Groundwater arsenic contamination and its health effects in the Ganga-Meghna-Brahmaputra plain

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Even before the onset of the twenty first century, twenty groundwater arsenic contamination incidents had been reported in different parts of the world. Of these, five were from Asia and in order of the severity of arsenic contamination included, Bangladesh> the state of West Bengal in India> Inner Mongolia, the Xin-Xiang province in the P.R. China > Taiwan. In more recent years, additional arsenic groundwater contamination incidents (Figure 1) have been reported from other Asiatic countries and include new sites in China, the Lao People's Democratic Republic, Cambodia, Myanmar and Pakistan. Severe groundwater arsenic contamination has also been reported in Vietnam where several million people consuming untreated groundwater run a considerable risk of chronic arsenic poisoning. Further, it has been reported that the Kurdistan province of western Iran has had people suffering from arsenicosis since 1984. Groundwater arsenic contamination was also reported in the Terai area of Nepal in 2001. In 2003, we reported arsenic groundwater contamination in the Middle Ganga Plain of the state of Bihar in India. More recently we have also discovered arsenic groundwater contamination in the Uttar Pradesh and Jharkhand states in the Gangetic plain and the state of Assam in the Brahmaputra plain of India. It appears that a good portion of all states and countries in the Ganga-Meghna-Brahmaputra (GMB) plain, comprising an area over 500,000 km^2 and a population over 450 million may be at risk from groundwater arsenic contamination (Figure 2).

Arsenic contamination in groundwater of India was first reported in 1976 from Chandigarh and different villages of Punjab, Haryana and Himachal Pradesh. It was further reported high arsenic content in the liver of five out of nine patients examined with non-cirrhotic portal hypertension (NCPH) who had been drinking arsenic contaminated water and concluded that, "Cirrhosis (adult and childhood), non-cirrhotic portal fibrosis (NCPF) and extrahepatic portalvein obstruction in adults are very common in India and suggest that consumption of arsenic contaminated water may have some role in the pathogenesis of these clinical states".

The next example of arsenic poisoning is the one was reported in 1983 from the state of West Bengal in the Lower Ganga plain. In 1992, while working in the arsenic affected districts of West Bengal we noticed arsenical skin lesions in women who came from bordering areas of Bangladesh to West Bengal after marriage. On being interviewed, they revealed that many of their relatives in Bangladesh had similar skin lesions. Later we analyzed water from hand tubewells, hair, nail, skin scale and urine of some of the patients from Bangladesh and found most of the samples to be highly concentrated in arsenic. Realizing the gravity of the arsenic situation in Bangladesh, we informed in 1994 the WHO and UNICEF in Bangladesh about possible extensive arsenic contamination in Bangladesh. Although the international arsenic conference held in Calcutta during February 1995 was attended by the representatives of WHO, UNICEF-Bangladesh and the government officials of Bangladesh, none of them reported any arsenic groundwater contamination and the resulting suffering of people in Bangladesh. The magnitude of the arsenic calamity in Bangladesh surfaced after the international arsenic conference held in Dhaka, Bangladesh from 8-12 February 1998. Two reports were published by the 'Guardian', a London daily, with interviews of international funding organizations and arsenic experts. In that published report the World Bank's local chief said, "Tens of millions of people are at risk." The World Bank further mentions that in Bangladesh 43000 villages out of 68000 are presently or could be at risk in the future. A report by the WHO predicts that, within a few years, death across much of southern Bangladesh (1 in 10 adults) could be from cancers triggered by arsenic.

In this paper we report our recent findings regarding groundwater arsenic contamination and its health effect in all the states and countries in the GMB plain (*i.e.*, Uttar Pradesh, Bihar, Jharkhand, Assam, West Bengal of India and Bangladesh). Tens of thousands of hand tubewell water samples, thousands of biological samples have been analyzed for arsenic and more than 100,000 villagers from affected villages have been examined in an effort to better characterize the extent and severity of the arsenic problem in this region.