-contaminated produce is crucial to sustaining a safe food market.

Using funding from the United Nations Trust Fund for Human Security, I recommend Bangladesh install more reverse osmosis (RO) systems . This cost-effective method for removing arsenic can be thought of as filtration at the molecular level. Special selective membranes allow water molecules (H₂O) to pass through while keeping larger inorganic Arsenic molecules (As) out. RO systems are a reliable solution as they are 95% effective for the removal of As(V)—carcinogenic to human health. These systems can be installed in Bangladeshi homes near kitchen sinks or tap sources to produce 2-3 gallons of treated water per day. Water that has been filtered can be stored in a small tank and can be easily accessed through kitchen faucets (Oregon Health Authority). The obstacles with this approach should be noted, as the biggest challenge with the implementation of new technology in developing regions tends to be the lack of adaptation to new systems due to strong cultural barriers.

The Ministry of Water Resources, a Bangladeshi government agency, should offer incentives to farmers for reporting arsenic contamination in order to receive farming insurance payouts. Additionally, The Ministry of Water Resources should create public recognitions and awards for farmers that have taken proper safety precautions in watering their crops to encourage safe practices and ensure to consumers that the food market is arsenic-free by recognizing farmers that have been awarded for their successes. Bangladeshi farmers who do not follow such protocols may also receive putative fines.

Water plays an integral role in Bangladeshi society, acting as a symbol of life and serving as a blessing to citizens across the country. Bangladesh continues to grow economically and socially, however with such accelerating growth, the demand for arsenic-free drinking water increases. Arsenic-contaminated water has already posed a disruption to the health of Bangladeshi citizens, raising questions on safety and technology, affecting everyone from large industrial producers to small rural farmers. With the cooperation of Bangladesh’s government and United Nations counsels, such as the Food and Agriculture Organization (FAO) of the United Nations and the United Nations Children’s Fund, arsenicosis education programs can reach small rural farms making Bangladeshi citizens aware of the risks associated with drinking arsenic-contaminated water. With more funding, Bangladesh can install reverse osmosis systems widespread, helping families avoid drinking arsenic-contaminated water in their own homes. With combined efforts between The Ministry of Water Resources and farmers, Bangladesh can prevent the contamination of the food market, keeping their agriculturally flourishing economy sustained. Arsenic contamination has posed a great threat to the people of Bangladesh, but with sustainability, safety, and success in mind, Bangladesh can work towards an arsenic-free future.

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