



Arsenic contamination of groundwater in Bangladesh

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BANGLADESH HAS ABOUT 1.8 million hand tubewells (HTWs) supplying drinking water from underground sources to more than 95 per cent of 124 million people. She has also about 30,000 deep tubewells (DTWs) 6,44,000 shallow tubewells (STWs) and 1,40,000 manual pumps (MPs) lifting groundwater for irrigation purposes. Using all these pumps more than 12,000 million cubic meter (MCM) water is pumped every year from the underground water sources. Over 90 per cent of all groundwater abstraction is used in irrigation (Rashid, 1997).

The supply of pure drinking water has been one of the few success stories in the public health care. This has helped reduce the water-borne diseases. But the detection of arsenic contamination in groundwater in the recent years has now become the new threat to the nation. Many of the tubewells are now not supplying safe drinking water, rather they turned to the reservoirs of liquid poison, arsenic. Bangladesh is in arsenic disaster where about 65 million people are now exposed to the threat of arsenic poisoning through drinking water. Thousands of people are suffering from arsenic affections, ranging from melanosis to skin cancer and gangrene.

Arsenic contamination have been reported from many parts of the world such as Australia, New Zealand, Chile, Taiwan, Mongolia, India, China, Thailand, USA, UK as well as Bangladesh. But in terms of severity of the problem, Bangladesh tops the list, followed by India and China.

Arsenic and its occurrence

Arsenic is a naturally occurring poisonous chemical element and always present as compound. It is widely distributed in the soil profile as component of different minerals

and found in nominal amounts in all organisms. Arsenic is a partially metallic substance and always present as compounds.

Organic arsenic is generally less (about ten-fold) toxic than inorganic arsenic. The commonly existing inorganic As-species in groundwater are in the form of arsenate (As v) and arsenite (As III), the later being more mobile and toxic (40-60 times) for living organisms.

Arsenic occurs in Bangladesh as geological deposits at a shallower depths (usually at 40-150 feet). Generally shallow tubewell water is found heavily contaminated by arsenic ranging from 0.01-3.0 mg/l. The most common arsenic mineral is arsenopyrite which often occurs as impurity in arsenopyrite- rich sulphide ores.

Arsenic contamination in Bangladesh

In Bangladesh, arsenic in groundwater above the permissible limit was found in 41 districts out of the total 64. About 8000 water samples from these 41 districts were tested in the laboratory and arsenic content in about 44 per cent samples (tubewells) was found above maximum permissible level, according to WHO, which is 0.05 mg/l (or 0.05 ppm). Arsenic content in groundwater in rest of the districts was found from 0.01-0.049 mg/l in 11 districts and less than 0.010 mg/l in 8 districts. Four districts (hill tracts and Cox's Bazar) were not surveyed. People suffering from various affections caused by arsenic pollution (arsenicosis) have been identified in 20 districts, so far. The Ganges floodplains, the Meghna flood plains, the Atrai floodplains, the tidal regions and the coastal plains are the major physiographic regions vulnerable to arsenic pollution. About 60 per cent of the country is under arsenic contamination (DCH, 1997).

While comparing the arsenic scenario of West Bengal, an Indian state adjacent to Bangladesh, with that of Bangladesh, it appears that Bangladesh's arsenic disaster may be more severe and jeopardizing in nature and extent. An updated status report reveals that about 38,000 sq.km area (8 districts) and 38 million people in West Bengal and 87,000 sq.km area and 65 million people in Bangladesh are affected. Figure 1 shows comparison of arsenic concentration in tubewell water of 41 districts of Bangladesh and 8 districts of West Bengal (Dhar, 1998).

Table 1 shows the arsenic concentration in hair, nail, skin-scale and urine of patients in arsenic contaminated areas of Bangladesh (Dhar, 1998). Some urine samples contain arsenic upto 235 times the normal, nail samples upto 30 times, hair samples upto 80 times. It was also

Figure 1. Comparison of arsenic concentration in tubewell water of 41 districts of Bangladesh and 8 districts of West Bengal

observed that skin test was the most reliable test for detection of arsenic.

It is a matter of great concern that chronic arsenic poisoning due to the use of contaminated groundwater has emerged as a serious health hazard in the country. Reports from various sources revealed that more than 2 million people are suffering from arsenicosis in Bangladesh.

Sources and/or causes of contaminations

In different countries arsenic contamination in water supplies is known to have been caused by dissolving naturally occurring geological deposits, from industrial discharges, and from application of pesticides. But, there are several speculations about the sources of arsenic contamination in Bangladesh, such as:

- wooden electric poles of Rural Electrification Board which are treated with chromated copper arsenate (CCA), ammoniacal copper arsenate (ACA) and ammoniacal copper zinc arsenic (ACZA);
- high use of fertilizers and pesticides, particularly phosphate fertilizers;
- role of microbes in the aquifers;
- reduction of iron oxyhydroxides; etc. Gradually, all these speculations were rejected based on the field observations and situation analyses.

Finally it was recognized that only the shallow and hand tubewell (STW & HTW) water contained high concentration of arsenic. A survey indicated that this high concentration is restricted in the upper alluvial sediments, usually at 40-150 feet depth. This indicates that the source of arsenic in Bangladesh is naturally occurring geological deposits. It was also recognized that arsenic affected areas are on sediments called "Alluvial and Younger deltaic deposit" which are rich in arsenopyrites. Due to heavy groundwater withdrawal and fluctuation of water table and also due to thousands of boreholes, the aquifer have been aerated. This transforms an essential anaerobic environment to

aerobic. The newly introduced oxygen oxidizes the arsenopyrites and releases arsenic into water. If this water comes in contact with another aquifer, the latter is also contaminated.

In Bangladesh, surface water and groundwater from deeper aquifer is arsenic free. Water supply in urban areas are usually from deep aquifers. The rural people drink HTW water from shallow aquifers. Moreover, they drink larger quantities to compensate sweating due to hard work in the sun. For this reason, rural people are more affected by arsenic contamination.

Effects of arsenic on health

Any form of arsenic compound is toxic to human. Its toxicity is more than four times higher than that of the toxic trace element mercury. The toxic effect of arsenic species depends mainly on their chemical form, route of entry, age, sex, doses and duration of exposure. Arsenic toxicity occurs through contaminated food or drinking water.

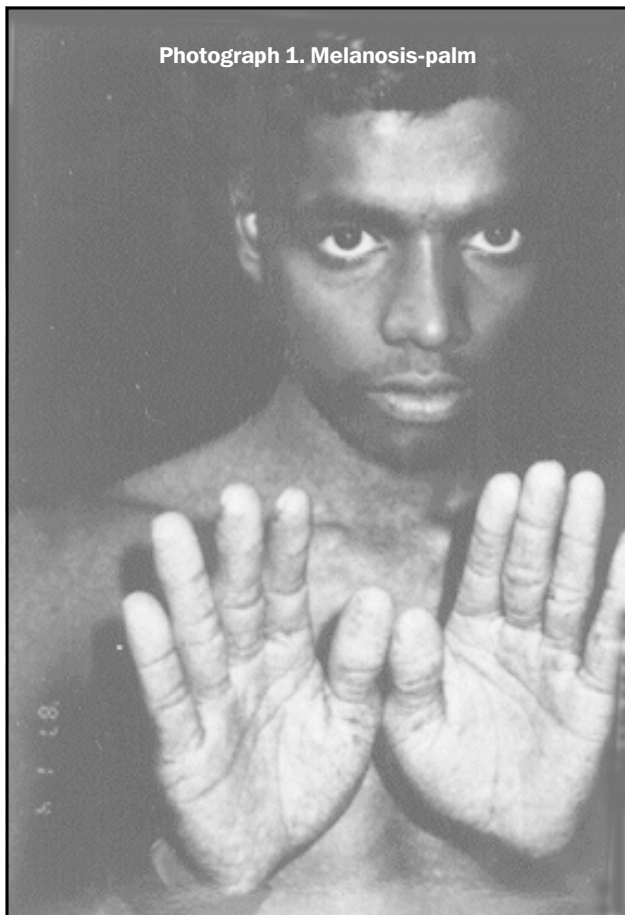
Skin diseases are the common effects of arsenic poisoning. Long term exposure to excessive arsenic causes changes in skin pigments and hyperkeratosis; promotes development of ulcerations of skin; and accelerates the risk of cancer in liver, bladder, kidney and skin. It happens in three stages:

- i) Initial stage: Desmatities, keratities, conjunctivities, bronchities and gastroenterities.
- ii) Second stage: Peripheral neuropathy, hepatopathy, melanosis, depigmentation and hyperkeratosis.
- iii) Final stage: Gangrene in the limbs, malignant neoplasm, and cancer.

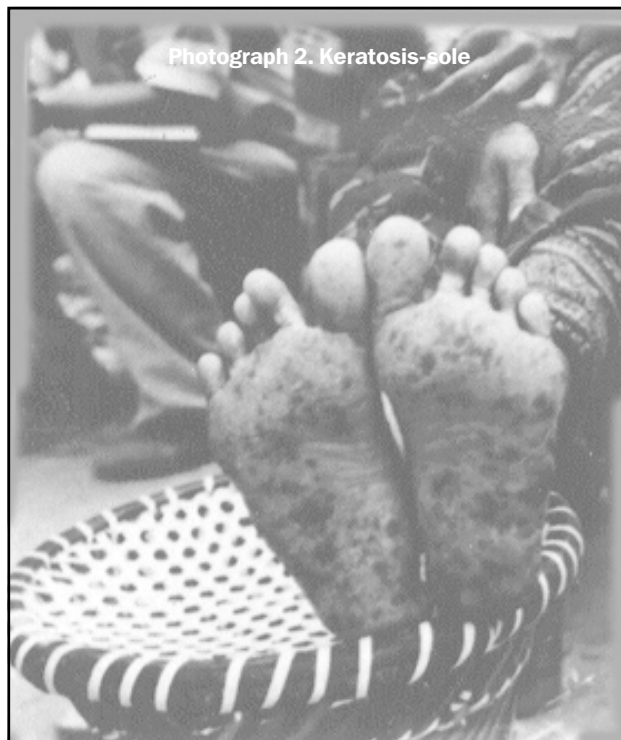
According to the recent newspaper reports about 2,20,000 people in Bangladesh are suffering from arsenic related diseases ranging from melanosis to skin cancer and gangrene (Photographs 1 - 3). Of them 2027 are seriously affected and four have died (BCAS, 1997). Arsenic contamination is not contagious or transferable.

Table 1. Arsenic concentration in hair, nail and skin-scale and urine in arsenic contaminated areas of Bangladesh

Photograph 1. Melanosis-palm



Photograph 2. Keratosis-sole



flocculation processing container should be poured into cowdung, leaves of arum plant, water hyacinth, cabbage, etc for detoxification (arsenic is converted into methyl acid, then evaporates off).

Mitigation of arsenic problem

Change of drinking habits and source of drinking water is the chief tool to combating arsenic problem. People in the arsenic affected areas must be made aware of the hazards of drinking contaminated water and cooking with it. They must drink safe water and eat nutritious foods. If alternate source with safe water is not available, treated water may be used. Sedimentation of contaminated water over night and treatment of contaminated water with copper sulphate (fitkari) can remove arsenic.

Abstraction of groundwater for irrigation must be regulated. Immediate development of surface water and conjunctive use of surface and ground water must be ensured. To combat the situation watershed management, finding alternate source of drinking water and awareness campaigns at grassroots level are needed urgently. The alternate water supply options in arsenic problem areas may include: deep tubewells, pond water with slow sand filtration (PSF), sanitary ring well, rain water harvesting, infiltration galleries, surface water treatment for urban people and As treatment plant where no other option exists.

Disposal of arsenic wastes

Disposal of the arsenic waste must be done very carefully. If the arsenic water is randomly disposed, it can create further havoc by contaminating water sources. The sediment-rich water left at the bottom of the sedimentation or

Conclusion

Over exploitation of groundwater for irrigation purposes is becoming very common in developing countries, like Bangladesh, India and China. Millions are exposed to arsenic poisoning and suffering from arsenicosis from drinking contaminated groundwater. Over exploitation of groundwater unjudiciously caused this grave situation. The arsenic poisoning, a world's worst episode, may aggravate if appropriate measures are not taken to halt its spread. Any country where water withdrawal goes similarly unchecked could leave themselves open to similar calamity. We can not exploit natural resource recklessly. To combat the situation, we need urgent watershed management and awareness campaigns at grassroots level.

Photograph 3. Gangrene



People must drink arsenic free water and eat nutritious food.

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