TOWARDS AN ARSENIC SAFE ENVIRONMENT
IN BANGLADESH

EXECUTIVE SUMMARY

WORLD WATER DAY
22 March, 2010

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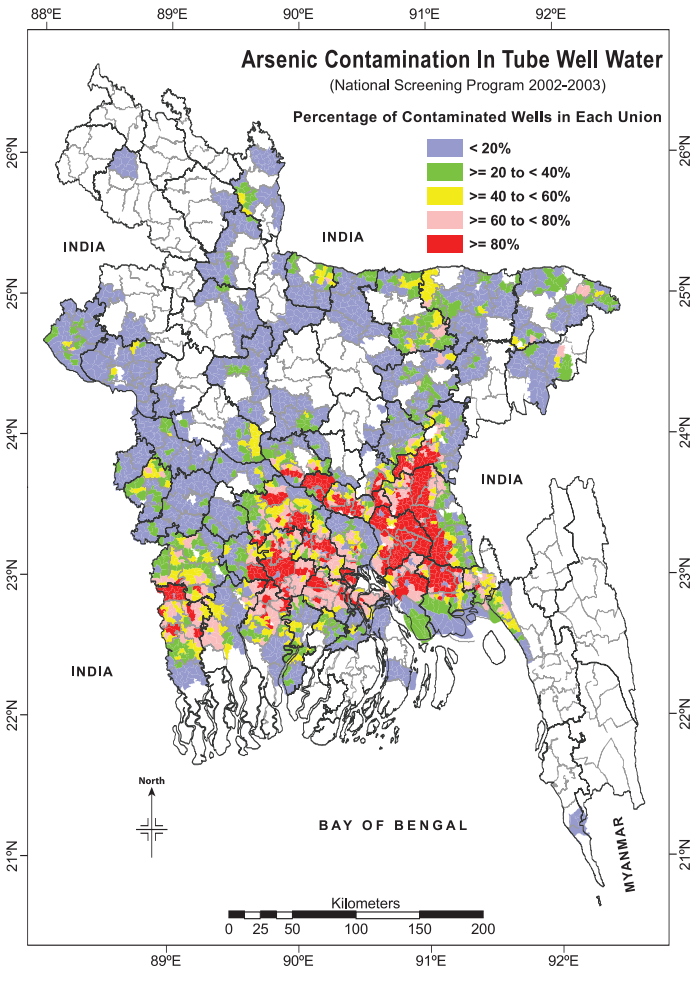
INTRODUCTION

It was thought that Bangladesh had succeeded in offering safe drinking water to the vast majority of its population through tube wells with hand pumps by the early 1990s. However, during the same decade this success was challenged by the discovery of widespread arsenic contamination exceeding the Bangladesh drinking water standard of 50 microgram per liter. Several screening campaigns have determined the extent and severity of arsenic contamination. Tens of millions of people were at risk, reducing the safe water coverage of Bangladesh from nearly universal to about 80%. The Government of Bangladesh together with stakeholders have undertaken a range of arsenic mitigation strategies guided by the National Policy for Arsenic Mitigation issued in 2004, and the Implementation Plan for Arsenic Mitigation. Both the public and the private sectors have made significant progress towards mitigation.

The Government of Bangladesh elected on January 6, 2009 committed in its election manifesto that the **arsenic problem will be tackled and measures will be taken to ensure the supply of safe drinking water for all by 2011.**

However as of 2009 this problem is far from solved, jeopardizing the progress towards achieving the Millennium Development Goals. Despite massive efforts to provide safe water supplies in arsenic-affected areas, a water quality survey in 2009 by the Bangladesh Bureau of Statistics and UNICEF has found that 12.6% of drinking water samples collected from 13,423 households around the country do not meet the Bangladesh drinking water standard for arsenic (Figure 1). This is equivalent to approximately 20 million people still being exposed to excessive quantities of arsenic. Recent knowledge of the health threats posed by arsenic, as well as evidence of arsenic penetration into the food chain make urgent action absolutely essential. In recognition of the continuing challenge posed by arsenic, the present Government of Bangladesh committed in its election manifesto that "the arsenic problem will be tackled and measures will be taken to supply drinking water for all by 2011." This document stresses the urgency of the situation and recommends key actions to be taken to achieve this goal.



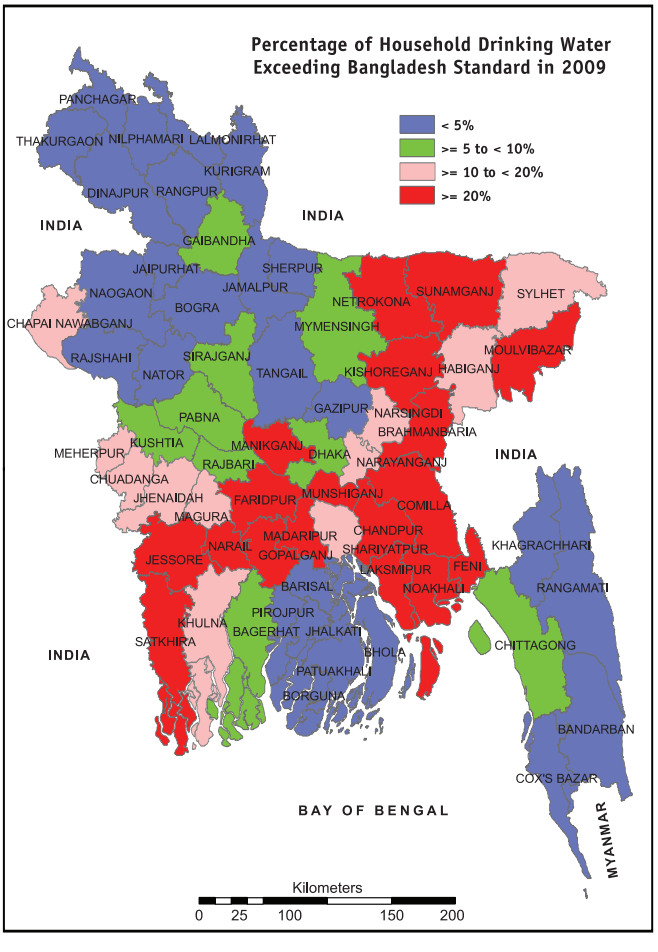


Figure 1. NAMIC data depicting the extent of arsenic contamination of tube wells based on surveys in 2002 and 2003 (top panel), and the Bangladesh Bureau of Statistics (BBS) and UNICEF Multiple Indicator Cluster Survey data depicting the extent of arsenic contamination of household drinking water in 2009 (bottom panel).

WHAT HAS BEEN DONE

After the detection of arsenic in the groundwater in the 1990s, a series of initiatives were undertaken by the government, non-governmental organizations (NGOs) and development partners. This resulted in a reasonable assessment of the extent of arsenic problem from tube wells (Figure 1).

Almost 5 million of hand pumps and tube wells across the country were demarcated red or green to indicate arsenic level. The red painted wells are in exceedance of the Bangladesh drinking water standard for arsenic, whereas the green painted wells are in compliance. The red/green painting of the wells has been a powerful way of informing users of the status of the arsenic contamination. However, this has not always been sufficient to prompt the users to switch from the red painted wells to the green painted wells, and the painted color did not last long.

More than 100,000 safe water points have been installed in arsenic affected areas since the discovery of the arsenic problem, with the great majority being deep tube wells. However, the targeting of these water sources to the most affected areas has been poor and an Arsenic Policy Support Unit study found that many of those water points were not operational with the exception of deep tube wells.

Six arsenic removal technologies have been approved by the Bangladesh Council of Scientific and Industrial Research. There are concerns regarding the performance, affordability and sustainability of these technologies.

The no-longer existing National Arsenic Mitigation Information Centre (NAMIC) held a database of arsenic tube well screening results (Figure 1). This valuable dataset has now been incorporated into another government database to be preserved, updated and ultimately expanded to manage groundwater resources and to ensure drinking water quality standards to be met in Bangladesh. According to the archived NAMIC dataset, of the 4.94 million wells screened, 1.44 million were found to contain arsenic above 50 microgram per liter in 270 upazilas from 54 districts. In these upazilas 38,430 suspected arsenicosis patients were identified out of the total 66,034,962 residents, although there are some questions about the validity of the arsenicosis patient screening data.

THE POLICY AND INSTITUTIONAL FRAMEWORK

The Government of Bangladesh has formulated policies for the three different sectors affected by arsenic contamination in the ground water; namely the National Agriculture Policy, National Water Policy and National Health Policy; however there are no provisions for arsenic mitigation in these policies. Although an Arsenic Policy Support Unit and a National Committee was established, under the implementation plan for Arsenic Mitigation of 2004, the Arsenic Policy Support Unit no longer exists and the National Committee is inactive. Both the policy and implementation plan need to be revitalized by the Government to bring a new dynamism to arsenic mitigation in Bangladesh. A significant institutional review commissioned by the Local Government Division (LGD) of the Ministry of Local Government, Rural Development and Co-operatives (MLGRD&C) and the Policy Support Unit (PSU) called for a review of the Implementation Plan for Arsenic Mitigation of 2004. This is a first crucial step towards revitalizing arsenic mitigation.

The LGD of the MLGRD&C is the nodal Government unit for managing the arsenic issue. Under the LGD; the Pourashavas, the City Corporations, the Water and Sanitation Authorities in Dhaka and Chittagong, Local Government Engineering Department (LGED) and the Department of Public Health Engineering (DPHE) have contributed to arsenic mitigation. DPHE is the lead technical organization responsible for supporting the LGD and the local government institutions (LGIs) in planning and delivery of solutions and the management of the arsenic problem. The LGIs have been delegated the responsibility to ensure safe water for all. To execute this responsibility, the LGIs can deploy their social and legal authority to leverage 'testing and marking' of all sources for arsenic contamination by all water service providers (i.e. public & private, households & communities) within their jurisdiction.

One of the features of the institutional landscape is the very large number of agencies (governmental and non-governmental) engaged in arsenic-related interventions. Coordination is challenging not least because of the multi-sectoral nature of the problem.

Arsenic awareness campaign in schools

EMERGING
THREATS

Though considerable attention was initially focused on the arsenic issue, this problem has received little attention by both Government and development partners over the last five years. However, recent scientific findings call for urgent action:

- The recognition that in addition to cancers, arsenic can lead to significantly increased mortality from heart attacks and other cardio-pulmonary diseases.
- The recognition that in addition to cancers, arsenic can impair the intellectual function of children.
- The possibility that arsenic from groundwater used for irrigation can reduce crop yield.
- The possibility of arsenic from ground water entering the food chain through its accumulation into rice, the rice straw that is used as animal fodder, as well as in other crops.

Though more research needs to be undertaken to ascertain the full impact of these findings in the Bangladesh context, the potential consequence justifies that pro-active action should be taken to reduce exposure to arsenic from drinking water and to develop coordinated implementation plans for arsenic mitigation in health, agriculture, water supply and water resources sectors.

HEALTH

While skin lesions are the best-known symptom of arsenicosis they are not life threatening. Furthermore, many people exposed to arsenic will never show skin lesions but may still go on to develop lung, cardiovascular disease and cancer as a direct consequence of this exposure. Children are particularly vulnerable to arsenic poisoning, and are much more likely to face adverse health impacts than adults. There is an increasing body of evidence that prenatal arsenic exposure is associated with significant morbidity and mortality later in life due to lung, cardiovascular disease and cancer. The commonly reported symptoms of chronic arsenic exposure are melanosis, keratosis, ulcer, gangrene, peripheral vascular disorder, chronic lung disease, kidney failure, liver failure, cardiac diseases, skin cancer, and a number of internal cancers. Arsenic leads to very high excess deaths; there is high latency for cancers but less for heart attacks; and for both cancers and heart attacks, men are more vulnerable than women.

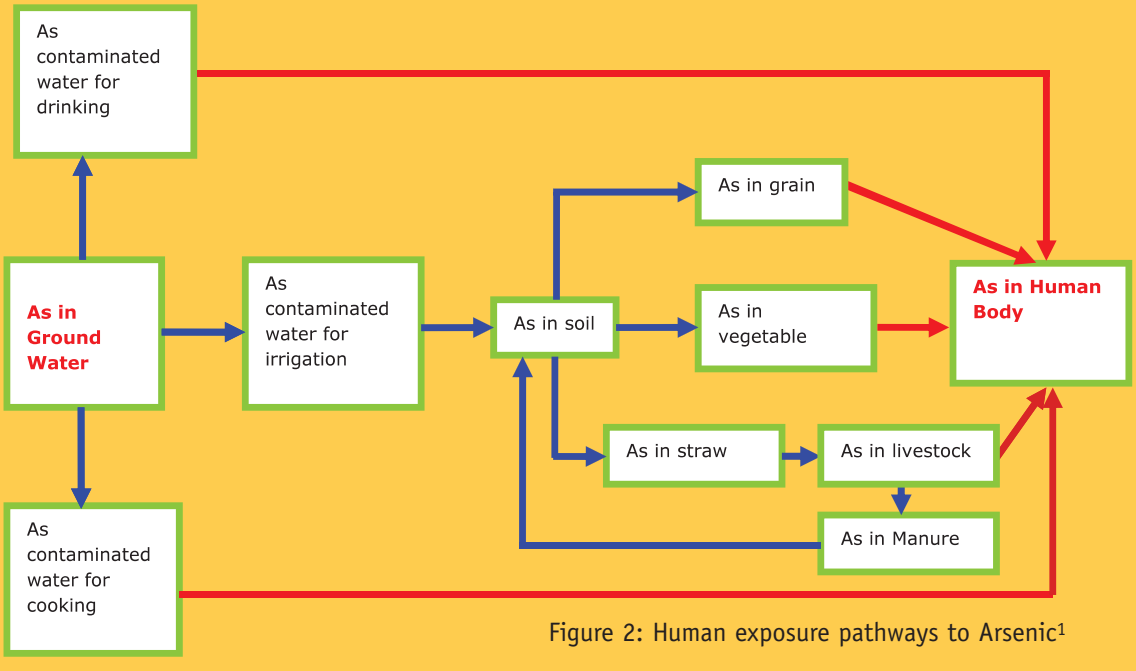


Figure 2: Human exposure pathways to Arsenic[1]

Estimates of the economic impact of poor health arising from arsenic in groundwater in Bangladesh suggest that the cost of inaction is extremely high. The Gross Domestic Product (GDP) output lost due to illness and people becoming unable to work is estimated to be US$23 billion while the cost of treating arsenic-related diseases is estimated to be much lower at US$0.6 billion for a constant discount rate of 10% over a 50-year period. This suggests that while the costs to the health care system are large, the costs to the economy due to loss in productivity are at least an order of magnitude greater.

[1]Arsenic may also enter the human food chain via arsenic-contaminated animal fodder and from milk provided by As-affected cattle

The primary treatment for arsenic poisoning is to reduce ongoing exposure as much and as quickly as possible. Human exposure to arsenic occurs through a number of different routes (see Figure 2). Besides this, micronutrients such as vitamins A, C, E, zinc, selenium and folic acid have been shown to be effective in the alleviation of arsenicosis symptoms, specifically skin lesions and in accelerating the natural excretion of arsenic from the body. These are all essential vitamins and minerals, yet care is needed to ensure that these are not prescribed in excessive, potentially toxic dosages. Most of these compounds require between 6 and 12 months treatment to be effective and even then recurrence rates are high.

More research is needed to find alternate therapies which are effective within a shorter period (2-4 weeks) with minimum adverse effects. Potential treatments using spirulina, garlic and maize have been suggested based on an animal model.

FOOD
SAFETY

The impact of arsenic on food safety is increasingly being recognized. Recent data on total and inorganic arsenic in rice and vegetables from some districts of southwestern Bangladesh indicate that rice can contribute significantly to the daily intake of arsenic. The average daily intake of arsenic from rice for a Bangladeshi adult is approximately 100 microgram, equivalent to consumption of 2 liters of water if the water contains arsenic at the Bangladesh drinking water limit of 50 microgram per liter. The WHO Provisional Maximum Tolerable Daily Intake (PMTDI) for an adult is 140 microgram arsenic per 65 kg body mass. In parts of the country arsenic levels in rice are higher than average because irrigation water contain high arsenic. In Faridpur, for example, boro rice consumption leads to an average intake of 150% of the PMTDI. However, further research is needed to ascertain the full impact of these findings, especially because there is no evidence yet to suggest that arsenic in rice at this concentration is toxic to humans.

In addition to arsenic concentration in edible crops, arsenic may also enter the food chain through fodder crops (Figure 2). Rice straw is the main cattle/buffalo feed in Bangladesh and arsenic-contaminated straw could impact animal health and the quality of animal products. It has been found that cattle manure has approximately the same arsenic concentration as straw feed. Manure is also used as a kitchen fuel, which provides an additional route for human exposure to arsenic.

FOOD SECURITY

The continuous build up of arsenic in the soil from arsenic-contaminated irrigation water may reduce crop yields. Evidence from field trials in Bangladesh tends to confirm that arsenic accumulation in soils is negatively affecting productivity.

In the short-term it seems unlikely that Bangladesh will be able to lessen its reliance on irrigation from tube-wells for crop cultivation although the increased use of surface water appears to be a sensible option to be considered where it is technically feasible.

To reduce the negative impact of arsenic on food safety and security, a focus on mitigating arsenic in irrigation water may be the most realistic strategy in the short term. Other short-term options include substituting crops which are more arsenic tolerant and making use of cultivation techniques such as raised-bed cropping. In the medium-long term breeding and the propagation of arsenic-tolerant strains may be important. Breeding programs could also focus on the development of strains which require less irrigation. This potentially can be a second "green revolution" to reduce the need for application of arsenic-contaminated water. This would have additional benefits in reducing the costs of cultivation and cutting greenhouse gas emissions.

WATER
SUPPLY

There has been progress in safe water provision. A recent situation analysis found that of the 22 million people residing in areas where more than 40% of wells have unsafe level of arsenic, 12 million have been provided safe water options. However, in the most affected areas where more than 80% of wells display unsafe level of arsenic, only 4 out of the total 9 million residents have been provided alternative safe water options by the government (Table 1). Therefore, an urgent task is to reach the millions still without arsenic safe water in these highly affected areas. Approximately 20 million people are still being exposed to excessive quantities of arsenic in 2009.

Table 1. Total population vs. population with public safe water in the most affected areas

Division	*Population**	*Population with public safe water*
Barisal	421, 242	229,980
Chittagong	5,370,472	2,694,780
Dhaka	2,456,298	817,390
Khulna	794,618	401,875
Sylhet	47,416	31,785
Total	**9,100,046**	**4,175,810**

**where NAMIC data found >80% wells containing > 50 ug/L arsenic in 434 unions in 5 districts (Source: Situation Analysis of Arsenic Mitigation 2009. JICA/DPHE)*

Of the various water supply options that have been endorsed by the National Policy for Arsenic Mitigation of 2004 for use in arsenic-affected areas, deep tube wells emerged as the preferred option even though the policy gives preference to the use of surface water over the use of groundwater. Deep tube wells are a popular option because they resemble the shallow tube wells which people have grown to consider safe. Tube wells also provide water that is largely safe from fecal contamination, thus ensuring that health gains on diarrhea and other fecal-oral diseases are not lost. However, there were valid concerns about the risk of contaminating the deep aquifer with arsenic drawn down from shallow depths. Since then, studies have shown that when the deep aquifer is used only for domestic water supply but not for irrigation, the risk of arsenic contamination is negligible. However, if crop irrigation, which accounts for about 90% of all groundwater use, is also made from the deep aquifer, there can be a real risk of arsenic contamination. These new findings highlight the importance of management and regulation of groundwater abstraction, especially when agriculture and domestic supply compete for the same resource.

KEY ACTIONS

Several key actions have been identified to ensure that joint efforts on arsenic mitigation are reinvigorated in health, agriculture and water sectors to protect health of vulnerable populations and to achieve MDGs in Bangladesh. The institutional review of the Implementation Plan for Arsenic Mitigation of 2004, recently called for by the Local Government Division and the Policy Support Unit, provides the government an opportunity to put a realistic plan in place to decisively deal with the arsenic problem. The key actions recommended below emphasize on the development of local scale management strategies.

HEALTH SECTOR

- Establish an arsenicosis patient registry to ensure the early identification of arsenicosis patients through a robust surveillance program; that district hospitals are adequately resourced to manage arsenicosis patients in most affected areas; and that specialist care is available in tertiary hospitals;
- Share information about patient locations with agencies responsible for water supply so that new water points can be targeted to these villages;
- Harness the health promotion workforce to continuously press home the health risk of arsenic exposure;
- Invest in training, screening capacity and necessary equipment for arsenicosis patients in district and upazila hospitals;
- Introduce school-based arsenic education as a means of widely disseminating factually correct information about arsenic.

AGRICULTURE SECTOR

- Optimize conjunctive use of surface and ground water to minimize arsenic exposure to crops while not compromising sustainability of deep groundwater for domestic water supply;
- Monitor agriculture practices to ensure the lowest level of arsenic contamination from food sources such as specific types of rice and vegetables with development of a national database on soil, rice and vegetables;
- Develop agriculture practices - such as arsenic resistant varieties, raised-bed cultivation, shifting to surface water for irrigation - to ensure lowest exposure of the population to arsenic from food sources and irrigation;
- Organize a strong campaign for raising awareness among key stakeholders regarding the risks of arsenic in the agriculture sector;
- Undertake multidisciplinary research in understanding the uptake of arsenic by rice and vegetables from soil irrigated by high arsenic water. Further, greater understanding is required for the linkages between arsenic from food and uptake by human body.

WATER SECTOR

- Translate the Government's goal of "Safe Water for All by 2011" into plans with quantifiable targets, clear responsibilities, sufficient budget allocations, and time frame for implementation;
- Focus on providing the worst-affected unions with needed financial and technical support to provide alternative safe water options;
- Establish and maintain a robust arsenic monitoring system at local level by registering all water sources in the union, including their status (e.g. unpainted, red or green, last tested), and based on this information, determining demand for safe water in the union while simultaneously implementing a new public awareness campaign on arsenic;
- Strengthen the water quality monitoring capability in public and private sectors to address chemical and biological quality standards to avoid substituting one risk for another;
- Regulate the indiscriminate abstraction of deep ground water.

CONCLUSION

During the 1980s and 1990s Bangladesh made substantial progress towards food security and access to safe water, largely through a shift towards irrigated agriculture and investment in shallow tube wells with hand pumps for drinking water. The process was characterized by significant social mobilization, significant local investment and enhanced local management. These gains are now under serious threat from the risks posed by groundwater with unsafe level of arsenic for human consumption.

Arsenic poses health risks to a significant proportion of the population, and the numbers of those at risk is likely to grow if effective action is not taken urgently. Exposure to arsenic occurs both through drinking water and through the food chain, while food security is at risk from falling crop yields as arsenic accumulates in the soil. The well-known skin lesions caused by arsenic are only the tip of the iceberg of many health impacts, including cancers, lung and heart diseases.

Urgent action is needed to re-focus the attention of the nation towards an arsenic-safe environment. The emphasis on arsenic monitoring and mitigation, research and action of the 90's must be urgently reinvigorated if significant ground is not to be lost. Central government, political parties, local government, the private sector, NGOs, research organizations, communities and development partners all have a role to play in achieving this noble objective and the related Millennium Development Goal for safe water supply.

Note: This is a summary document only. The reader is referred to the main report for a full discussion of the issues with relevant scientific and policy references.

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in Bangladesh

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