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Foreword

During the middle of 20th Century, South Asian countries like India and Pakistan (Bangladesh was then East Pakistan) had two major problems. The first was providing food for the huge population and the second was preventing water contaminated diseases like dihorrea, cholera, typhoid, dysentery, etc. The yearly rainfall, though among the highest in the world in Bangladesh and in West Bengal—India, was not potent enough to satisfy the needs. Moreover, India and Bangladesh, with plenty of available surface water, did not have the necessary infrastructure for the preservation, distribution, and purification facilities. The overall watershed management was poor. The farmer had to plea desperately for the rains in order to grow a harvest. The annual rainfall allowing a single harvest a year was not enough for the population and the situation would be even worse if there was a drought. Such circumstances called for alternative remedies.

Sometime during the year 1950, in Charmajdia, a small village of the district Nadia, West Bengal, the first induction of groundwater by pump created a furor. Villagers fled at the sight of water gushing out from the earth. They shrieked, "Devil's water." They believed underground was the proverbial "Hell" where Satan resided. Hence, they refused to use that water. Nevertheless, this water came at a trying period for the struggling people. These trusting people, thoroughly advised by the government and aid-agencies, finally decided to use the forbidden water. They were given assurance that with this groundwater, the bliss of God would bring green revolution and good health. The revolution did come and the discovery of 'Devil's water' became mere annals of history. The underground water survived the test of time and faith. It overcame the stigma of being a tool of the devil. The villagers drank cold water during the summer and moderately warm water during winter by merely pushing the handle of a small machine known as a Tube-Well.

Bangladesh and West Bengal are lands of rivers. The average annual rainfall in these two areas is 2000 mm. Bangladesh has 11,000 m^3 of available surface water per capita and West Bengal has about 7000 m^3, but government and aid agencies overlooked these facts. The villagers started sinking tubewells and pumped out

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groundwater without any test, oversight, or regulations. The farmers took naps while their pump sets flooded the ground. The water bodies dried out during summer were refilled by pumping underground water in to them and were used for the cultivation of fish. There was even common practices of emptying vast rain water reserves by connecting them to a river through canals, thus serving as a single site for cultivation. The blessings in the form of underground water had enthralled all of West Bengal. The use of natural water was almost forgotten.

During the 80's, the use of groundwater had assumed mammoth proportions. The irrigation system was quite dependent on the underground water. Drinking water was also supplied from underground by pipelines to distant places. Unavailability of storage-tanks at many places meant 60–70% of the water was wasted. Even during monsoon season, a few days without rain called for the use of underground water. Even though inexpensive technologies were available to purify and reserve surface water and rainwater, there were no plans or efforts on behalf of government and aid agencies to use the vast surface water and rainwater resources of West Bengal and Bangladesh and reduce groundwater extraction.

During this same time, a new kind of skin disease was discovered in West Bengal. The disease was incurable. The people afflicted with the disease lose their physical well-being and their desire to live. In July 1983, the disease was diagnosed and its origin was traced to the presence of arsenic in tubewell water. During the next decade, arsenic in groundwater (above 50 microgram per liter) rose from a single village in West Bengal to a whopping number of 400 villages. Arsenic had now assumed a dangerous proportion in groundwater.

The epidemic came into the limelight for the first time during the International Arsenic Conference held at Calcutta during February 1995. The statement 'West Bengal is the worst arsenic affected place in the world' was made. The magnitude of this calamity was often compared to that of the Chernobyl disaster. The grim arsenic situation of Bangladesh was declared. The International Arsenic Conference at

Figure 1. Source of arsenic: groundwater for irrigation and drinking.

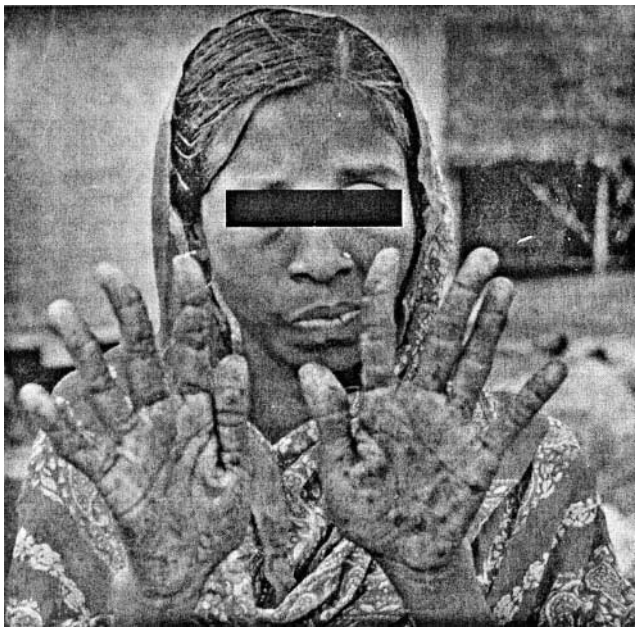

Figure 2. Effect of arsenic: an arsenicosis patient.

Dhaka in February 1998 proclaimed that the disaster in Bangladesh was unprecedented by the world arsenic scenario. On the eve of this conference, World Bank declared that within a few years, death across much of southern Bangladesh (1 in 10 adults) could be the result of cancers triggered by arsenic. World Bank, UNICEF, and WHO agreed that Bangladesh and West Bengal were in a crisis regarding the arsenic problem.

The diabolic situation of these two nations had not been the effects of overnight callousness and misconception. It was the effect of years of ignorance and negligence. The organizations responsible to set up tubewells in these two nations had not paid enough attention towards testing the underground water quality. During the 80's and 90's, the foreign organization which tested the quality of tubewell water in Bangladesh did not even conduct the tests for arsenic. The organization did not test for arsenic during the 1992 survey either. Ironically, in 1989, the same organization tested for arsenic in a London aquifer. This certainly points at their share of responsibility towards today's situation. Professional negligence from aid-agencies towards developing countries was certainly not appreciable. The newspapers started publishing extensive articles on the arsenic issue in West Bengal from 1983 onwards. There are also instances of the devastating situation in West Bengal being reported on in the national as well as international research journals from 1987 onwards. It is worthwhile to mention that the UNICEF report of 1995 stated 25 million people in India were suffering from fluorosis, a disease caused by the consumption of underground water containing fluoride. This report by UNICEF supports that

Figure 3. A possible solution: water from natural lake or water reservoir.

underground water may contain toxins, which may cause devastation. The number of fluorosis victims currently in India is a staggering 62 million. Now, arsenic in groundwater has caused similar devastation, if not more.

Before the beginning of the century there were 15 countries in the world that had arsenic contamination in water. Four countries, Bangladesh, West Bengal—India, China, and Taiwan, had populations that were suffering seriously. In fact, in the time span of only two years (2000–2002) six more nations have found significant groundwater arsenic contamination. These are Cambodia, Lao People Democratic Republic, Pakistan, Myanmar, Vietnam, and Nepal. The International Arsenic Conference at San Diego (July 2002) brought out a new aspect of this debacle. For the first time the serious situation of Bihar (another state of India in Middle Ganga Plain), was confirmed. This new discovery reveals that a good portion of the Ganges Plain, with an area of about 530,831 sq. km., may be contaminated with arsenic. This area has a population of about 450 million (including Bangladesh)!

The actual scientific reasoning of how arsenic compounds and minerals in the sediment leached out of the source into the aquifer is not yet clear. Excessive use of underground water high in arsenic definitely has helped the devil's cause. During the last five years, arsenic has found its way into many tubewells that were tested as safe to drink. The level of arsenic has increased in many of the existing tubewells. In this circumstance, tubewells in the arsenic affected regions may not be reliable in the end. While arsenic is found in the alluvial sediment, other toxins may be present in non-alluvial region. For example, Birbhum and Bankura, districts of West Bengal, do not contain arsenic, but do contain fluoride. Moreover, other toxins could appear in the underground water in the future. These observations point to the need for a continuous critical evaluation of groundwater quality before its use in massive scale.

The ecological balance is a gift of Mother Nature herself. A sudden disruption to the natural system may bring serious unintended consequences. We know 40% of the

world's population faces water shortages and by 2050, half the world will face the same. West Bengal and Bangladesh are abounding with hundreds of rivers, flooded river basins, ox-bow lakes, lagoons, ponds, and rainwater resources. But this 'molten gold' needs proper utilization. Proper watershed management with people's participation could not only eliminate the crisis but also could have significant impact on the economy. The world may learn from West Bengal and Bangladesh that such consequences may happen in any country that would use their natural resources indiscriminately without a critical scientific appraisal.

The purpose of this issue is to highlight the presence of arsenic in groundwater, its mining, and its detrimental effect on environment and human health. We hope that our effort to bring out this issue will help others to understand the present situation in terms of its occurrence in representative countries, health effects, and scientific approaches to study the health effects, chemical speciation, and mitigation approaches. We hope the scientific exposition will be useful to devise local, regional, and international management approaches towards solving the problem.

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Dipankar Chakraborti
School of Environmental Studies
Jadavpur University, Kolkata
India

Abul Hussam
Chemistry Department
George Mason University
Fairfax, Virginia
USA

Mohammad Alauddin
Department of Chemistry
Wagner College
Staten Island, New York
USA

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