SUITABLE ARSENIC MITIGATION OPTIONS IN BANGLADESH: VOICES OF LOCAL PEOPLE

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ABSTRACT

Groundwater arsenic mitigation is a major contemporary issue and research theme in Bangladesh. From the very beginning of the identification of groundwater arsenic concentrations, mitigation policies have been formulated by government agencies, non-government organisations, and other stakeholders. This paper employs mainly qualitative enquiry to investigate suitable arsenic mitigation options, using local rural people's voices to investigate their relative merits and demerits. Participant observation, in-depth interviews, focus-group discussions, as well as formal and non-formal dialogue were the principal means of generating data.

INTRODUCTION

Groundwater arsenic poisoning in Bangladesh has since the early 1990s been recognised as a major environmental health hazard. Estimates vary but a minimum of 25 million people are presently exposed to the risk of chronic symptoms that range from changes in skin pigmentation to cancers of the skin, bladder, liver or lung (Hassan, 2003; Hassan *et al*., 2003). In recent years attention has turned to mitigation. Since therapies for arsenicosis are limited, options must be considered that will either prevent or reduce exposure. These include (a) chemical and non-chemical options; (b) household and community options (Anstiss *et al*. 2001; Brewster, 1992; Chen *et al*., 1999; Cheng *et al*., 1994; Ghurye *et al*., 1999; Hering *et al*., 1996; Hoque *et al.*, 2000; Jekel, 1994; Kartinen and Martin, 1995). The purpose of this paper is to consider a neglected aspect, what the local people think about the mitigation options. It seems to us to be crucial that consumers' attitudes should not be neglected in the rush to find appropriate technological solutions. A number of factors are important, from the obvious matters of affordability and practicability, to the less tangible socio-cultural considerations of acceptability that may be enough to tip the balance of an innovation either in favour or against the likelihood of its long-term sustainability.

The literature on arsenic mitigation is dominated by scientific and technological publications. This is understandable given the complex geochemistry of groundwater arsenic and the challenge of providing technologies that will work consistently across the vast swathes of the countryside that are not only very poor but are afflicted also by other environmental hazards, such as floods. As yet, there is comparatively little work of the qualitative kind that we discuss in this paper, although questionnaires have been extensively employed (Caldwell *et al*., 2003; Paul, 2004).

DATA AND METHODS

Data collection. The data collection, undertaken by Dr Hassan in 2001 in the course of his PhD studies, used a number of qualitative methods in the context of a participatory rural appraisal. In-depth interviews and focus-group discussions in particular were employed to elicit the people's perceptions of suitable arsenic mitigation options and their relative merits and demerits. For the in-depth interviews, open-structured questions were used so that a long discussion would be possible in each interview if appropriate. Some twenty-three in-depth interviews were undertaken, of which 11 were with people affected by arsenicosis and the remainder were from a wide variety of occupations.

The focus-group discussions employed 'interaction discussion' (Powell and Single, 1996) as a means of generating "rich details of complex experiences and the reasoning behind actions, beliefs, perceptions and attitudes" (Carey, 1995). Five focus-groups were selected for this study, comprising people at various levels of income, literacy and land holding status, and also NGO and local government officials, social activists, political leaders, and local elected administrators.

The study area. The relevant data for this study were collected from Ghona *Union* (the 4th order local government administrative unit in Bangladesh) in Satkhira District of south-west Bangladesh, near the Indian border. The study area consists of 5 *mauzas* (the lowest level administrative territorial unit having separate jurisdiction list numbers in the revenue records) and 9 administrative wards having a total area of 17.26 Km^2 with a population of about 11,000 in the 1991 census. The study area may be characterised as rural, with socio-economic conditions in terms of income, literacy level, and occupation pattern that are lower than the Bangladesh average.

Data analysis. The in-depth interviews and focus-group discussions were transcribed and divided into units based on the nature of the subject matter. These units were coded using topical codes, which were then grouped into clusters of similar topics and recoded using interpretive codes. Finally, the interpretive codes were grouped to reflect the themes (Winters, 1997). The resulting data were analysed from multiple perspectives using different analytical modes (Miles and Huberman, 1994; Silverman, 1993; and Wolcott, 1994). Thick description was used to consider the data without 'interpretation and abstraction' (Geertz, 1973); ethnographic representation was used to create a 'rich descriptive narrative' (Strauss and Corbin, 1998) and a vivid presentation of new understandings; and discourse analysis helped us to build new understandings and theory using high levels of interpretation and abstraction (Bunne, 1999 and Strauss and Corbin, 1998).

MITIGATION OPTIONS

There are several options for arsenic mitigation but most of them have not yet reached the study area. The Bangladesh Arsenic Mitigation & Water Supply Project (BAMWSP), the umbrella organization for a national water testing and health survey, has approved both the surface water and chemical options for mitigation purposes (*The Daily Star (Dhaka)*: 6th July 2001). The BAMWSP has recommended some preventive measures and several available low-cost arsenic removal technologies to provide arsenic-free and microbiologically safe drinking water (http://www.bamwsp.org). This paper reviews the people's perceptions about the suitability of some of the existing mitigation options.

Sharing existing arsenic-free tubewells

Well-switching or the sharing of any existing arsenic-free tubewells is a community option for arsenic mitigation. The World Health Organization (2000) regards this to be "the simplest and the most immediately achievable option", a view echoed by the UNICEF (2000), van Geen *et al*. (2002, 2003) and Caldwell *et al* (2003). From the field survey, however, we found that almost all of the tubewells in the study area are contaminated, very few producing water that is safe to drink. Many people are reluctant to use even these when they are in private hands because the sharing of such a scarce resource can cause tension and, in the words of one respondent 'it is embarrassing to collect water from a neighbouring tubewell. I have had bitter experiences in collecting from different tubewells'. Tubewell-holders, on the other hand, claim that visitors may damage their tubewells, create a lot of noise and make the tubewell platform dirty.

The present campaign of painting tubewells red or green in accordance with the results from arsenic analysis, the success of such an information campaign depends upon people believing that the screening method is valid and accurate (Ahmed *et al*, 2003). In truth several of the test kits presently used to determine arsenic content are under a cloud because of the high potential for operator error in field conditions (Pande *et al*. 2001; Rahman *et al*. 2002) and many villagers are not impressed by the ability of ‘experts’ to improve this or any other aspect of their lives.

Dug-wells

The BAMWSP has recommended using shallow, dug-wells as a non-chemical based short-term mitigation option in highly arsenic-contaminated areas. These are a traditional source of water that was abandoned in the 1970s, and it is reported that the water from such wells is arsenic-free and it does not contain harmful chemicals or bacteria (UNICEF, 2000). Chakraborti (2001) found one tubewell containing a highly toxic 1.390 mg/l level of arsenic, whereas a dug-well located 10 metres away had only <0.003 mg/l of arsenic. Problems arise with dug-wells during the dry months because, since the green revolution in the study area in the 1980s, extraction by machine-pumped deep tubewells for agricultural purposes has lowered the water table.

Local people in the study region confirmed that if water were available in dug-wells, they would use it to reduce the risk of arsenic poisoning. This mirrors the experience of Jakariya *et al*. (2003).

Rainwater harvesting

Rainwater harvesting is potentially an important source of arsenic-free drinking water. Both the BAMWSP and the UNICEF have recommended it as a viable strategy. It is a recognised and successful water technology in use in many developing countries, including China, Sri Lanka and Thailand. Properly stored rainwater is safe from bacteria, and can be kept for many months (WHO, 2000). Research by the International Centre for Diarrhoeal Disease Research in Bangladesh confirms that rainwater can be a safe drinking source (UNICEF, 2000).

This system has been used in coastal districts for years, and is now being introduced into arsenic-affected areas inland. People of the southern districts of Barisal division, for instance, store rainwater for drinking purposes (*The Daily Star (Dhaka)*: 17th June, 2001. The NGO forum, a national-level NGO, first started a rainwater harvesting plant in Patuakhali District in 1999 and now about 190 such plants have been set up.

The rainwater is collected using either impervious roofing material and guttering or a plastic sheet with the water being diverted to a storage container (WHO, 2000 and UNICEF, 2000). To minimize possible contamination from dirt and dust on the roof, the first few minutes of rainfall are allowed to run off before collecting the water. Since Bangladesh has a monsoon climate, people can preserve rainwater during the rainy season (June to September) for the dry months.

Some respondents were positive about the use of rainwater, but mentioned that they need technological help, while others rejected it because of financial constraints. It is worth reminding ourselves that even the cheapest options are beyond the pocket of poor people in the study area, who anyway live in huts with straw roofs.

Use of surface water: digging ponds or reservoirs

The Minister for Local Government, Rural Development and Cooperatives (LGRDC) in the Awami League Government promised in a

National Conference on 'Coordinated Action for Arsenic Mitigation Programme', which was co-organised by the Government of Bangladesh and UN Agencies on 27-28 February 1999, that the government would solve the arsenic problem within ten years by digging at least one pond in every *union* for arsenic-free drinking water in arsenic affected areas (*The Daily Star (Dhaka)*: 22nd September 1999). The field survey showed that local people were wary about such government policies. They thought the proposal to be untrustworthy and to have political 'spin'. They asked how the government could resolve the problem within ten years, when arsenic concentrations are increasing rapidly, and when many government-owned ponds, tanks, and canals are occupied illegally. They also commented that the ponds would need to be renovated annually or the banks would break during the rainy season and dirty water enter. Pond water is not pathogen-free and its use for drinking can lead to different types of water-borne diseases. At the moment ponds are used for washing cattle, bathing, and laundry.

Most people in the study area are not at all interested in using pond water; they prefer deep tubewells to any of the alternative mitigation options. In their view a deep tubewell is more economical to sink and maintain than digging and managing a pond. In one focus-group the participants estimated that 'to dig a medium-sized pond would cost TK75,000 ($1,200) and need more money each year for taking care of the pond. With such a budget it is possible to install 2-3 deep tubewells in Ghona.'

Use of deep tubewell water

People have come to know from many sources that arsenic-free safe drinking water is available from deep tubewells. They abandoned pond water about three decades ago and now they are fully dependent on tubewells. One respondent told us that:

> 'I came to know from some training that tubewells installed at a depth between 100-150 feet have high levels of arsenic but concentrations are very low in deep tubewells. I then started using deep tubewell from Ghona *Hatkhola* [periodic market] and other people from this area are doing the same. I do not use my own tubewell water and do not allow others to do so.'

It is true that the deep aquifer is much less contaminated than the shallow one. A hydrogeological study conducted by the British Geological Survey tested 280 tubewells deeper than 200 metres, and found only two contaminated with arsenic (BGS, 1999). The Department of Public Health Engineering (DPHE) has also tested many deep tubewells, and found only limited arsenic contamination (UNICEF, 2000). The use of deep tubewells has been suggested as a safe option in the face of arsenic contamination of groundwater in a report undertaken by the DPHE with financial assistance from the Japan International Cooperation Agency (*The Daily Star (Dhaka)*: 8th August 2001).

People in our study area assume that it is the responsibility of the government to help poor people and provide deep tubewells for arsenic-free and safe water. It was suggested, for instance, that a deep tubewell for every 40-50 households free of cost is needed. A similar conclusion was reached by Caldwell *et al.* (2003), who insist that identifying households at risk is another key task of government.

Despite their popularity amongst the people as a long-term solution, it may be that deep tubewells are not as safe as sometimes assumed. According to Mandal *et al* (1996), in 1990 the Indian Public Health Engineering Department installed deep tubewells to depths of 150 metres in Nadia, where the shallow aquifer was found to be arsenic contaminated. At the outset the water was arsenic-free but in the course of time all of these deep tubewells have become contaminated.

Boiling surface water

Boiled surface water is an important potential source of arsenic-free drinking water, but the field survey revealed worryingly that people assume that boiling tubewell water can remove the arsenic, whereas, in reality the risk is increased. Some respondents and participants showed a willingness to drink boiled water, but most people in Ghona are small farmers or agricultural labourers and they cannot afford firewood for the daily boiling of water.

Reflexive sedimentation

A very simple, traditional technique for arsenic mitigation is to '*pani basi kore khaoa*' which means 'to drink water after letting it settle overnight' (Alaerts *et al*, 2001). This 'reflexive sedimentation' involves the lower one-third of the water in a storage jar being discarded after settling for 12 hours (Jones, 2000). Arsenic concentrations are reduced in the top layers. However, in the study area almost all of the tubewells contain a remarkably high level of iron concentration and, if water is left overnight, it becomes viscous and yellowish and loses its original taste. So, unfortunately 'reflexive sedimentation' in this region yields tasteless and smelly water.

Low-cost technologies

There are several 'low-cost' technological options for removing arsenic from the groundwater. The five most promising technologies presently being evaluated by the BAMWSP are Alcan's enhanced activated alumina filter; the Bangladesh University of Engineering and Technology activated alumina filter; the Sono 3-kolshi method; Stevens Institute technology, where iron sulphate or iron chloride is added as a coagulator with an oxidising agent bleaching powder (Anwar, 2001); and the tetrahedron ion exchange resin filter (http://www.bamswp.org). 'Low-cost' they may be in western terms but to rural people in the study area they remain beyond reach, and even where subsidised there have been problems of the amount of time required by the people (usually women) attending to them and the need of regular maintenance (Hoque *et al*., 2004).

Piped water systems

Many towns and cities in Bangladesh have arsenic-free piped water systems. Satkhira Municipality has two water-lifting pumps, two overhead tanks and two water treatment plants to cover the whole municipality. Treated, piped water would be a suitable solution for inorganic arsenic poisoning, but the cost for this and the other affected areas of Bangladesh would be substantial. There is an issue as to whether treatment systems should use as their standard the arsenic concentrations allowed by the Bangladesh standard level (0.05 mg/l) or the much more stringent WHO permissible limit (0.01 mg/l). Satkhira Municipality's system was installed recently by Dutch Aid but we found that it is not fully arsenic-free, operating at slightly higher than the DoE standard (0.053 mg/l). Nor is it environmentally friendly, the highly toxic arsenic sludge being disposed in a nearby canal (*Pranshire Khal*) without any treatment.

For a piped-water supply system to reach the rural areas, planners need to keep in mind the clustered form of settlement in Bangladesh. To minimize costs, treated water could be stored in reservoirs at some point of optimum distance from users and then supplied through a piped-system to each settlement cluster or community for easy access from a standpipe. This option was the overwhelming preference of the respondents in a study by Hoque *et al*., (2004).

CONCLUDING REMARKS

The study has attempted to reveal people's perceptions about the applicability and suitability of the different mitigation options. During in-depth interviews and focus-group discussions, people said that they are unable to afford most mitigation options and they are not willing or able to buy water for their drinking and cooking purposes. Amongst the low-cost technologies, most are not affordable by poor people but another factor is the reluctance amongst the population generally to adopt unfamiliar innovations when they are so fully adapted to the tubewell culture. It is essential in this regard to increase awareness and influence people to try safe options, for instance to use pond water by either boiling it or purifying it with a filter until a sustainable mitigation option is accessible. In our opinion, the best basis for such outreach is, first of all, to listen to the people's voices about their present constraints, understandings and prejudices. A top-down information campaign might fail without such prior knowledge.

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