UNDERSTANDING ARSENIC CONTAMINATION OF GROUNDWATER IN BANGLADESH

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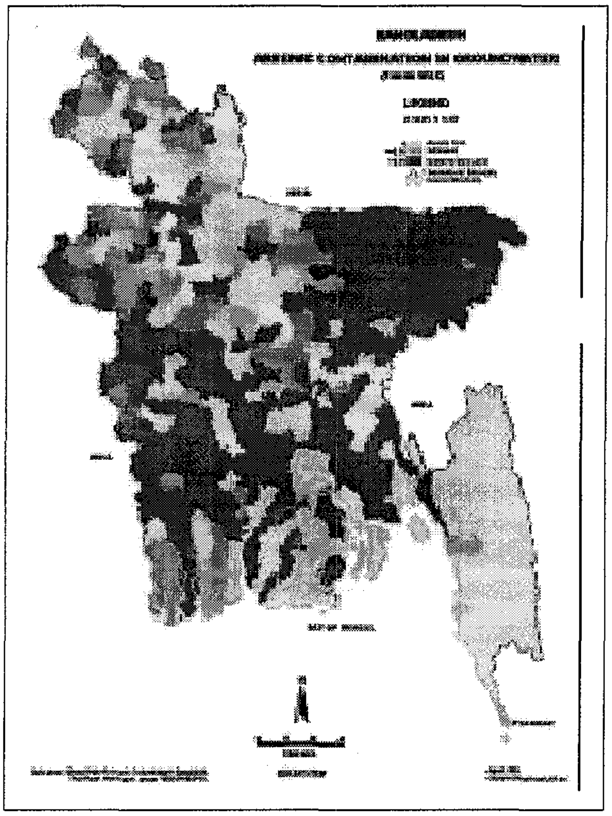

The problem of water contamination by naturally occurring arsenic confronts governments, public and private utilities, and the development community with a new challenge for implementing operational mitigation activities under difficult conditions of imperfect knowledge—especially for arsenic mitigation for the benefit of the rural poor.

With more than a conservative estimate of 20 million of its 130 million people assumed to be drinking contaminated water and another 70 million potentially at risk, Bangladesh is facing what has been described as perhaps the largest mass poisoning in history. High concentrations of naturally occurring arsenic have already been found in water from tens of thousands of tube wells, the main source of potable water, in 59 out of Bangladesh's 64 districts. Arsenic contamination is highly irregular, so tube wells in neighboring locations or even different depths can be safe. Arsenic is extremely hazardous if ingested in drinking water or used in cooking in excess of the maximum permissible limit of 0.01 mg/liter over an extended period of time.

Even in the early 1970s, most of Bangladesh's rural population got its drinking water from surface ponds and nearly a quarter of a million children died each year from water-borne diseases. Groundwater now constitutes the major source of drinking water in Bangladesh with 95% of the drinking water coming from underground sources. The provision of tube well water for 97 percent of the rural population has been credited with bringing down the high incidence of diarrheal diseases and contributing to a halving of the infant mortality rate. Paradoxically, the same wells that saved so many lives now pose a threat due to the unforeseen hazard of arsenic.

Bangladesh is a developing country with a GNP per capita of US$280 and a population of over 130 million. Its population density is very high, and most people live in small to medium sized villages (500-3,000 cap). Most of the country is a flat deltaic area with soft soils and high water table. This allowed the successful introduction of shallow and medium-deep hand pumps since the seventies. Although estimates vary, recent counting suggests that possibly near 10 million hand pumps are being used, of which 10% have been installed by the Government with UNICEF assistance, and another 10% by NGOs (DCH/Uposhon 2000). The majority of the pumps seem to have been installed on private initiative. The size of the affected area, the very large numbers of people "at risk", and the often very high arsenic concentrations (well above 0.5mg/L) make it decidedly a priority concern at national scale.

The provenance of arsenic rich minerals in sediments of the Bengal basin as a component of geological formations is believed to be from the Himalayan mountain range. Arsenic has been found in different uncropped geological hard rock formations underneath Bangladesh. Logically, arsenic is likely to be present as compounds within sediments comprising the aquifer systems and may be associated with iron oxides, organic matter, sulfides etc. High arsenic contamination of groundwater in Bangladesh is a serious issue requiring appropriate understanding of the phenomenon relating to the occurrence and release of arsenic in groundwater.

The water supply challenge is as much one of quantity as of quality. In many regions of the world, it means bringing water closer to the house. Further, if the water supply is of good quality, it improves public health. Three developments of the past decades have spurred new approaches to water supply and public health. First, the capacity to analyze smaller amounts of constituents in water has advanced substantially. Second, the health status and life expectancy have risen substantially across most countries. Finally, health and epidemiological research have advanced as well, and we are now much better informed of longer-term health effects of prolonged ingestion of contaminants.

Arsenic is currently the most significant example of a natural water contaminant present in relatively low concentrations. Its acute toxicity has been known for thousands of years, but the enhanced capability to detect very low concentrations in water has allowed to link arsenic to the incidence of cancer. This is especially worrisome because, in contrast to many other contamination types, we do not dispose of simple technologies or alternatives to mitigate the problem, especially in the case of isolated rural households.

The consensus among experts is that it is a priority to provide arsenic-free drinking water, partly because it is a *preventive* measure, and partly because in many arsenicosis patients clean water flushes out excess arsenic from the body and reverses to a major extent disease symptoms (see WHO 1997). Therefore, the strategy concentrates in first instance on water service delivery rather than strictly on health care.

There are, at present, few (if any) low-cost technology and affordable solutions for the treatment of arsenic in non-piped water systems. Proposed interventions in rural areas must include alternative water sources such as rainwater harvesting, more efficient use of non-contaminated wells in the area, treated surface water, selective well drilling to deeper aquifers, and simple arsenic removal techniques as they are found effective.

Arsenic contamination apparently can occur in a wide variety of hydrogeological and socioeconomic conditions. Therefore, any mitigation strategy will have to be tailored to suit the local geological, institutional and financial situation. However, the experience with water supply across the world demonstrates that the offered technical options will be sustainable only when the local community, or the customers, are truly committed to it and are willing to contribute financially to (at least) the operation and maintenance of the system.

The arsenic "crisis" has taught that the use of groundwater for water supply – and for that matter also agricultural irrigation – needs much more thorough scrutiny with respect to its chemical composition. In general, if arsenic now has proved to be more widely present in groundwater than originally thought, and if it has such dramatic health effects that occur after long-term ingestion, then other low-concentration elements in groundwater may equally be a cause or a factor in other disease patterns. This requires simpler techniques to determine water quality of different aquifers and the long-term safety of these aquifers. Isotope hydrology has proved to be a good tool in Bangladesh to identify source of water in different aquifers.

Water quality dimensions are often absent in on-going efforts to clarify, codify, and implement the policy, legal and institutional dimensions to promote groundwater use for economic and social development, particularly in the developing world. Moreover, past water and sanitation projects financed by the World Bank and other donor agencies have rarely included a systematic consideration of groundwater quality issues. Our belief is that some of these issues require urgent attention - such as the need to immediately include and implement the systematic analysis of groundwater quality in the environmental analysis of development efforts with a groundwater component or impact.

TABLE 1: COMPARISON OF WORLDWIDE LEVEL OF THREAT TO HEALTH POSED BY DIFFERENT WATER SUPPLY DEFICIENCIES

Problem faced	People affected (Magnitude)	Health effect	Remedies available Type	Technical complexity
Limited access to drinking water	*Only developing countries:* 1.5 billion[1]	Various	Increase coverage by replicating water supply programs	Moderate
Gastro-intestinal diseases due to water-carried pathogens	*Only developing countries:*	Diarrhea, cholera, Often fatal	Improve hygiene ehavior, sanitation bdis-infect water	Low
Lead in water supply Distribution pipes)	1 million	Neural / cerebral disorders	Replace lead pipes and fixtures	Low
Fluoride in water supply (Groundwater)	*Mostly in developing countries:* 5 million	Tooth decay, bone deformation	Remove fluoride, or provide water from alternative source	Moderate
Arsenic in water supply (Groundwater)	*Mostly in developing countries:* 50 million	Skin diseases, intestinal cancers; often fatal	Remove arsenic, or provide water from alternative source	Moderate to high

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