Chapter 8

When a Public Health Story Goes Sour

Arsenic Contaminated Drinking Water in Bangladesh

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WATER, WATER, EVERYWHERE, NOR ANY DROP TO DRINK[1]

Bangladesh's greatest boon has been the immense network of rivers that forms the world's largest delta, that of the Ganges, Brahmaputra and Meghna. The resulting vast supply of freshwater and alluvial soil was once responsible for making 'Golden Bengal' renowned for its wealth, and now supports some of the highest population densities in the world. However, the water that makes possible up to three crops a year also poses immense challenges. It contributes to making Bangladesh vulnerable to natural disaster, with serious flooding occurring every few years. Equally serious is the challenge the water poses for the health of Bangladesh's population—much of Bangladesh's apparently bountiful freshwater supplies are not truly fresh. The rivers have long been a source of cholera and other diarrhoeal diseases. These diseases are due, in part, to the combination of uncontrolled, even uncontrollable, water and the extreme population pressures leading to contamination of water supplies by faecal matter.

Bangladesh was chosen in the late 1960s for the location of the Southeast Asia Treaty Organization's (SEATO) Cholera Research

Laboratory (CLR) precisely because it experienced some of the highest levels of cholera and other diarrhoeal diseases in the world. The CLR was established to field-test cholera vaccines, which it showed lacked sufficient efficacy for public health programmes, but in its subsequent reincarnation as the International Centre for Diarrhoeal Disease Research, Bangladesh (ICDDRB), it helped to develop oral rehydration solution (ORS), also known as oral rehydration treatment (ORT). ORT has helped to greatly reduce case mortality from diarrhoeal disease, and is now a central part of public health campaigns in developing countries around the world.

However, while ORT reduces case mortality, it does not reduce the incidence of diarrhoea. This requires safe water supplies, sanitation and good hygiene practices. While all three are ideal, in Bangladesh, as in many other countries, there has been a tendency to concentrate on the first. It is cheaper and easier to provide than sanitation, while the agencies that deal with water and sanitation tend to prefer providing technical solutions to addressing issues such as hygiene, which require difficult to undertake health education programmes.

In urban areas, efforts to provide clean water have concentrated on reticulated water supplies, piping water either to public taps or ideally directly to houses. This is a good means of providing plentiful water, but requires expensive infrastructure to install and maintain, and an effective organization to ensure water standards and to collect revenue needed to maintain the system. Where such organization is lacking or weak, such systems fail to meet the needs of the population and indeed become health hazards themselves.

In rural areas, reticulated water generally has not been considered a viable option, given that the more spread out populations would require even more expensive infrastructure, which could not easily be afforded by the impoverished local populations. Other solutions are possible but they too are generally expensive, and impose considerable burdens on the users in terms of cost of installation, maintenance and protection of water quality. Moreover, most methods do not provide water directly to the household in plentiful quantities. This is important as the quantity of water is as important as the quality of water in ensuring good health (Esrey et al. 1991). Moreover, contamination from storage and handling are major sources of diarrhoeal disease, and are much more likely when water has to be brought some distance, especially from a public source.

Convenient water at the house is much more likely to be accepted by the household, and more broadly will contribute to the well-being of those dealing with water, usually the women of the household.

TUBEWELLS: THE KEY TO 'SAFE' WATER

When policies were being devised as to how to improve water supplies, especially drinking water, what was needed was a cheap water solution that provided water directly to the house. In Bangladesh, this solution was provided, almost miraculously, by copious quantities of microbiological pure ground water obtained through tubewells—tubes bored down 10–200 m with hand-pumps to draw up the water. The deltaic conditions meant that groundwater was plentiful and close to the surface, and hence tubewells were cheap. Tubewells were used in British India as early as the 1920s for agriculture but their widespread use in Bangladesh came only after the establishment of the new nation in 1971. The new government and the myriad international agencies which sought to assist it, saw in tubewells an alternative to frustrating attempts to purify ponds, discover means of immunizing against water-borne disease and develop safe latrines (Caldwell et al. 2003a).

Initially, the wells were provided by both government and non-government agencies and were publicly accessible, open to all who wanted to use them, but later private contractors provided tubewells to individual households willing to pay for them. Those without their own tubewell normally opt to use the well of a neighbour and are rarely refused. By the early 1990s, there were 2.5 million tubewells and 95 per cent of rural Bangladeshis were using tubewell water (Mitra and Associates 1992). It has recently been estimated that there are now up to 10 million tubewells of which three-quarters are believed to be privately owned (van Geen et al. 2003), with most households either having their own tubewells or easy access to tubewells.

The spread of tubewells was indeed accompanied by a marked decline in mortality from diarrhoeal disease, but much of this can be attributed to ORT and other treatments in reducing case mortality. The data does not exist as to what the impact of tubewells themselves was in Bangladesh, though comparable data suggests that it was probably a contributory factor to the mortality decline, but not the major factor. Early studies from the ICDDRB field site of Matlab

showed no difference in cholera and other diarrhoeas by water source (Briscoe 1978; Levine et al. 1976; Sommer 1972), or at most a very limited protection in the form of a small benefit offered by drinking microbially safe water. Its original condition was of minor significance because of the subsequent exposure to surface water through utensil washing, food preparation and hand washing.

More recent international studies have suggested that safe water supplies do significantly reduce diarrhoeal disease incidence and thus mortality, but that the effect is much reduced by the absence of adequate sanitation. Esrey et al. (1991) in a review of the available evidence found that the provision of safe drinking water and sanitation reduced diarrhoeal disease by 65 per cent but that safe drinking water by itself reduces mortality by only 20.8 per cent. In Bangladesh, the spread of basic latrines, mostly pit latrines, has been much slower than that of tubewells, probably because they are more expensive and require more maintenance and also because they do not provide the greater convenience to householders that tubewells do. Access to improved sanitation is estimated at 41 per cent in rural Bangladesh, implying that the remaining 59 per cent have inadequate sanitation (Lokuge et al. 2004; WHO/UNICEF 2001).

While the water and sanitation programmes may have been inadequate (sanitation was left behind), the spread of tubewell water has been regarded as a remarkable achievement, indeed a public health success story. In a few years, Bangladesh has gone from being a country where few rural dwellers had access to water uncontaminated by microbial pathogens, to one where the great majority do; indeed Bangladesh was listed by UNICEF as having one of the highest levels of access to safe water among the developing countries (UNICEF 2003). For this very reason, the discovery that something might be wrong with Bangladesh's groundwater came as a devastating blow, one that many were initially reluctant to acknowledge.

ARSENIC: A CRUEL BLOW

In recent years it has been found that groundwater in the deltaic lands of Bangladesh and the neighbouring Indian state of West Bengal are contaminated by significant levels of arsenic (Ahmad et al. 1998: 187; Chatterjee et al. 1995; Chowdhury et al. 2000; Dhar et al. 1997;

Murdur 1996, 2000; Saha 1995; Smith et al. 2000; Yanamurra 1999). Arsenic is present in the southern two-thirds of the country, especially in a broad belt stretching east–west across the middle of the country. The arsenic is present in a shallow aquifer and there appears to be little arsenic danger in water drawn from the first 10 m, mostly dug wells, or below 200 m—deep wells usually used for agriculture but sometimes for drinking especially in the south of the country near the sea. Even in the areas most heavily affected, there is great variability in the arsenic content of water from different tubewells within small areas (van Geen et al. 2003).

The discovery of arsenic in the groundwater was unexpected and hence delayed because previous cases of arsenic contaminated groundwater had been associated with mining sites. For this reason, no one had thought to test groundwater for arsenic contamination. There have been a number of claims of negligence in this regard, with at least one major suit against an international organization, claiming damages on behalf of the victims of arsenic poisoning (Vidal 2003). The precise mechanisms leading to the contamination are not known, but are probably the result of arsenic leaking into the aquifer. The arsenic, presumably bound to ferrous salts, was deposited over time in high concentrations in the deltaic soils of Bangladesh (Nickson et al. 2000).

The levels of arsenic contamination involved are moderate by the standards of arsenic-contaminated mining sites, previously the focus of arsenic related health research, but large numbers of people are drinking water from tubewells whose water contains arsenic exceeding the Bangladesh government's recommended maximum levels and even larger numbers above the levels recommended internationally. The overall numbers of people drinking contaminated water are far greater than in all previous known cases. Indeed, the numbers affected in Bangladesh provide a case for calling this the greatest mass poisoning in history.

The British Geological Survey (BGS&DPHE 2001) estimated that 35 million people were drinking water containing arsenic exceeding the Bangladesh maximum of 50 ug/L (50 parts per billion) and 57 million water exceeding the World Health Organization's recommendation of 10 ug/L (10 parts per bn). Fewer people are believed to be affected in India though Chakraborti et al. (2003) have argued that the numbers affected may be much higher than previously believed.

The response to the arsenic issue has been considerable though at times confusing given the many agencies involved. The Bangladesh Government, with assistance from the World Bank and other donors has launched the Bangladesh Arsenic Mitigation Water Supply Project (BAMWSP) to address the issue through extensive testing of wells and the promotion of arsenic free water sources.

THE HEALTH AND SOCIAL RESEARCH PROJECT

Despite this apparent progress, the key issue of how to address arsenic as a health issue remains unresolved. The remainder of this chapter will address this issue using data from a study the author was involved in, 'The Health and Social Research Project: Risks and Benefits of Arsenic Mitigation Programmes in Bangladesh'.[2] The project had two key components, the first of which involved a nationally representative sample survey of rural Bangladesh to examine water usage, and the response to the arsenic crisis, as well as to get an approximate estimate of the people affected. The second involved a study examining the risks and benefits of alternative interventions.

The national survey conducted in 2002 was a follow-up to an earlier national survey in 2000 (Caldwell 2003a, 2003b). The 2000 survey involved interviews with respondents in 3,780 households containing 20,260 individuals. This sampling frame was a sub-sample of the 1996–97 Bangladesh Demographic and Health Survey (Mitra et al. 1997). The 2002 survey was in turn a 25 per cent sub-sample of the earlier survey. Fifty per cent of interviews were conducted with male respondents and 50 per cent with female respondents. The interviews were, where possible, with the household head or spouse. By interviewing men and women it was possible to compare responses by gender. Given the separate roles that men and women have in the household, notably in water management, this was important. For more information on methodology see Caldwell et al. (2002a, 2002b, 2005) The two surveys allowed an examination of the situation in rural Bangladesh, not only as it was in the years in which they were undertaken, but of the changes in between, particularly in response to public awareness campaigns and well-testing being promoted by BAMWSP (Caldwell et al. 2005).

The surveys revealed that awareness of arsenic had expanded greatly by 2002 from the low levels found in the 2000 survey. In 2000, 32.2 per cent of male respondents and 22.3 per cent of female ones were aware of arsenic; in 2002 the equivalent figures were 63.0 per cent of males and 59.9 per cent of females. The increase among women is particularly significant given that in most households they are the principal users of water, and their cooperation is essential to any health strategy concerned with the appropriate use of water. Educated respondents, male and female, were much more likely to be aware of arsenicosis than uneducated ones, though the differential had declined somewhat by 2002. The increase in awareness among women and less educated respondents largely reflected an enhanced role of NGOs in raising awareness. Most respondents, however, did not know what the effect of arsenic was, and only a minority were aware that arsenic could result in death (12.9 per cent).

A key component to the government response to arsenic was well-testing. The surveys indicated that while most wells remained untested, there had been an impressive improvement from 5.7 per cent in 2000 to 16.3 per cent in 2002. This is well below the 50 per cent reported for affected areas (NAISU 2003, p. 12), but our survey included substantial areas outside those most affected. Nevertheless, even taking this into account, there remains a substantial discrepancy. Of households in 2002 whose wells had been tested, 34.2 per cent of the pumps were painted red indicating they exceeded acceptable levels of arsenic, 27.3 per cent were painted green as being acceptable, while in 38.7 per cent of cases the wells had been left unpainted. It was unclear why these wells had not been painted.

Of greatest concern is the popular response to the government campaign. Despite the campaign and greatly increased awareness concerning arsenic, there had been only a moderate behavioural response in terms of using the preferred water solutions. BAMWSP has promoted the use of alternatives to tubewell water, such as sanitary dug-wells and filtered pond water and deep tubewells, or, where these are not available, water filtered to remove arsenic. Deep tubewells are believed to be less dangerous than (ordinary or shallow) tubewells because they draw water from a deeper aquifer less likely to be contaminated by arsenic. They are much more expensive and normally require a large hand-pump or often a mechanical pump. Despite this campaign, the data indicates that the use

of tubewell water from both shallow and deep tubewells has continued to increase. In 2000, 87.2 per cent of respondents reported using shallow tubewells and 6.9 per cent deep ones. In 2002, 88.5 per cent were using shallow tubewells and 7.4 per cent deep tubewells. The proportion of rural households not using either type of tubewell had declined from 5.9 per cent to 4.1 per cent. These findings are not surprising; they are a continuation of previous trends with the desire of every house that can afford it to have its own source of water. Realistically only inexpensive shallow tubewells provide such an option.

There is more to the desire to have one's own tubewell than simply the wish for a new and very prominent prestige item in a country where few obvious consumer items can be afforded. Many continue to associate tubewell water with safe water—at least in the sense of diarrhoeal disease, while women, in particular, want a water source that is convenient—given that water collecting can consume a great deal of their time, and one which they can control by having a tubewell installed (Caldwell et al. 2002a, 2002b).

Disputes over access to water are a source of village conflicts. When households who had access to their own wells were asked in the 2002 survey their main reason for installing tubewells, there was a remarkable contrast between the answers of male and female respondents, reflecting different gender perspectives on water. Among males, 70.3 per cent gave the main reason as 'safe drinking-water', while only 18.0 per cent gave 'convenience' and 11.5 per cent 'ability to control one's own water supply'. Among female respondents, 31.1 per cent listed 'safe water', while 32.2 per cent gave 'convenience', and 36.7 per cent 'the ability to control one's own water'. The men's answers appear to reflect past information campaigns, while women's answers reflect their greater role in water management, and concern about practical issues that directly affected them. The implication of these responses is that if the government wishes to move households away from using tubewell water, its message will need to be very convincing, especially to those most concerned in water management, women. So far the message has not been adequately explained or convincing.

An alternative to moving from tubewell water is for households to filter tubewell water to remove arsenic. This is potentially cheaper and more convenient than abandoning tubewells but requires careful maintenance of the filter system. It also requires training and at least initially, some support. Perhaps for this reason very few respondents (0.6 per cent) reported filtering water for arsenic. When asked why they did not treat their water, the majority (56.7 per cent) in 2002 said they did not know how to, while smaller proportions said they did not believe their wells contained arsenic (34.1 per cent) or they did not perceive arsenic to be a problem (8.1 per cent).

The main behavioural response to arsenic being identified was changing the water source. Nearly 90 per cent of those who have responded in any way did so by changing tubewell water source. This may be the most appropriate response. Considerable variability has been reported in levels of arsenic between neighbouring wells; provided not too great a distance is involved, this solution offers lower arsenic intakes while retaining the advantages of tubewells in providing water free of microbial contamination. A number of writers have recommended this approach (Caldwell et al. 2003b; van Geen et al. 2003). Despite the attractions of this approach, it has not generally been favoured as there continue to be concerns about the reliability of testing, and the fact that many wells falling below the government standard contained some arsenic. It was found that many households had changed from tubewells that had been painted red to tubewells that had not been tested at all. Many households continued to use tubewells that had been painted red.

A prerequisite for a larger response is a greater number of well-testings. While testing has increased, most wells remain untested. For people to respond adequately they need to know whether their existing well is safe or not, and if they prefer to use an alternative well, whether it is safe. This may also imply the retesting of wells as it has been argued that arsenic levels in wells may change over time.

The single largest factor preventing a behavioural response to arsenic is, however, probably a lack of conviction that it is necessary, or that it is in the interests of households to change their current water-use behaviour. While the respondents had heard of arsenic, the survey data did not suggest that they regarded it as an urgent health concern. As noted only 12.9 per cent reported that arsenic could lead to death. Very few could identify people who were affected by arsenic and even fewer believed that a household member might be suffering from it.

Many of the conditions that arsenic poisoning may contribute to such as internal cancers and cardiovascular diseases also have other causes, and, especially for lay people, are not obviously connected to arsenic. A long latency period, where arsenic induced conditions may not manifest themselves for decades, contributes to this confusion. It is partly for this reason that it took so long for the dangers of arsenic to be realised. The most obvious condition caused by arsenic is arsenicosis, which involves skin lesions that may, in due course, lead to skin cancer. Nevertheless, there has been considerable debate about defining a diagnosis for arsenicosis and its link to more life-threatening conditions (WHO 2002a).

The difficulties noted above in changing water usage behaviour emphasize the need for clear and concise information on the most appropriate behaviour. This requires a better knowledge base than currently exists. The suspicion that many of the respondents have that their health may suffer if they change their water source precipitously is not without foundation. Unless properly implemented, there is a danger that the risks of arsenic mitigation may outweigh the benefits. As noted earlier, while the tubewell programme may not have been the major source of the decline in mortality from diarrhoeal disease, the evidence indicated that it had made a significant contribution. Given that diarrhoeal disease remains a significant health danger, any programme that risks an increase in diarrhoea would need to be significantly counterbalanced by an equal or greater reduction in arsenic-related morbidity and mortality to be justified (Lokuge et al. 2004).

THE RISKS AND BENEFITS OF ARSENIC INTERVENTION

Attempting to estimate the likely impact of diarrhoeal disease is extremely difficult. In theory, a great deal should be known about the dangers of diarrhoeal disease, but in practice most studies on diarrhoeal levels have examined incidence, while few have estimated mortality (Lokuge et al. 2004: 3). Reliable estimates require large sample sizes, so most mortality studies are undertaken in hospitals, an approach that does not provide reliable community level estimates. Data from the World Health Report (WHO 2002b) suggest that 6.2 per cent of all deaths in Bangladesh can be attributed to diarrhoeal disease but Streatfield et al. (2001), suggest a much higher proportion of deaths, namely, 11 per cent.

Arsenic-related morbidity is even more uncertain. While arsenic is well known as a cheap poison for rats and a particularly unpleasant and slow poison for humans as popularized in detective stories, its precise human health affects are uncertain, particularly at the 'moderate' levels prevalent in groundwater in Bangladesh. Furthermore, unlike diarrhoeal disease, which is an immediate acute illness, lasting one or two weeks before recovery, the effects of arsenic can take decades to be manifested. Arsenic is carcinogenic and is believed to cause a number of forms of cancer, including skin cancer and a number of internal cancers such as bladder cancer. It has also been related to high blood pressure and cardiovascular disease. As arsenic poisoning is only one factor contributing to cardiovascular disease and the relevant cancers, it is difficult even for epidemiologists to determine its contribution to the development of these outcomes.

As part of the ANU-led project, Lokuge et al. (2004) analyzed data from the scientific literature on what is known of arsenic as a cause of morbidity and mortality from cancer, cardiovascular disease and other health outcomes for given levels of arsenic intake. Their conclusion was that arsenic was a major contributor to poorer health and death only in concentrations above 50 ug/L. On this basis and what is known of concentrations of arsenic in drinking water in Bangladesh, they estimated that it contributed about 0.3 per cent of the total disease burden of Bangladesh. Their conclusion was that although it was a significant cause of disease burden in the exposed population, it was less significant at the national level than many other risk factors. The lesson they drew was not that it could be ignored but that, given Bangladesh is a poor country with limited resources and multiple competing interests, interventions need to be 'targeted to those areas where exposure has been confirmed, and that those interventions provided achieve significant reductions in arsenic exposure without concomitantly causing substantial increases in other risks such as water-related infectious disease' (Lokuge et al. 2004).

Their calculations were complicated by the fact that much of the morbidity and most of the mortality caused by diarrhoeal diseases occur in young children under five years, while the major effects of arsenic poisoning is in older adults. Comparative measurements of health effects are most commonly calculated using disability adjusted life-years, which strongly emphasizes the impact of child mortality due to their greater number of potential years of life lost as compared to what their disability-adjusted life-expectancy might otherwise have been.

INTERVENTION STUDY

While raising serious concerns about a too broad and unfocussed response to arsenic contamination, these concerns also highlight the importance of ensuring that interventions are properly designed and undertaken on a properly scientific basis. Consequently, the ANU-led project undertook as one of its components, an intervention study of the health impact of the provision of two arsenic mitigation interventions as compared to a control group. The two interventions were the provision of sanitary-protected shallow tubewells to provide an arsenic-free water source, and a 'three-pitcher' filter system[3] to remove arsenic from tubewell water. These are two of the most widely promoted interventions in Bangladesh and represent broadly the two main approaches to arsenic mitigation. The project installed dug wells or provided three-pitcher filter systems to households in the intervention areas, and provided training to caretakers on maintaining the system. It also provided health education on diarrhoeal management to ensure that the interventions had no adverse mortality consequences (the factor being measured was cases of diarrhoea, not mortality from diarrhoea).

Initial results indicate significant difficulties in compliance, with usage of both methods, especially dug wells, falling off badly (Milton et al. 2006). While, when used, dug wells did lead to sharply decreased arsenic intake, the impact of the three-pitcher method in removing arsenic fell off badly over the trial period apparently because of poor maintenance. Surprisingly, diarrhoeal rates appear to have fallen, including among the users of dug wells—where it was feared that rates might rise, but more detailed analysis suggested that this was due to the impact of the associated health education campaign. It appeared that among users of dug wells there had been a moderate rise in diarrhoeal rates compared to people who had failed to comply with the intervention and had reverted to tubewells. The intervention study suggests that for arsenic mitigations to be effective they require ongoing support to obtain compliance in correct usage and appropriate hygiene education to ensure that the risks of increased diarrhoea does not exceed the benefits of reduced arsenic intake. The intervention study also reinforced earlier evidence of the preference of the local population for water from safe tubewells if these are available.

CONCLUSION

The discovery of arsenic in groundwater as a serious health issue in Bangladesh is a concerning one, in part, because of the role of international agencies in promoting the use of groundwater through tubewells as a safe water option. One of the factors that distinguish the poorer countries of the world is that their people are subject to much higher levels of illness and individuals are at much greater risk of capricious, often early death, in a way that is now rare in richer countries. One of the great achievements of recent decades is the reduction of this risk. What has made possible this great improvement in health is improved knowledge of disease transmission and how to prevent disease as well as how to treat it. An important part of this has been reduced transmission of waterborne diseases. The discovery of arsenic-contaminated groundwater is a major setback, but the key point is to learn from an objective examination of the evidence.

It is important that the response to arsenic is not simply a reflex reaction to what in a very literal sense is an unpalatable discovery but instead is driven by a reasoned analysis of the risks and benefits of tubewells and alternative water sources. This is necessary, in part, not only because of the fact that people's health is at stake, but also to provide an ethical and convincing basis for people to adjust their behaviour in the way most favourable for the health and well-being of themselves and their families.

Concern about safe water is only one factor affecting people's behaviour in regard to water but it is an important one not just for health professionals but for the householders themselves. Householders, and especially women in the household, are concerned about family well-being and health. Women, particularly educated women, know that the water they use and how they use it is important in this regard. Nevertheless, there are many obstacles to changing their water-use behaviour. Women, especially, will be reluctant to surrender the control and access to water that tubewells

have brought. Most alternatives are likely to be costly financially—which will concern the menfolk of the family, who are generally in charge of household expenditure—or costly in terms of time and effort. The latter affects mostly the women who have to collect the water, maintain filters and suffer the indignity of sharing water with others and who are most concerned about restrictions on water availability. In theory, arsenic-affected water could be used for purposes where arsenic ingestion is not involved, for purposes other than drinking and cooking, such as washing, but this involves its own complexities in the separation of water for drinking and cooking from other water. The biggest single problem may well be the concern that any solution involving shifting away from tubewell water may bring with it increased diarrhoeal levels.

The estimates made by Lokuge et al. (2004) and the evidence from the intervention study suggests that these concerns are not without foundation. In the current situation regarding health in rural Bangladesh, the study by Lokuge et al. (2004) estimates that unless arsenic levels exceed 50 u/L, no intervention can be justified. If the data that Lokuge et al. draw on underestimate the health dangers of arsenic, then a lower maximum level would be appropriate. Furthermore, this may also be true if deaths from diarrhoea continue to fall either as a result of reduced diarrhoeal incidence or continuing improvements in treatment, for example, not all sufferers yet receive appropriate ORT.

Nevertheless, even if Lokuge et al.'s (2004) conclusions, based on the literature review, are correct and arsenic poisoning is primarily an issue where arsenic levels exceed 50 ug/L, arsenic remains a substantial issue for Bangladesh. There remain 35 million people whose drinking water exceeds this limit. Indeed many more people than this are in the position of being 'potentially' at risk, in that their tubewell sources have either been found to exceed this level, or more commonly have not been tested. This emphasizes the need for testing all currently used wells and where feasible, potential alternative wells. This would allow householders whose wells exceed the acceptable limit to use alternative safe tubewells if available, and only if none was easily available put them in the position of having to use alternative water sources to tubewells. Given that the costs of testing are much lower than the costs involved in using alternative water sources, this would appear the most viable strategy.

Where it is not possible for households to use water from their own tested tubewells or other tested tubewells, then alternative options will be needed. Nevertheless, it will not be simple to get them accepted on an ongoing basis. As noted above, compliance levels fell in the intervention study, especially for the preferred approach, dug wells, even though there was considerable external input in advice and motivation from the workers of the project's NGO partner, more than could be expected in an everyday situation. As also noted, the filtering system which had better but also diminishing compliance was not maintained properly and did not adequately remove arsenic.

If people are to be encouraged to move to alternative water sources, there are a number of critical issues. Any adequate alternative in terms of providing 'safe' water will generally be much more expensive and will require maintenance and, in consequence, will generally be shared by several households. This raises issues as to who will pay and how payment, access and responsibility for maintenance will be shared. Crucially, any efforts to encourage householders to shift to alternative water sources will need to be accompanied by programmes to reduce diarrhoea. The new water sources need to be designed to be as safe from microbial contamination as possible, but it will also be important to encourage a better understanding of the importance of hygienic handling of water. This applies to a lesser extent to those who continue to use tubewell water.

NOTES

1. This is a quote from 'The Rime of the Ancient Mariner' by Samuel Taylor Coleridge.
2. The project was undertaken by a collaborative partnership of the National Centre for Epidemiology and Population Health, Australian National University (ANU), NGP Forum for Water Supply and Sanitation, Bangladesh, The National Research Centre for Environmental Toxicology, University of Queensland, the Department of Epidemiology and Preventive Medicine, Monash University Medical School and Mitra and Associates, Dhaka. The participants were the author, Dr Bruce Caldwell, Professor Wayne Smith, Dr Geetha Ranmuthugala, Dr Keith Dear, Dr Kamalini Lokuge, Dr Abul Hasnat Milton, Dr Malcolm Sim, Dr Jack Ng and Mr S.N. Mitra.

3. This system contains three clay pots, one above another, to filter water with two top pots containing filtration media and precipitants. The primary active ingredient is iron filings to which arsenic binds. The resultant precipitate is filtered out.

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Issues and Challenges for Nations and Communities in South Asia

Edited by
Kuntala Lahiri-Dutt and
Robert J. Wasson

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