Arsenic – India's health crisis attracting global attention

Water, water, everywhere,
Nor any drop to drink.
— Samuel Taylor Coleridge

The spread of arsenic contamination in groundwater seems to be assuming gargantuan proportions. What is worse is that inhabitants of the affected areas are unaware and the local authorities totally oblivious to this grave problem. It was known that West Bengal (WB) and Bangladesh had high levels of arsenic in the groundwater, but slowly the problem is spreading to other states like Uttar Pradesh. This is confirmed by the reports of All India Institute of Medical Sciences, New Delhi that people living in the Ballia district of UP also have high levels of arsenic in their blood, hair, nails, etc.

According to the Union Ministry of Water Resources, eight districts of WB and one district of Bihar are arsenic-contaminated. The fact is that arsenic is increasingly found in the districts of Bihar, Terai UP and even Assam. Scientists report that arsenic is natural and is found in this region because it came with the silt deposited by the mighty rivers centuries ago. This silt was deposited when the rivers meandered and slowed down, so it is widespread in the deltas of WB and Bangladesh.

In WB and Bangladesh, the surface resources of sweet water such as rivers, wetlands, flooded river basins and oxbow lakes are among the largest in the world. These two areas are known as the land of rivers and receive approximately 2000 mm annual rainfall. Proper watershed management and village participation are needed for proper utilization of these huge bodies of water.

How it began

The first cases of arsenic poisoning in WB were reported up in the early 1980s. Water from tube wells was identified as the culprit. These wells were having depths in the range of 20–150 m. Although the arsenic-contaminated water at first came mainly from the middle of the three aquifers in WB, researchers now believe that the problem is more extensive. 'No tube well of any depth is safe in the arsenic-affected villages', says Dipankar Chakraborty (Director and Head, School of Environmental Studies, Jadavpur University). According to him, the situation caused by the arsenic-polluted drinking water in eastern India and Bangladesh is alarming. Nine districts in WB, India and 42 districts in Bangladesh have arsenic levels above the WHO maximum permissible limit of 50 μg/l. The area and population of the 42 districts in Bangladesh and nine districts in WB are 92,106 sq km and 79.9 million and 38,865 sq km and 42.7 million respectively. Chakraborty and his group started their survey for arsenic-affected villages in 1989 in WB, whereas the work in Bangladesh began in 1995. According to their survey, more than 1000 villages are arsenic-affected in the nine districts of WB. As more villages are surveyed, more arsenic-affected villages are discovered. They suggest that the problem is related to large-scale withdrawal of groundwater. The seasonal fluctuation of water table results in rapid and regular intake of oxygen within the pore space of the sediments. This inflow breaks down sulphides in the arsenic-laden pyrite rock through oxidation and thus releases arsenic into the water.

Arsenic toxicity

According to Subhas Mukherjee (Calcutta Medical College), symptomatology of arsenical toxicity may develop insidiously after 6 months to 2 years or more depending upon the intake of arsenic-contaminated water. Clinical features include diffuse melanosis (darkening of the skin) in the whole body or on the palm of the hand, spotted pigmentation commonly seen on the chest, back or limbs, leucomelanosis, buccal mucous membrane melanosis on the tongue, gums, lips, etc., conjunctival congestion, nonpitting swelling of the feed, hepatomegaly, spleen megaly, ascitis, etc. Squalors cell carcinoma, basal cell carcinoma, Bowen disease, carcinoma of the lungs, uterus, bladder, etc. are apparent in patients with advanced cases that have suffered for many years.

There is no medicine for chronic arsenic toxicity; safe water, nutritious food, fruits and vegetables and physical exercise are the only preventive measures to fight chronic arsenic toxicity.

According to Chakraborty and his group, the prophylactic measures that should be adopted to combat the present arsenic crisis include the following:

- In most of the villages surveyed in WB and Bangladesh, an average of 35% of the tube wells contain water that is safe to drink. These wells should be tested for arsenic every 3–6 months.
- Epidemiological research is needed in the arsenic-affected areas to characterize and quantify the arsenic-related public health burden and to document the long-term health benefits of arsenic exposure reduction.
- People should be made aware that their arsenic-related diseases are due to the arsenic-contaminated groundwater they are using for drinking and cooking.

Solutions for alleviating the arsenic problem

1. An estimated 30 million people in the Ganges delta are drinking well water contaminated with naturally occurring arsenic. India so far has spent $3 million on arsenic removal plants (ARPs) to capture the dissolved arsenic using ferric salts. About 20% of the plants are functioning well; many are not removing arsenic to the required standard. Villagers are not being trained to maintain the plants. Of the 2000 arsenic-removal plants installed in the villages of WB, 4 out of 5 are either abandoned or deliver smelly and discoloured water. According to a 2004 report of the School of Environmental Studies (SOES), Jadavpur University, out of 20 ARPs, 15 were found in good working condition; of which 8 were not useful in removing arsenic (according to the Indian standards value of arsenic in drinking water) and 14 (93.3%) were not useful in removing arsenic (according to WHO recommended value of arsenic in drinking water). Out of 16 ARPs, 14 (87.5%) were not useful to remove iron from raw water (according to Indian standard value and WHO recommended value of iron in drinking water).

The report further states that though the treatment plants were installed for supplying safe water, the endeavour fails to succeed because of technological limitation of the plants, lack of proper service and maintenance, lack of peoples' participation, lack of awareness of people, lack of education, village politics, poor socio-economic condition, etc. Thus in the villages predominant in India and Bangladesh, development of such technology is possible only when bureaucrats, technocrats and villagers cooperate with proper village level participation.

2. Several chemical methods are also applied for purification of the arsenic-contaminated water. Arsenic is present in the soluble state in the form of sodium, potassium and ammonium salts. The chemical method for separation of arsenic involves oxidation of arsenites present, preferably by chlorine water. The insoluble arsenates are then filtered. The filtrate is used for drinking purpose on a small scale.

3. A mechanism for the mobilization of arsenic in groundwater has been designed by D. Chatterjee and his group (Department of Chemistry, University of Kalyani, Kalyani). Arsenic is mobilized under reducing conditions from the adsorbing sites of the secondary phases of iron, aluminium, manganese oxides and hydroxides.

Mobilization depends on the redox geochemistry of arsenic that plays a vital role in the release and subsequent transport of arsenic in groundwater. Mitigation includes alternative source for safe drinking water supply[1]. Lowering of the ingested inorganic arsenic level and introduction of newer treatment options (implementation of laterite, the natural material) to ensure safe water supply (arsenic free and/or low arsenic within permissible limit) are the urgent needs to safeguard against mass arsenic poisoning and internal arsenic-related health problems.

4. Removal of arsenic (III and V) during biological iron oxidation has been investigated at the Laboratory of General and Inorganic Chemical Technology, Department of Chemistry, Aristotle University, Thessaloniki, Greece. Results showed that both inorganic forms of arsenic could be efficiently treated, for the concentration range of interest in drinking water (50–200 μg/l). In addition, the oxidation of trivalent arsenic was found to be catalysed by bacteria, leading to enhanced overall arsenic removal, because arsenic in the form of arsenites cannot be efficiently absorbed onto iron oxides. This method is a cost-competitive technology, which can find application in treatment of groundwaters with elevated concentrations of iron and arsenic[2].

5. Madhushanta De (Department of Genetics, Vivekananda Institute of Medical Sciences, Kolkata) and her group has been searching for natural remedies to counter the ravages of chronic arsenic poisoning for the past few years. She has found black tea useful for this purpose[3], as tea contains polyphenols that can scavenge free radicals. Extracts of green and two varieties of black tea as well as their principal polyphenols, (–)-epigallocatechingallate and theaflavin, efficiently counteracted the cytotoxic effects of arsenic compounds. She suggests those who have been consuming arsenic-contaminated water for more than 10 years, to take at least three cups of black tea every day.

6. In a search to find inexpensive treatments for arsenic poisoning, Khuda-Bukhsh *et al.*[4] have found the homoeopathic remedy Arsenicum Album to be effective. According to the them, 'this potentiated drug not only has the ability to help remove arsenic from the body, but also in microdoses appear to have the ability to detoxify the ill effects produced by arsenic in mice'. They have noted[4] that Arsenicum Album reduces liver damage caused by arsenic poisoning.

7. In another work[5], in collaboration with Kalyani University, WB, a team of researchers at the University of Manchester report mechanisms responsible for raising arsenic levels in water across South and Southeast Asia. Farhan Islam has shown, using microcosm experiments and DNA data, that the processes responsible for groundwaters acquiring arsenic from their host sediments are mediated by a special group of bacteria that live in the aquifer sediments. According to Islam, 'we now have a much better idea of how arsenic is released into the drinking water in aquifers in the region. It is hoped that the results will help to arrive at ways to remedy the water, leading to a healthier supply of water for thousands of people'.

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Antarctica and Arctic: India's contribution

As the Indian team of scientists left for Antarctic from Goa in December 2004 for the 24th Expedition, it is of interest to trace the origins and perspectives of polar research. Although the presence of land near the southern pole was predicted in the 3rd century BC by the Greek, the reports of Captain James Cook (UK, 1773) about his trips on crossing the Antarctic Circle and seeing the existence of wildlife led one to believe the presence of land. Even so, the existence of a southern polar continent was not proven until the 19th century. Much of the early ventures of the Antarctic land/waters that were undertaken were for sealing and whaling activities. The presence of a peninsular region was realized accidentally when ships got wrecked in adverse weather conditions. The UK, France, Norway, Sweden, Belgium, Germany, Russia and the USA are some of the countries to have started expeditions during the 19th and early 20th centuries. Most of the work was done using timber-hulled sailing ships that lacked the structural strength, power and sophisticated navigation aids of modern era.

The first recorded ongoing settlement on Antarctica was in 1903 when the Scottish National expedition established a building on Laurie Island. The station was handed over to Argentina the following year and was later named 'Orcadas'. It is the longest continuously operating station in Antarctica. The International Geophysical Year (1957), proved to be a landmark in the history of Antarctic expeditions. After that, permanently staffed stations were established at many points around the continent. Most national Antarctic programmes continue using vessels as the principal means of transporting supplies and personnel. Air transport is also used by many operators for inter and intra-continental movement of personnel and supplies.

1 December 2004 was the 45th anniversary of the signing of the Antarctic Treaty and India has been part of this treaty for the past 21 years (since 19 August 1983). The first Indian Wintering was conducted in the permanent station 'Dakshin Gangotri' built in 1983 on the Prince Astrid ice shelf. Following this, India was admitted as member of the Scientific Committee on Antarctic Research (SCAR) in 1984 and a member of Convention for the Conservation of Antarctic Marine Living Resour-