

## Arsenic in drinking water: a natural killer in Bangladesh and beyond

*An urgent alternative watershed management strategy is needed*

The world has vast natural reservoirs of geological arsenic. The ubiquitous nature of this element means that in some countries arsenic contaminates drinking water, enters the food chain and imposes significant human health risks. Globally, up to 100 million people are at risk of exposure to excessive levels of naturally occurring arsenic in well water or groundwater.<sup>1</sup> The countries where arsenic levels in drinking water supplies exceed acceptable levels include Argentina, Bangladesh, Bolivia, Chile, China, Hungary, India, Mexico, Nepal, Peru, Romania, Taiwan, the United States and Vietnam.<sup>1,2</sup>

In Bangladesh, the problem is particularly widespread. Many of the tube-wells in Bangladesh, which supply 95% of the water to 138 million people,<sup>3</sup> are contaminated with arsenic at concentrations much higher than the current recommended levels.<sup>4,5</sup> If no action is taken now, it is likely that within 20 years a substantial proportion of the Bangladeshi population will develop arsenic-related disease, including cancer. Here, we describe the magnitude and the consequences of the problem, and consider what actions are being pursued and what more needs to be done to prevent this potential public health catastrophe from becoming a reality.

Arsenic is a human carcinogen.<sup>6</sup> Chronic arsenicosis is characterised by hyperpigmentation and hyperkeratosis of the skin and cancers of the skin, lungs and bladder. Other adverse health effects include hypertension, cardiovascular disease (ischaemic heart disease), cerebrovascular disease, diabetes and reproductive effects including low birthweight, higher occurrence of spontaneous abortions and stillbirths, and congenital malformations in the offspring.<sup>7</sup>

The World Health Organization's Guidelines for drinking-water quality<sup>8</sup> set a provisional level for arsenic in drinking water of 10 µg/L (or 10 ppb [parts per billion]). In Australia, the guideline value set by the National Health and Medical Research Council and the Agricultural and Resource Management Council of Australia and New Zealand is 7 µg/L.<sup>9</sup> However, in many developing countries, including Bangladesh, 50 µg/L is commonly adopted as the guideline value, often for economic reasons, thus exposing the population to long-term risks.<sup>10</sup>

In Bangladesh, since the 1970s, in an effort to curb water-borne diseases from pathogen-contaminated surface water sources, over 10 million tube-wells have been installed by aid agencies and non-government organisations as sources of clean drinking water. Unfortunately, arsenic was not measured in tube-well water until the 1990s, and it is now known that 30%–90% of the wells in

many of the villages tested contain levels in excess of the national standard of 50 µg/L — placing tens of millions of Bangladeshis at even higher risk.<sup>4,11</sup>

Arsenic-related skin lesions and the other non-cancerous conditions caused by arsenic contamination have a latency period of about 5–10 years, whereas the latency period for arsenic-related cancers is about 20–30 years. A full survey of contaminated wells in Bangladesh has yet to be completed, but initial estimates predict the cancer burden on the health system will be substantial. Lifetime excess mortality risks (per 100 000 persons) from liver, bladder and lung cancer attributable to arsenic in drinking water have been reported as 0.9, 21.5, and 175.9 in males, and 3.4, 2.1, and 48.3 in females, respectively.<sup>12</sup> In countries such as Bangladesh whose gross domestic product or gross national income is dwarfed by those of developed nations (Bangladesh is rated 54th of 60 countries),<sup>13</sup> the burden of arsenicosis will have a significant impact on the economy, health system and social structure.

An urgent alternative watershed management strategy is needed to prevent further arsenic poisoning, and several options are currently being investigated. Bangladesh's high annual rainfall means that a key option is large catchments and dams with proper disinfection facilities to treat pathogens from surface water supply. But this is considered a long-term solution, requiring large capital investments beyond the resources of Bangladesh. For an immediate solution, relatively inexpensive interventions are being trialled at the family or village levels. These include the use of alternative water sources with low arsenic concentrations, such as dug-wells, deep tube-wells and rainwater storage. Other strategies have included the use of slow sand-filtration systems with or without chlorination and low-cost domestic filtration and/or precipitation systems using iron compounds, alum, or coal fly ash. Ultimately, it



A young girl drinking water from a tube-well. (Reproduced with permission: PE-12G-003/Shehzad Noorani/UNICEF Bangladesh.)



Construction of a dug-well in Bangladesh which uses a shallower aquifer to provide "arsenic free" water.

is likely there will be more than one solution. The advantages and disadvantages of these strategies have been discussed.<sup>5</sup> Cost and compliance will be the governing factors — but we can be certain that action must be taken now.

Since the problem was discovered, international aid agencies have been working with the government of Bangladesh and non-government organisations in an attempt to test every tube-well in Bangladesh to identify which wells have arsenic-free drinking water. They are also implementing many small to medium sized water treatment technologies to reduce arsenic contamination, as discussed above. However, future priorities should focus on large-scale nationally managed watershed programs and better utilisation of the vast surface water source that exists in Bangladesh. In addition, international effort is needed to find effective therapies for the people who have developed arsenicosis.

Some view this as a problem that only concerns the developing world. However, continuing pressures on water resources in many developed countries, coupled with the presence of geological arsenic and acid sulfate soils, indicate that the events now occurring in Bangladesh could be repeated elsewhere. For example, in mineral-rich countries, where acid sulfate soil is prevalent in many areas, the acid-generating potential of the soil will mobilise arsenic present in ore bodies resulting in arsenic contamination in the groundwater.

Recently, we have focused on the effect of the catastrophic tsunami in Asia, hurricanes in the United States, and the earth-

quake in Pakistan and Kashmir — natural disasters that have claimed many lives. Generally, acute disasters get a lot more media and political attention and international aid. But we also need to look to the horizon to reduce the arsenic-induced casualty that is happening in Bangladesh where tens of millions of people's lives are potentially at risk.

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