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The use of alternative safe water options to mitigate the arsenic problem in Bangladesh: community perspective

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April 2003

BRAC
Research and Evaluation Division
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PREFACE

Bangladesh is facing the problem of arsenic poisoning in drinking water. Around 27% of the tubewells, which supply drinking water to most of the population, have arsenic concentrations above the government of Bangladesh limit of 50 µg per litre. This means that a quarter of the country's population is exposed to arsenic poisoning which is alarming and unprecedented in history. BRAC has been active in the field of arsenic to develop a sustainable community-based mitigation programme since 1999. This study forms part of the BRAC arsenic mitigation activities in Sonargaon and Jhikargachha *upazilas* (sub-district). A number of safe and arsenic-free options were distributed among the communities of the two *upazilas*. The main objectives of the study was to identify factors responsible for accepting or rejecting different safe water options by the communities. An earlier version of this report was presented as thesis in partial fulfilment of an MPhil programme in Environment and Development at Cambridge University, UK.

I would like to thank BRAC for giving me the opportunity and financial support to complete the MPhil study at Cambridge University. I am especially grateful to Dr. A.M.R. Chowdhury, Visiting Professor, Heilbrunn Department of Population and Family Health, Columbia University, New York, former Director Research, BRAC, for his support in all respects and also for allowing me to carry out the research in BRAC-operated arsenic mitigation project areas. I would like to thank Dr. Bhaskar Vira, MPhil Course Director for helping me formulate ideas about the research project and for his valuable comments on my dissertation. I would also like to thank Dr. Steve Studgill for his suggestions about the research. At the same time I am much obliged to Professor Dara Shamsuddin, Chairman, Urban Planning Department, Jahangirnagar University, Savar, Dhaka, for his valuable comments and review of the initial draft of the report. I am also grateful to Mr. Mark Falzon and Mr. Ross Nickson for their comments and review of the report. I am grateful to Mr. Hasan Shareef Ahmed for editing and finalizing the report. I am particularly indebted to those rural people who allowed me to carry out the research on time and help me in all respects despite all their day-to-day difficulties. I am also grateful to Mr. Md. Showkat Gani of BRAC for statistical analysis. I am grateful to the four research assistants who helped me in carrying the household survey.

INTRODUCTION

While the extent of the water crisis is well known in areas such as the Middle East, there are many professionals who believe that freshwater quality will become the principal limiting factor for sustainable development in many countries early in this century (Ongley, 1999). "Everything living is created from water" is an ancient quotation, which closely describes the importance of water (anon., 1977). Humans have been concerned with water from the very beginning of their existence. Until the early 1970s, more than 100 million inhabitants of Bangladesh and neighbouring West Bengal drank from shallow hand-dug wells, rivers and ponds. But pollution was causing epidemics of diarrhoea, aemebiasis, polio, typhoid and other water-borne diseases. This persuaded aid agencies such as UNICEF and others to spend tens of millions of pounds sinking tubewells. Following this example, the rural people of Bangladesh later sank many more tubewells privately. The current number of tubewells is estimated between 3-5 million whereas it was only about 50,000 during the British colonial rule (UNICEF 1999). But the recent discovery of arsenic in groundwater has ruined this decade-long success and the access to safe drinking water has now dropped to almost 80% (UNICEF, 1999). Figure (map) shows the spread of arsenic pollution in Bangladesh. Therefore, it is very important that any environmental policy be developed according to proper scientific and socioeconomic foundations otherwise things may go wrong at a tremendous expense without achieving any gain (Trudgill, 1990).

BRAC, the largest non-governmental development organization in Bangladesh, is testing a community-based arsenic mitigation programme in two *upazilas* (Administrative unit, equivalent to sub-district) of Bangladesh. To mitigate the arsenic problem, a number of alternative safe water options are available in Bangladesh. Some of these options are based on surface water and some are based on treating the arsenic-contaminated water.

The availability of different alternative safe water options is very important not only to evaluate and select the best options for a particular community but also because of the physiocultural and socioeconomic variation among communities. At the same time national policy and the influence of interest groups on bureaucrats and policy makers play an important role in promoting certain mitigation options. Although political decisions and the decisions of interest groups play an important role in implementing particular measures, in the long run sociocultural factors and community interests play the dominant role in sustainable implementation of some new ideas or the acceptance of something new by the community. It

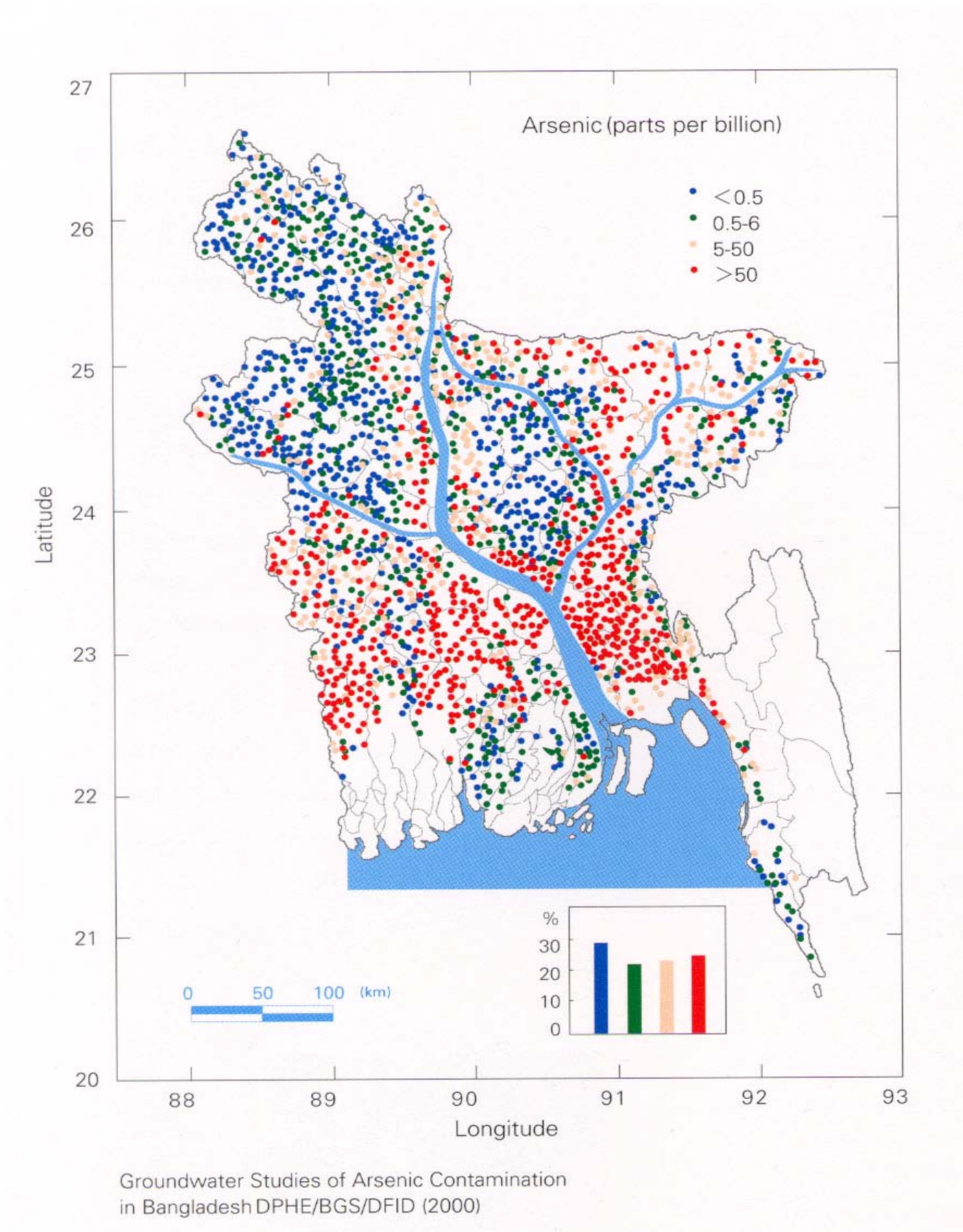

Figure 1. Arsenic contaminated areas in Bangladesh

has been observed that problems and prospects of communities depend on the communities' perception of particular subjects which in turn depends on information and knowledge, technology, socioeconomic and cultural characteristics, severity of problems, and exposure to the outside world.

In the study areas it has been observed that the percentage of acceptance of different alternative safe water options was not only unsatisfactory but also varied greatly among the communities. In one area, the community was very much concerned about getting water from alternative safe water options but in another area, people were reluctant on getting water from arsenic-free sources. It was observed that community is not only heterogeneous on a regional scale but also on a small-scale concentration of people. This heterogeneous characteristic of communities along with some other local factors made the response pattern different and the acceptance of different alternative safe water options by the communities low. Therefore, the main intention of this study was to find the factors responsible for different response patterns of communities regarding the alternative safe water options provided. This was focussed on to develop a sustainable implementation policy for alternative safe water options in other parts of the arsenic-affected areas of Bangladesh.

BACKGROUND OF THE ARSENIC PROBLEM

Bangladesh faces multi-faceted problems in relation to groundwater. At present there is a new threat - arsenic contamination in groundwater. Arsenic is a shiny, grey, brittle element possessing both metallic and non-metallic properties (Train, 1979). Arsenic compounds are ubiquitous in nature, insoluble in water, and occur mostly as arsenides and arsenopyrites. Arsenic exists in the trivalent and pentavalent states in nature and its compounds may be either organic or inorganic. Trivalent inorganic arsenicals are more toxic than the pentavalent forms both to mammals and aquatic species. Though most forms of arsenic are toxic to humans, arsenicals have been used in the medical treatment of spirochaetal infections, blood dyscrasias, and dermatitis (Merck Index, 1968).

Humans are exposed to arsenic mainly through ingestion and inhalation. The World Health Organization (WHO) has recently revised its original guideline value for arsenic in drinking water of 0.05mg/l (WHO, 1984) to a provisional guideline value of 0.01 mg/l (WHO, 1993). The Bangladesh government level is 0.05 mg/l (DoE, 1997). Water with high level of arsenic leads to health problems such as melanosis, leuko-melanosis, hyperkeratosis, black foot disease, cardiovascular disease, hepatomegaly, neuropathy, and cancer (Khan and Ahmad 1997). Arsenic tends not to accumulate in the body but is excreted naturally. If ingested more than it can be excreted, arsenic accumulates in the hair and fingernails (Khan, 1997). The toxicity of arsenic depends on the chemical and physical forms of the compound, the route by which it enters the body, the dose and the duration of exposure, dietary compositions of interacting elements and the age and sex of the exposed individuals.

As regards manifestation in human body, the symptoms of arsenic toxicity may take several months to several years. This period differs from person to person, depending on the quantity and volume of arsenic ingested, nutritional status of the person, immunity level of the individual and the total time of arsenic ingestion (DCH, 1997). Malnutrition and poor socioeconomic conditions aggravate the hazards of arsenic toxicity. Although arsenicosis is not an infectious, contagious or hereditary disease, arsenic toxicity creates social problems for the victims and their families (Khan and Ahmad, 1997).

There is a need to know more about the impact of arsenic poisoning on human health. For instance, there is no clear understanding of why some members of a family or community are affected, while others in the same family or community who are subject to the same contamination are not.

Early symptoms of arsenic poisoning can range from the development of dark spots on the skin to a hardening of the skin into nodules - often on the palms and soles. The WHO estimates that these symptoms can take 5 to 10 years of constant exposure to arsenic to develop (DCH, 1997). Over time, these symptoms can become more pronounced and in some cases, internal organs including the liver, kidneys, and lungs can be affected. In the most severe of cases, cancer can develop in the skin and internal organs, and limbs can be affected by gangrene. While evidence exists the link of arsenic to cancer, it is difficult to say how much exposure and for what extent will result in this disease.

The source of arsenic in drinking water is geological. Arsenic occurs naturally in the sediments of Bangladesh bound to amorphous iron oxyhydroxide. Due to the strongly reducing nature of groundwater in Bangladesh, this compound tends to break down and release arsenic into the groundwater (Nickson et al., 1998). Although arsenic occurs in alluvial sediments, its ultimate origin must be the outcrops of hard rocks higher up the Ganges catchment that were eroded in the recent geological past and then re-deposited in West Bengal and Bangladesh by the ancient courses of the Ganges. At present, these source rocks have not been identified. It is also important to understand that arsenic does not occur at all depths in the alluvial sediments. Although there is not enough evidence to draw firm conclusions, it appears that high concentrations of arsenic are restricted mainly to the shallow aquifer (less than 50 meters deep) (DPHE/BGS/DFID, 2000).

However, there are lots of controversies over the origin of arsenic in the groundwater. Indiscriminate use of agro-chemicals in the agricultural field for higher rice production and excessive use of groundwater for irrigation i.e. oxidation process, are also some of the alternative hypotheses for the release of arsenic in groundwater. Therefore, to implement different mitigation options it is important to find out the exact cause of arsenic contamination of groundwater.

A STRATEGY TO MITIGATE THE ARSENIC PROBLEM

Following is a diagrammatic representation of a strategy to mitigate the impact of the arsenic problem of Bangladesh:

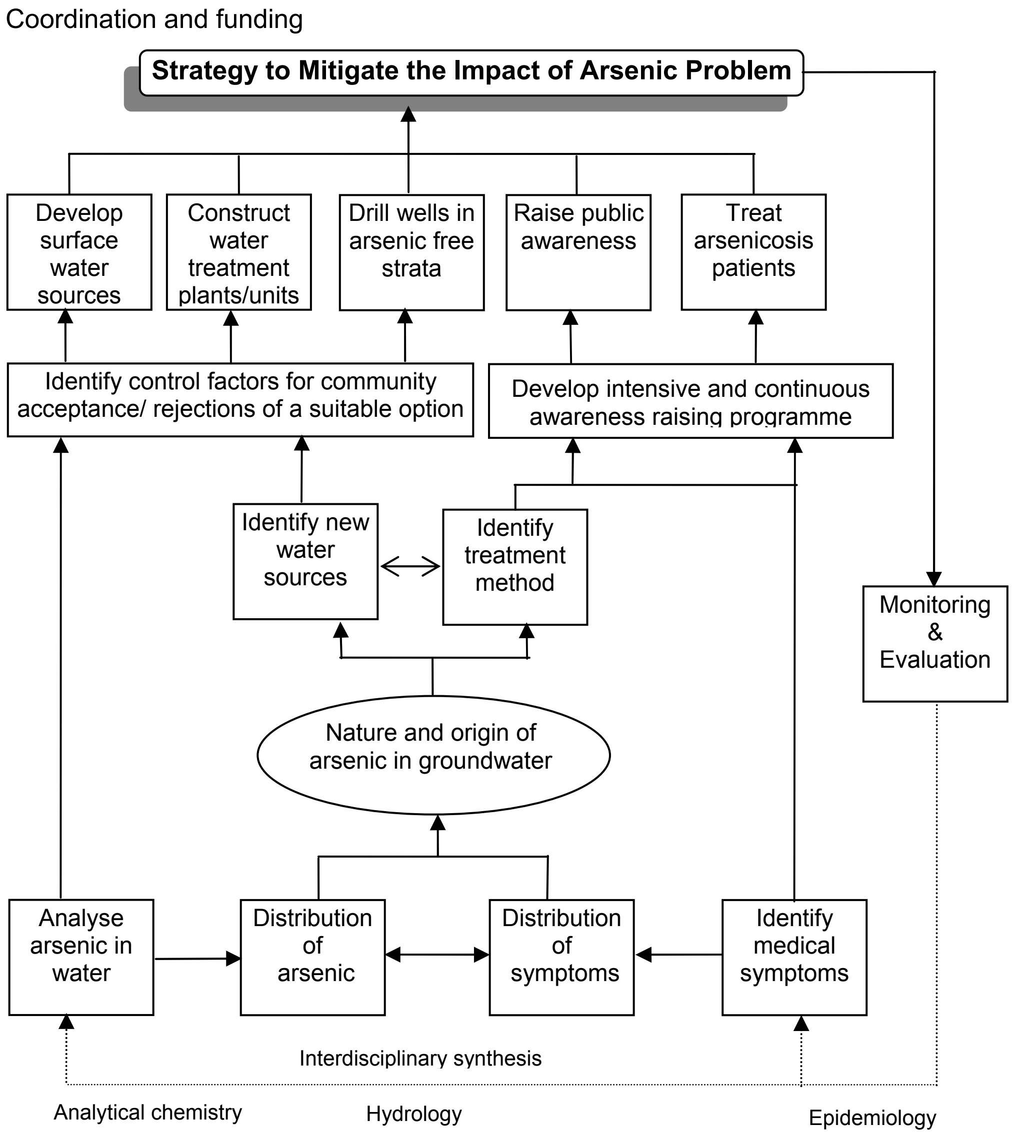

Figure 2. Diagrammatic view to mitigate the arsenic problem (modified from BEN, 1997)

It is to be observed from the above diagram that the whole arsenic scenario in Bangladesh can be divided into the following major categories:

- **Coordination and funding**

This is one of the most important components. Coordination is needed among different stakeholders not only to avoid repetition of activities but also to find a mitigation package that is acceptable to the community. Above all, funding is crucial in carrying out different arsenic-related activities and research.

- **Hydrology**

This is also an important component. Until and unless the exact causes of arsenic contamination in groundwater are identified it would be difficult to develop a standard community-acceptable mitigation package.

- **Analytical chemistry**

It is important to develop a system of arsenic detection in tubewell water that the community can operate themselves; this would minimise the expenses incurred in testing by outside experts.

- **Water supply and engineering**

Safe drinking water has to be community-acceptable and affordable. At the same time it is also important to make different types of mitigation options available for different types of communities and for different physiographic conditions. Therefore, the involvement of community in the selection, implementation, operation and maintenance of a system is crucial.

- **Epidemiology or public health**

Drinking arsenic-free water is currently the only way of preventing the diseases. Therefore, it is important to develop a strong awareness programme to motivate rural people to drink arsenic-free water. Further research is needed to develop proper treatment of arsenic-related diseases.

- **Monitoring and evaluation**

Continuous monitoring of the presence of arsenic in tubewell water is essential. Arsenic level varies seasonally, therefore the tubewells need frequent checking. Monitoring of the performance of the provided options is also important. It will be both cost-effective and convenient if communities are trained to carry out these activities themselves.

It has been observed from the above discussion that except for the geological investigation of the causes of arsenic contamination, the active presence of the community in all other activities is crucial for the sustainable implementation of the arsenic mitigation activities in the rural areas of Bangladesh.

Since almost all the alternative safe water options provided are new both to the experts and the community, proper consultation and community cooperation are pre-requisites for the establishment of a safe water implementation plan. The importance of identifying different factors for community participation in the various alternative safe water options can be observed from Figure 2. The community needs to be consulted through different phases of the project implementation, i.e. from the selection of options to the monitoring and evaluation of a particular option.

OBJECTIVES

Different communities have addressed the problem of arsenic contamination in different ways. The study aimed to identify the causes for different response patterns among people in the two study villages to understand the difference in community response patterns.

MATERIALS AND METHODS

Study area

This study was conducted in the areas where BRAC has been working to mitigate the arsenic problem for more than a year and has already completed the testing of tubewells and the awareness level of the people. BRAC distributed different safe water options among the community as free demonstration units. These free options were located and distributed among people selected by the community itself. A limited number of options were distributed in each village, the intention being to motivate and raise the awareness of the villagers about the provided options. Since the number of provided options in any one village was very low, perceptions of villagers about these options were collected from different parts of the respective *upazilas*. The villages were selected purposely to meet the criteria of the research project and for easy access in carrying out project activities with limited time and resources.

Focus group discussions (FGD) and household survey methods were used to generate ideas and identify the factors responsible for people's accepting or rejecting the provided safe water options, as well as the community's perception of the provided options.

General characteristics of the study area

It has been observed during reconnaissance visits that the two study villages (Fig. 3 and 4) have some distinct characteristics. These differences are presented in Table 1.

General description of the two *upazilas*

The arsenic problem at a glance in the two *upazilas* where the study villages were located

The whole of Jhikargachha *upazila* and most of the south of Sonargaon *upazila* is underlain by Holocene-Recent fluvial (river) sediments (GSB, 1990). However, there is a marked difference in the relative number of red wells. On average, in Jhikargachha the percentage of red wells was 48% while in Sonargaon it was 80% (BRAC, 1999) (Fig. 5).

Such variation in the contamination of groundwater of Sonargaon and Jhikargachha may be explained by considering the geomorphology and geology of the two areas (Fig. 6). Jhikargachha is rarely flooded and is geomorphologically more stable than Sonargaon which is mainly underlain by the active Meghna floodplain. It is likely that Jhikargachha is underlain by the full range of fluvial sediments (gravels, sands, silts, and clays) related to different relict features of fluvial systems such as in-filled oxbow lakes, floodplain, meander belts, levees, etc. In contrast, the sediments underlying the southern part of Sonargaon are more likely to be dominated by the finer grain sizes (silts and clays) which are associated with floodplains. As finer grained sediments (silts and clays) are more likely to contain arsenic (Mok and Wai, 1994) this geomorphological variation between the two *upazilas* may explain why more arsenic-contaminated tubewells are found in Sonargaon than in Jhikargachha (BRAC, 2000).

Figure 3. Bhagolpur Village

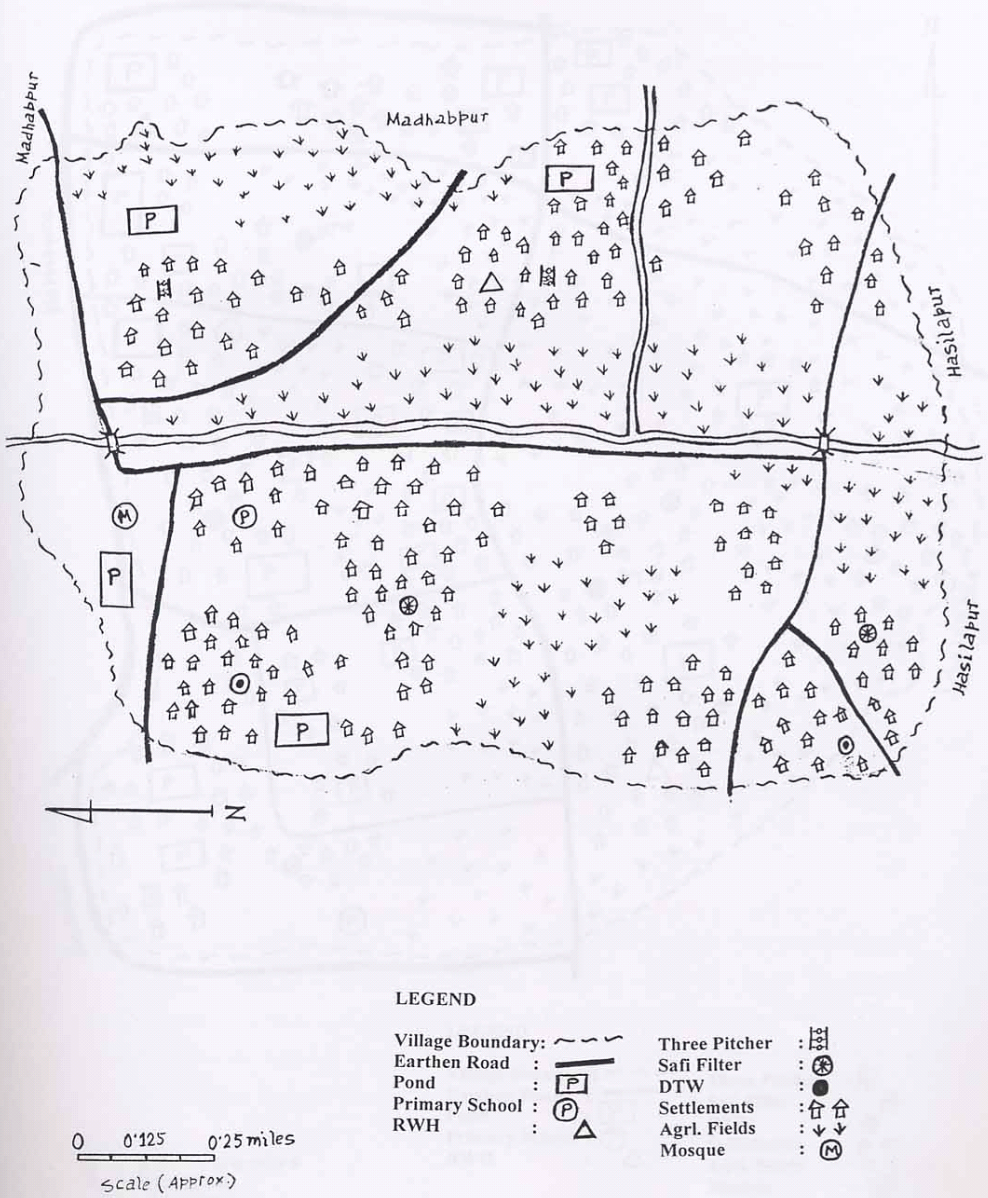

Figure 4. Kamarpara Village

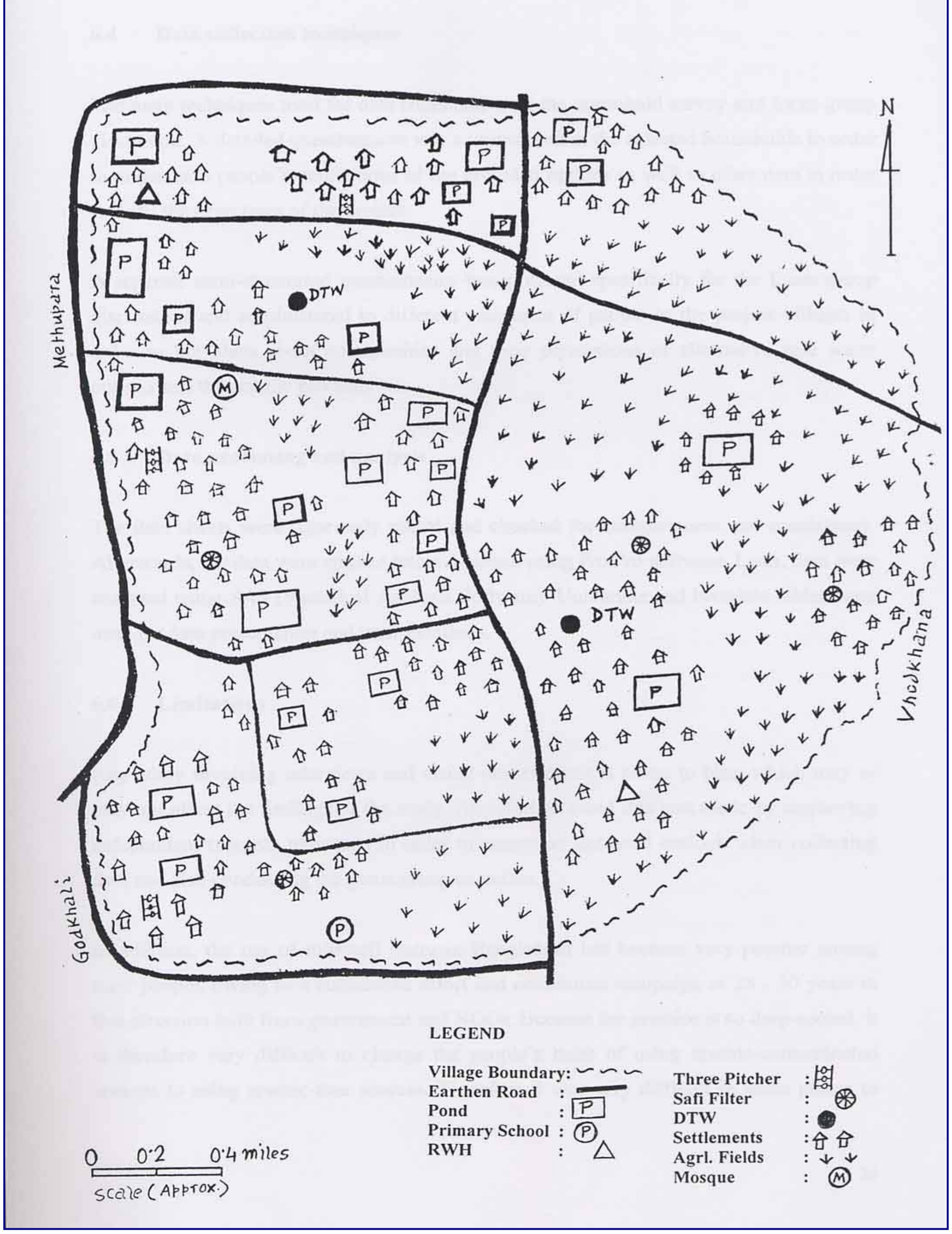

Table 1. Differences between the study villages

Bhagolpur (B) village: Sonargaon	Kamarpara (K) village: Jhikargachha
1. This *upazila* is very close to the capital of Bangladesh (20 km).	1. This *upazila* is far away from the capital city (350 km).
2. Average economic condition of the people of this village is relatively rich.	2. Average economic condition of the people of the village is relatively poor.
3. Culture of the people is mostly town oriented.	3. Culture of the people is mostly village oriented.
4. Professions of people are mostly business-oriented.	4. Professions of people are mostly agriculture-oriented.
5. Households are mostly individual- and family-oriented.	5. Households are mostly collective- and community-oriented.
6. Acceptance of any new technology or idea is very difficult; i.e. community people are not very responsive to motivation from outside the village mainly because of their exposure to the outside world.	6. Acceptance of any new technology or idea is less difficult; i.e. people are more open-minded.
7. Literacy rate is comparatively high.	7. Literacy rate is comparatively low.

Source: Field observations

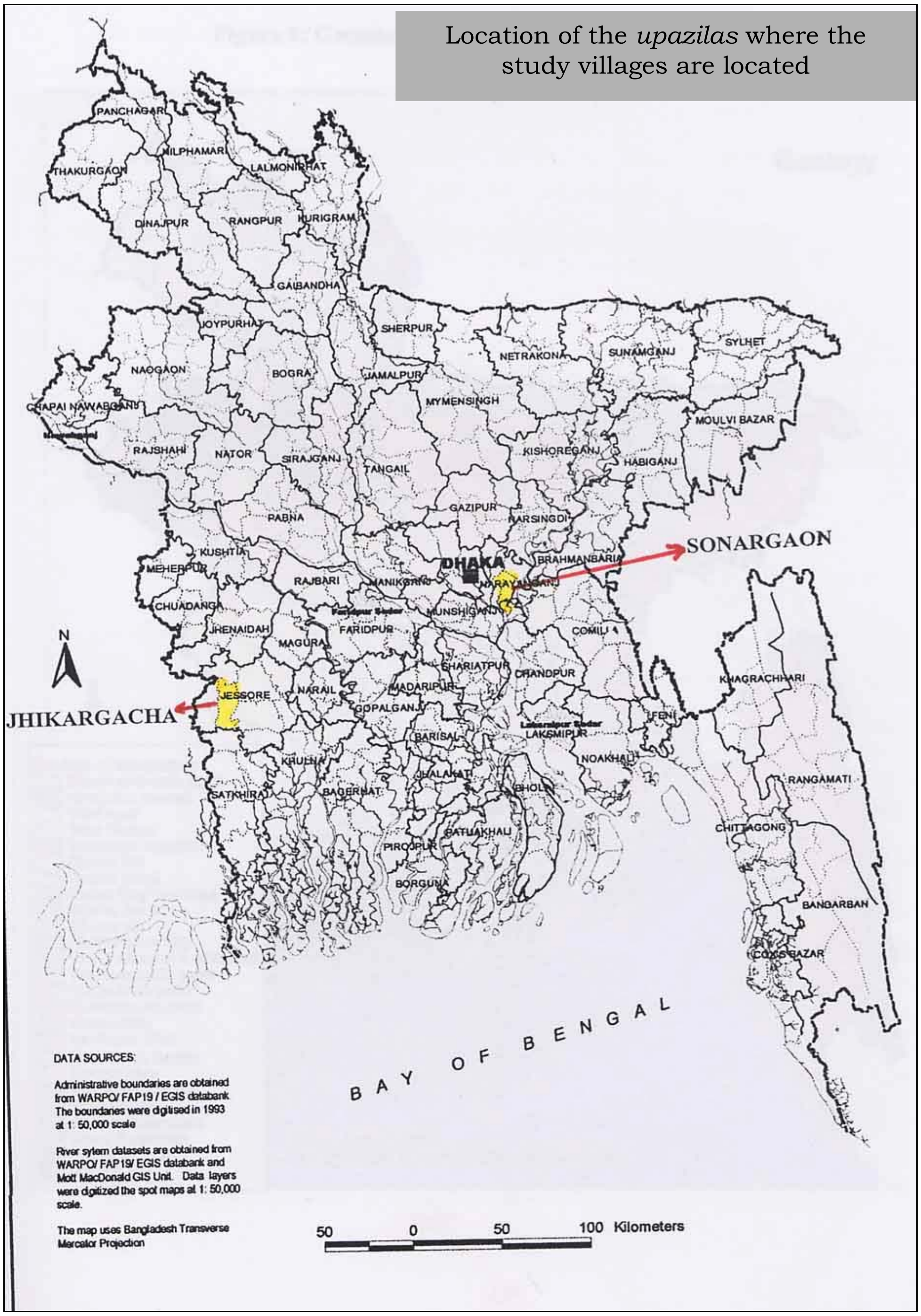

Figure 5. Location of the *upazilas* where the study villages are located

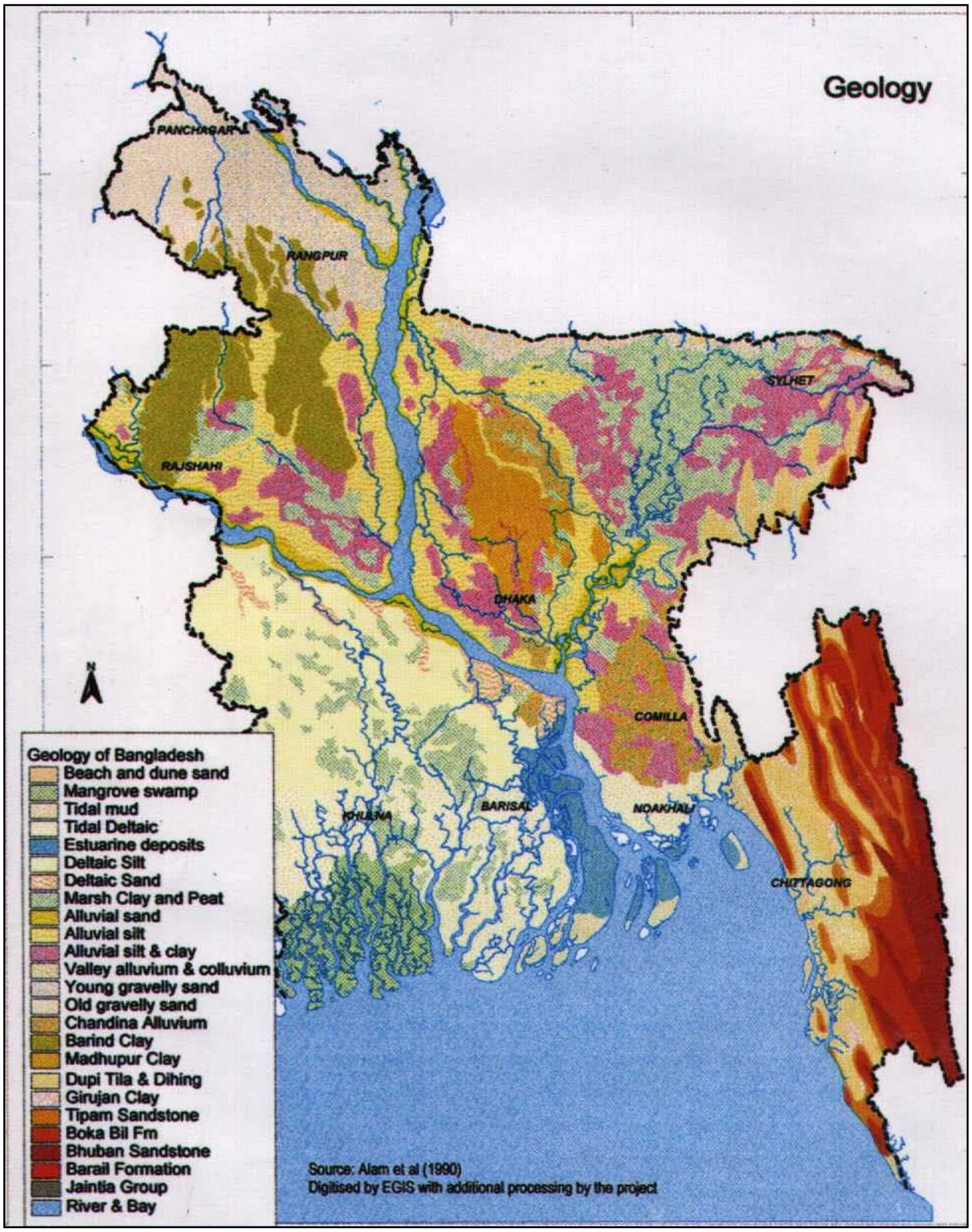

Figure 6. Geomorphology and geology of Bangladesh

Sample size and sampling techniques

BRAC has been conducting a community-based arsenic mitigation project in two *upazilas,* Sonargaon and Jhikargachha. Because of time constraints two villages were selected from BRAC-operated areas specifically to meet the objectives of the project. Bhagolpur village in Sonargaon *upazila* and Kamarpara village in Jhikargachha *upazila* were selected for household survey type analysis. In Bhagolpur the number of households was small (51) and therefore in this village a 100% household survey was conducted. In Kamarpara, one in every three households was selected for the household survey to keep the household number in the two *upazilas* consistent. Two field researchers were trained in each *upazila* to conduct the household survey and carry out the FGDs. Several FGDs were held in each location with different categories of people.

Data collection techniques

Since the study was implemented in a BRAC operated area, testing of water of all the tubewells of the two villages was completed well ahead by BRAC filed testers before starting this study.

Two Research Assistants were given two-day training on filling up the questionnaires and on conducting FGDs. A total of 5% of the households were re-interviewed to check the quality of the collected data.

The main techniques used for data collection were the household survey and FGDs. A detailed questionnaire was administered in the selected households to understand people's perceptions of the options provided as well as other data to fulfil the objectives of the study.

A separate semi-structured questionnaire was prepared specifically for the FGDs and administered to different categories of people in the study villages. This aimed to collect ideas from communities to get more detailed perceptions of alternative safe water options and the arsenic problem.

Data processing and analysis

The data sheets were rigorously edited and checked for completeness and consistency. Afterwards, the data were entered into a database using FoxPro software. Later, the data were analysed using SAS (Statistical Analysis Software). Univariate and bivariate tables were used for data presentation and interpretations.

Limitations

Any study involving interviews and visual observations is prone to bias, which may or may not affect the findings of the study. An effort to avoid this was made by employing independent research assistants who were not involved in the on going arsenic mitigation activities of BRAC just to ensure an unbiased outlook when collecting data and also conducting the focus group exercises. Apart from that 5% of the total households were re-visited with the same questionnaire by another research assistant in order to assess the quality of the collected data.

The use of tubewell water in Bangladesh has become very popular among rural people. It has been due to a cumulative effort and continuous campaigns for 25-30 years in that direction, both from the government and NGOs. Because the practice has become so deep-rooted, it is very difficult to change people's habit of using arsenic-contaminated sources to using arsenic-free alternative sources. Therefore, it was very difficult in some places to obtain villagers' positive feedback to alternative safe water options. Due to time constraints and the monsoon season it was also not possible to obtain a larger sample size than the present one and therefore the study findings can be generalized without incorporating local conditions to replicate in other parts of the country.

RESULTS AND DISCUSSION

Arsenic problem in the study villages

Villagers were asked whether they considered arsenic in tubewell water as a problem or not. Although majority of the respondents from both the villages recognized arsenic as a problem, the nature of perceiving arsenic as a problem varied significantly ($p<0.01$). As such, the type of expectation to solve the problem and other variables selected for the study were not similar (Table 2). The variables selected for this study were age, education, occupation, knowledge about arsenic and safe water options, and presence of arsenic patients. These are described in the following section. Although the percentage of arsenic concentration in the tubewell water of the two villages was almost the same, there were significant differences observed among all other variables.

Table 2. Arsenic in tubewell water perceived as a problem

Arsenic in tubewell water perceived as a problem	No. of respondents	
	Bhagolpur	Kamarpara
Yes	43 (90)	53 (96)
No	8 (10)	3 (4)
Total	51 (100)	56 (100)

The figures within parentheses indicate percentage
Significant at 1% level[1]

Arsenic problem in tubewell water perceived by age group

The mean age of respondents was 36 in Bhagolpur and 34 in Kamarpara. It was observed that pertaining to a certain age group played a key role in the type of answer to the problem in the two villages studied.

[1] **d = 2.96, ($p <.01$)**

Table 3. Arsenic problem by age group

Parameters	Age group							
	10-20		20-30		30-50		50+	
	B	K	B	K	B	K	B	K
Problem	13 (100)	20 (100)	18 (100)	20 (100)	9 (82)	12 (100)	3 (33)	1 (25)
No problem	0	0	0	0	2 (18)		6 (67)	3 (75)
Total	13	20	18	20	11	12	9	4

B = Bhagolpur, K = Kamarpara
The figures within parentheses indicate percentage

Table 3 shows that arsenic was considered to be a problem by the young and middle-aged group in both the villages although there are marked differences between the two villages with regard to perception and views of the problem. In both the villages, older people did not consider it to be a problem. They had been drinking water from the present sources for about 25-30 years without perceiving any difficulties and they think there will be no problem in the near future. Some of them also mentioned that this type of arsenic mitigation programme might be a ploy by the manufacturer of pipes as they knew from the information provided that the deeper aquifer might be free from arsenic.

Arsenic problem in the study villages by level of education

Level of education was also an important indicator - not in terms of accepting or rejecting the provided alternative safe water options, but with regards to recognizing arsenic as a problem. In this regard there was no major difference observed between the villages studied. Table 4 also shows that the level of education was higher in Bhagolpur village of Sonargaon *upazila*. In Bhagolpur 56% of the illiterate villagers do not consider arsenic in water as a problem whereas in Kamarpara this number is 10%. Here it is mentioned that although the number of people still drinking arsenic contaminated water was higher in both the literate and illiterate categories, the general perception that arsenic is a problem was lower among the illiterate categories.

Table 4. Arsenic in tubewell water perceived as a problem by level of education

Parameters	Illiterate		Literate	
	Bhagolpur	Kamarpara	Bhagolpur	Kamarpara
Yes	5 (44)	16 (89)	38 (90)	38 (100)
No	5 (56)	3 (11)	3 (10)	-

The figures within parentheses indicate percentage

It was observed that the nature of the response in the two villages was also different. In Bhagolpur, the majority of the respondents did not consider arsenic as a problem because they did not see any patients in their village.

Arsenic problem in the study villages by level of occupation

A clear difference was observed in the occupational profile of the two villages studied. In Bhagolpur, which is close to Dhaka and another port-city Narayanganj, the primary occupation of 82% of the respondents was in business, whereas in Kamarpara 70% of the respondents was in agriculture (Table 5). Occupation was a factor in the differing perception of people regarding arsenic and the options provided. For instance at the initial stage the people of Bhagolpur did not welcome the arsenic mitigation activities; they tried to hinder the functioning of some of the community-based options. At the initial stages it was found that people of this village even thought that the project got money either from government or from the donor so we are bound to construct the options whether these were useful or not. Later though, this attitude of the villagers changed, perhaps due to their more open-minded approach itself owing to their occupation and comparatively strong economic background. Further study, however, is needed to understand these relationships.

Table 5. Main occupation of respondents

Main occupation	No. of respondents	
	Bhagolpur	Kamarpara
Business	42 (82)	7 (12)
Agriculture	-	39 (70)
Van puller	-	2 (4)
Service	7 (14)	-
Student	2 (4)	8 (14)
Total	51 (100)	56 (100)

The figures within parentheses indicate percentage

The business-oriented people of Bhagolpur were reluctant to spend much time away from their business activities; at the same time they did not have as much leisure-time as the people in the other village. Respondents in Bhagolpur also mentioned that they have a lesser degree of community-cohesion and unlike the people of other villages they do not like to seek help from other members of the community. Instead, they talk to or seek help from relatives and other family members in case of emergencies. This was a factor effecting the different response pattern of this village from that of Kamarpara.

Main problems encountered by the respondents

Respondents of individual households were asked about the main problems of their locality. Although the majority of the respondents in both the study villages considered arsenic to be the severe problem, the percentage and the subsequent problems mentioned by the respondents were not similar (Table 6).

Table 6. Main problems encountered by the respondents

Main problem of the area	No. of respondents	
	Bhagolpur	Kamarpara
Arsenic	30 (59)	45 (80)
Sanitation	5 (10)	4 (7)
Financial problem	10 (20)	7 (13)
Jobless	6 (11)	-
Total	51 (100)	56 (100)

The figures within parentheses indicate percentage
Significant at 2% level[2]

In Bhagolpur 59% of the respondents mentioned arsenic as their major problem, followed by financial problems (20%) related to their business capital. The majority of the respondents were businessmen. Ten percent of the respondents mentioned sanitation, they meant a central sewage system like urban areas. In Kamarpara village the majority of the respondents (80%) mentioned arsenic as their principal problem, followed by financial problems.

The response pattern of the two villages varied significantly ($p<0.02$) when the arsenic problem was compared with other problems.

Monthly expenditure of the respondents

The average monthly expenditure of the respondents is higher in Bhagolpur, which indicates the better economic condition of the respondents of this village (Table 7).

An attempt was made to understand the relationship between the level of monthly income of the respondents and the arsenic problem (Table 8).

[2] d-test: d = 2.326 at 2% level ($p<.02$)

Table 7. Monthly expenditure of the respondents

Monthly expenditure (Taka)	No. of respondents	
	Bhagolpur	Kamarpara
Up to 1500	2 (4)	6 (11)
1501-3000	8 (16)	23 (41)
3001-5000	30 (59)	24 (43)
5001+	11 (21)	3 (5)
Total	51 (100)	56 (100)
Mean expenditure	3,990	2,938

The figures within parentheses indicate percentage

Table 8. Arsenic problem verses monthly expenditure

Parameters	≤ 3000 Taka		> 3000 Taka		Total	
	B	K	B	K	B	K
Arsenic is a problem	6	28	37	25	43	53
Arsenic is not a problem	7	2	1	1	8	3
Total	13	30	38	26	51	56

B = Bhagolpur, K = Kamarpara

The Table shows that there are more cells, which have frequencies less than 5, therefore the chi-square test is not possible in this case. But this relationship can be established in another way.

The proportion of inhabitants of Bhagolpur who identified arsenic as a problem was nearly 6/13=0.46 among those with a monthly income of up to Tk. 3,000; the proportion for the inhabitants who had monthly income of more than Tk. 3,000 was 37/38=0.973. On the other hand, the proportion of inhabitants of Kamarpara who identified arsenic as a problem was nearly 28/30=0.93 for those with a monthly expenditure of up to Tk. 3,000, and the proportion for the inhabitants who had a monthly income of more than Tk. 3,000 was 25/26=0.96. So, without performing a statistical test it can be said by observing the proportions that the difference is probably not significant.

Therefore, it can be said that in Kamarpara where a large number of arsenic patients were identified, irrespective of their income, the respondents perceived arsenic as a severe problem. On the other hand, this difference is significant in the case of Bhagolpur where there were no arsenic patient identified.

Knowledge about arsenic and alternative safe water options of the respondents

To assess the knowledge of respondents about arsenic, different questions were asked. When asked about the source of arsenic-related information the majority of the respondents in both the study villages mentioned BRAC, the NGO that first started working on arsenic-related issues in these two areas. This high percentage indicates that although radio and television were continuously broadcasting messages on arsenic long before BRAC's activities, physical appearance and personal contact rather than a distant motivation play an important role. In Bhagolpur, although 78% of the respondents had television they mentioned the name of BRAC first – the organization had personally told everyone in this village about arsenic and its related hazards and also about safe water sources (Table 9).

In replying to the question of whether arsenic is a contagious and/or a hereditary disease, all the respondents in Kamarpara answered correctly while in Bhagolpur, where there was no arsenic patients, 22% did not. It may be mentioned here that in Kamarpara, villagers at first considered it to be a contagious disease and those affected with this disease were kept aside from the rest of the village community; they were not even allowed to bathe in the same pond as the other villagers did. Apart from that, the incidence of divorce amongst the arsenic-affected women and a lot of other social problems were also prominent in the villages. However, these problems no longer existed in the village once the villagers understood the facts.

Table 9. Knowledge about arsenic and alternative safe water options

Knowledge about safe water options	No. of respondents	
	Bhagolpur	Kamarpara
Know about the options	44 (86)	56 (100)
Do not know	7 (14)	-
Total	51 (100)	56 (100)
Arsenic is a contagious and hereditary disease	Bhagolpur	Kamarpara
Yes	11 (22)	2 (4)
No	40 (78)	54 (96)
Total	51 (100)	56 (100)
Radio/TV ownership	No. of households	
	Bhagolpur	Kamarpara
Radio	43 (84)	21 (38)
Television (TV)	40 (78)	14 (25)

The figures within parentheses indicate percentage

In Kamarpara, all the respondents were informed or at least had some idea about the alternative safe water options, which was either provided by

BRAC or by the government i.e., DPHE. On the other hand, in Bhagolpur village, 14% of the villagers did not have any idea about alternative safe water options although they were informed about the problem of the presence of arsenic in tubewell water. At the same time 86% of the respondents knew about alternative safe water options but the majority of them were not found eager to get or use the existing alternative safe water options.

Arsenic testing and arsenic related information

All the respondents from both the villages mentioned that their tubewell or the sources from where they got drinking water were tested by BRAC. Initially in Bhagolpur all the tubewells but one were found to be contaminated with arsenic at levels higher than the safe standard for arsenic in Bangladesh; in Kamarpara only 9% of the tested tubewells were safe.

In Bhagolpur, two villagers sunk their tubewells deeper (300ft) with the help of local tubewell masons and got arsenic-free water. Several others followed them, but they failed to get arsenic-free water from the same depth. This indicates the irregular distribution of arsenic in the groundwater and made the villagers frustrated with their 'innovation'. People of this village were found eager to sink their tubewells deeper and were asking for expert opinion about this measure. In Kamarpara, the government provided two deep tubewells of the five safe tubewells of this village. It was observed during field visits that people of this village were interested in drawing deep tubewell water and that is why a long queue of village women was observed daily in front of the deep tubewells to fetch water.

An attempt was made to understand how many people were still using arsenic-contaminated water and to find out the reasons why they were doing so.

Table 10. Arsenic testing and related information

Arsenic test results	No. of respondents	
	Bhagolpur	Kamarpara
Arsenic-contaminated	49 (96)	51 (91)
Not contaminated	2 (4)	5 (9)
Total	51 (100)	56 (100)
Arsenic-contaminated water for drinking and cooking purposes	No. of respondents	
	Bhagolpur	Kamarpara
Still using	41 (80)	8 (14)
Not using	10 (20)	48 (86)
Total	51 (100)	56 (100)

The figures within parentheses indicate percentage

In Bhagolpur 80% of the respondents mentioned that they were still drinking arsenic-contaminated water although they were well-informed about the effects of arsenic poisoning, whereas in Kamarpara only 14% of the respondents were still drinking arsenic-contaminated water (Table 10). Villagers of Kamarpara mentioned that just after the testing of tubewell water and when alternative options were provided to them and particularly when the government provided deep tubewells, all the villagers used to take water from these safe sources. As time passed without the disease spreading or any other problems, some people - particularly those who were living away from the safe water sources - started drinking from their red tubewells. As the villagers mentioned, this percentage may increase if there are no further difficulties or problems of arsenic poisoning i.e. further spread of the disease.

An effort was made to find out the reasons why some of the respondents were still using arsenic-contaminated water.

Table 11. Reasons for using arsenic-contaminated water by the respondents.

Reasons			
Bhagolpur	No. of house-holds	Kamarpara	No. of house-holds
1. No arsenic free water/option available	11 (27)	1. Arsenic free option/well not available	2 (25)
2. Drinking for generations without having problems	17 (42)	2. Poor can not make arrangement for arsenic free water	2 (25)
3. No alternative better sources	7 (17)	3. Alternative sources are far away and also are not thought to be necessary for arsenic free water	3 (38)
4. Neighbours feel disturbed	3 (7)	4. Do not like provided options	1 (12)
Total respondents	41 (80)	Total respondents	8 (14)

The figures within parentheses indicate percentage

Table 11 shows that there are variations in the response patterns of the two villages. In Bhagolpur, the results clearly indicate that the people of this village were more reluctant to deal with the problem. Their expectations for better options not only implied their disliking of the existing alternative safe water sources but also reflected their comparatively better economic condition.

It was observed in Bhagolpur that without having any practical difficulties from drinking arsenic contaminated water for long time - that is without any arsenicosis patients in the village - people were not willing to accept that this might create any problem in the long run. They were also aware of the long incubation period of this disease and that their better nutritional status helped prevent it; this made villagers reluctant to use arsenic-free water. Instead, people of this village mentioned that the advocating of safe water options may be a ploy intended to make money through selling the options. Some of them also mentioned that if there were really an arsenic problem in the water, some medicine would likely be available in future. On the other hand, in Kamarpara very few people who are living far away from the deep tubewells and who do not have any extra hands in the houses to collect water from a distant place were still drinking water from the arsenic contaminated tubewells. A few aged people of this village who thought that the disease might not spread in new areas since it did not do so for the last several years were also drinking contaminated water. Although villagers of this category also mentioned that when they found favourable situations in the house, they try to collect water from the deep tubewells (that is from the arsenic-free source).

As regards the options, the majority of the respondents of this village mentioned further sinking of the existing tubewells as one of the better option to alleviate the arsenic problem. On the other hand, villagers of Kamarpara mentioned deep tubewells as the best option. They were also hopeful of getting more deep tubewells from the government.

Arsenicosis patients: correlations

Of the 40 arsenic-affected patients identified in Kamarpara by BRAC, the household survey covered only 15 households that included such patients. All the arsenic-affected patients concentrated in two residential clusters in the village. People of the two clusters were not affected with the arsenicosis disease at the same time. There was a belief among villagers that the people who were affected later (i.e. affected people from the second cluster) used to criticise and socially avoid the arsenic-affected patients of the first cluster from the same village. They did not even want to allow the arsenic patients to use their ponds for bathing, washing, and other purposes. For this reason, the rest of the villagers still believe that some people from the second cluster are affected with the same disease. There was not much difference observed between the two groups of people in terms of average income, source of arsenic-contaminated drinking water (but the exact concentration of arsenic was not checked), average duration of exposure, etc. An in-depth investigation is needed to find out the reasons behind this.

Table 12. Number of arsenic-affected patients in the study villages

Monthly income	No. of patients	No. of total respondents
1000-1500	4 (27)	6 (11)
1501-3000	10 (67)	23 (41)
3001-5000	1 (7)	24 (43)
5001+	-	3 (5)
Total	15 (100)	56 (100)

The figures within parentheses indicate percentage

When the relations between household income and the number of arsenic-affected patients in the households is analysed, it results that there are clearly very few patients in high income households - the number of patients decreases as household income increases. From Table 12 it is also observed that not all the low-income households were affected with the disease. Therefore, the relation between household income and the number of patients is not linear. In any case, however, no patient was observed in the high-income categories, which indicates a relation with the nutritional condition of the exposed population. A number of studies confirm this relation (DCH, SOES, 1999). At the same time it is also true that not all the members of a family are necessarily affected with the disease, although drinking from the same contaminated sources for roughly the same period of time. A detailed epidemiological study is needed to identify the reasons for this pattern of spreading the disease.

Alternative safe water options

Different types of safe water options were identified as alternatives to arsenic-contaminated water. Providing safe drinking water is not easy because very little is known about the different technologies that could be used to supply safe drinking water. Some of the options are totally new to the community. Therefore, a substantial amount of time is needed to assess both the technical viability and the community acceptance of the options provided. It has been observed in the past that in any new initiative, people generally express their curiosity but are reluctant to accept new approaches or technology. Rather they prefer to wait, observe carefully and take time to decide (Hadi, 2000). Some of the options were found not working properly. Some prospective new options were also included in the safe water option list and later provided to the community.

Although the project activities started in June 1999, the distribution of the alternative safe water option was started around September 1999. Therefore, the total time to assess the options both in terms of community acceptability and technical viability was not enough to draw a conclusive recommendation about options and their acceptance. It took 25 to 30 years to convert up to 97% of the rural population of Bangladesh to using tubewell water; and even then it was easier than today's alternative safe water options in terms of acceptance, technical viability, financial, and maintenance aspects. It should be pointed out that this study did not cover all the options for community assessment provided by BRAC in the two *upazilas*. Potential sources identified as alternatives to the arsenic-contaminated water were as follows:

- ⇨ Treated pond water
- ⇨ Rain water
- ⇨ Treated groundwater

Table 13 shows the alternative safe water options assessed in this study.

Table 13. Alternative safe water options

Technology	Water source	Coverage
Pond-Sand-Filter (PSF)	Surface water	40-60 families
Rain-Water-Harvester (RWH)	Rainwater	Small community
Safi filter	Tubewell water	One family
Three-Pitcher method	Tubewell water	One family
Two-Chamber-Treatment Units	Tubewell water	One family

Two Chamber Treatment Unit was later excluded from the project due to concerns about residual aluminium in the treated water.

It was observed that not all the provided alternative safe water options were feasible for every region and for every class of people in a society. Therefore, it was necessary to evaluate the viability, effectiveness and acceptance of the provided options by the different classes of people in a community.

Description of individual options

In this section the main features of the assessed alternative safe water options are discussed; technical and other details as well as a comparative assessment of different alternative safe water technologies are presented in Appendix 1.

Pond sand filter (PSF)

Filtration is the process whereby water is purified by passing it through a porous material or media. In slow sand filtration a bed of fine sand is used through which the water slowly percolates. The suspended matter present in the untreated water is largely retained in the upper 0.5-2 cm of the filter bed. This allows the filter to be cleaned by scraping away the top layer of sand. The filter cleaning operation need not take more than one day, but one to two more days are required after cleaning for the filter bed again to become fully effective (DPHE/UNICEF, 1988-93).

Figure 7. Pond sand filter

In the coastal belt of Bangladesh where much of the groundwater is saline, the local people are dependent on surface water from dug ponds. However, water from these ponds is not potable without adequate treatment. DPHE with funding from UNICEF has installed slow sand filtration units into which pond water is fed using a tubewell.

These units are called Pond sand filters (PSF). The use of PSF technology to filter surface water is also considered appropriate for areas where groundwater is contaminated with arsenic. One pond sand filter can supply the daily requirement of water for drinking and cooking for 40-60 families (DPHE/UNICEF, 1988-93).

Ponds for the PSF were selected on the basis of the following criteria:

- Ponds will not be used for fish culture; almost all the ponds in recent years were used for culture fisheries and therefore chemical fertilisers and pesticides are usually used in these ponds.
- Ponds should be protected in all respects, e.g. free from agricultural and domestic runoff, and also from any kind of sewerage discharges, etc.
- Ponds will not be used for washing livestock or any other domestic purposes.
- Ponds should be permanent (not prone to periodic drying-up).

⇨ There should be community pledges on the operation and maintenance of the ponds and PSFs.

A water-management committee composed of potential users of the PSF was formed for each of the PSF constructed. They were given training on the operation and maintenance of PSF. The construction cost varies from Tk. 25,000-40,000 per PSF depending on the size of the PSF.

Rainwater harvester (RWH)

Rainwater is used in many parts of the world to meet the demand for fresh water. There is a long-established tradition of rainwater collection in some parts of Alaska and Hawaii and even in some areas of Bangladesh where shallow groundwater is problematic due to salinity. In the city of Austin in Texas a tax rebate is offered to households for using rainwater. Gibraltar has one of the largest rainwater collection systems in existence. Rainwater harvesting is also popular in Kenya, South Africa, Botswana, Tanzania, Sri Lanka, and Thailand (Daily Star, 24 September 1999).

Figure 8. Rainwater harvester

In some areas of Bangladesh the potential for rainwater harvesting is good - however, the amount of rainfall varies across the country. Rashid (1977) shows that mean annual precipitation ranges from 1,400 mm (55 inches) along the country's east central border to more than 5,000 mm (200 inches) in the far north-east. The wet months are mid-June to late September and the dry period is from January to April. About 80% of the annual precipitation occurs in the monsoon period.

Rainfall patterns were confirmed with local communities to ascertain the feasibility of RWH, and alternatives and parallel use of other options were considered before constructing RWH jars. The capacity of a jar is about 32,000 litres and the cost is about Tk. 8,000 (DPHE/UNICEF, 1988-93).

It was observed that the cost was too prohibitive for it to spread locally. Also, in every case the RWH was used by more than one family so the water lasted for a limited period (maximum one month when the rainy season stops - i.e. not long enough to cover the full dry period).

Safi filter

This household filtration device, developed locally in Bangladesh by Prof. Safiullah (Jahangirnagar University, Bangladesh), works by filtering arsenic out of contaminated tubewell water.

One small Safi filter is designed to handle approximately 40 litres of water per day. This should be more than sufficient for the needs of a family of six for hygienically safe and arsenic free water. The cost of such filter is Tk. 900. Larger filters for schools, etc. are available which can filter 80 L of water per day and costs Tk. 2000 (BRAC, 1999).

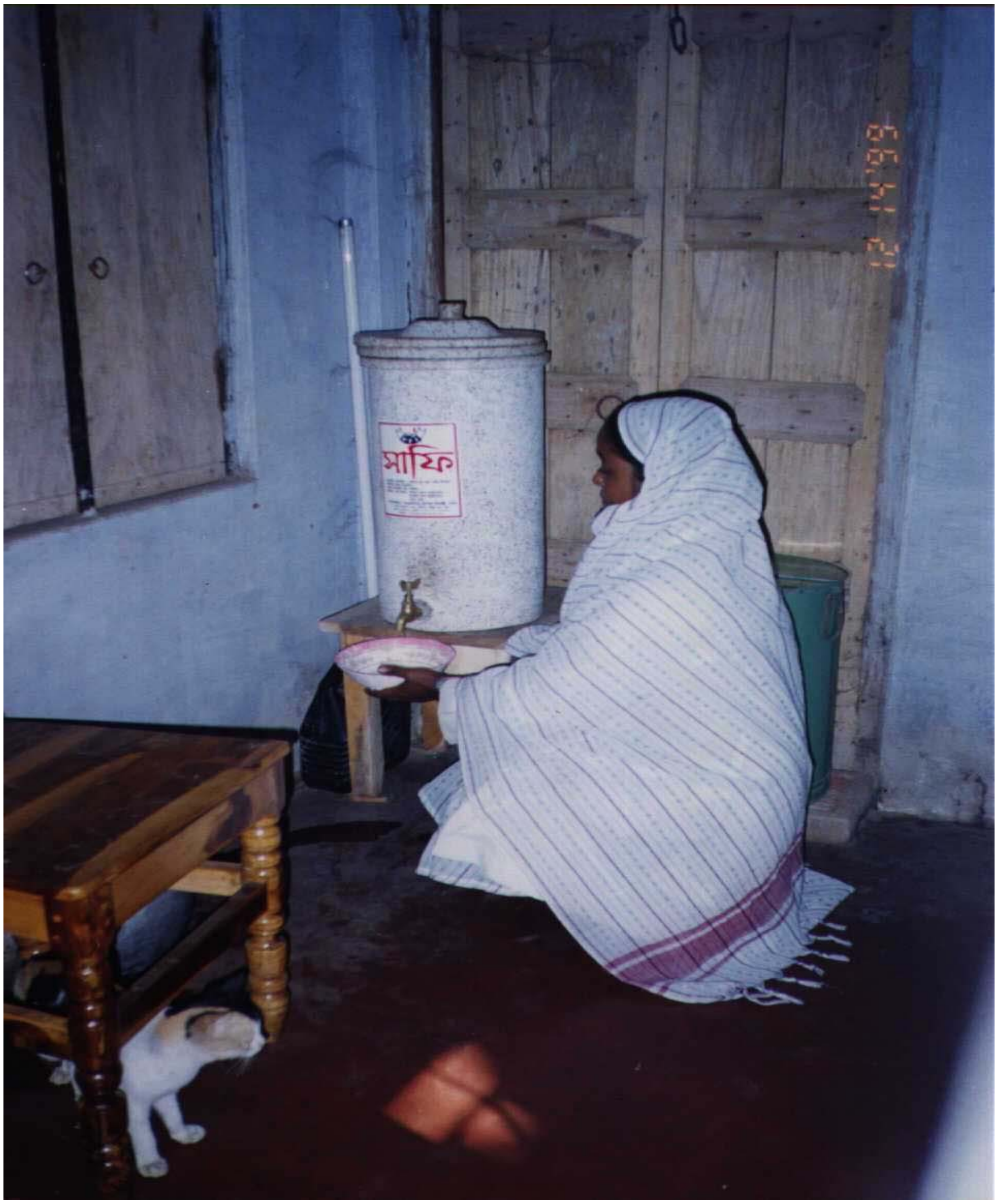

Figure 9. Safi filter

Three-kolshi or three-pitcher filter

The Three-*kolshi* filter is based on an indigenous method of filtration, which has been used in Bangladesh for many years. Local clay pitchers (called '*kolshi*') are filled with sand and charcoal, and small holes are made at the bottom of the first two pitchers. Water pass through these pitchers to remove suspended matter from surface water and more recently to remove iron from tubewell water. Scientists from Bangladesh and the US have noted the potential of this simple method to remove arsenic from groundwater. The system has been modified by adding iron filings to provide an additional source of iron oxide to absorb more arsenic (Rasul, S.B. et al, 1999). The results obtained by Rasul et al., (1999) were more than enough for the system to merit further and large-scale testing. Water can flow through this system continuously and the total cost per unit is about Tk. 250.

Figure 10. Three-*kolshi* filter

Deep tubewell (DTW)

There are two main aquifers in Bangladesh - shallow and deep. Usually there is a thick layer of silt and clay between the two aquifers. Water can not easily pass through this layer. It has been observed that the deeper aquifer is much less contaminated than the shallow one. A recent hydro-geological study conducted by the British Geological Survey (DPHE/BGS/MML, 1999) tested 280 tubewells of >200 m of depth and found unsafe levels of arsenic in only two of them – less than 1%. DPHE has also tested many deep tubewells, and found only limited arsenic contamination. BRAC has also tested some deep tubewells that were contaminated with arsenic beyond acceptable limit. These sporadic statistics indicate the uncertain safety of the deep aquifer and careful observation is needed before making a general recommendation for this option as a safe source for arsenic free water in the future. So, deep tubewells cannot be drilled in all areas. This is because in some parts of the country, rocky layers make drilling impossible. Due to these constraints, deep tubewells that are not yet scientifically proven to be safe were not included as a safe source of arsenic free water in the BRAC-UNICEF community-based arsenic mitigation project.

Community perceptions of the alternative safe water options

Two types of perceptions of the villagers about the alternative safe water options were observed. In Kamarpara, before the introduction of deep tubewells by the government (i.e. by DPHE), villagers were interested in the options provided and those who got the options were using them regularly for getting arsenic-free water. When villagers got deep tubewells they gradually started losing interest in other options. On the other hand, people of Bhagolpur were not interested in the alternative safe water options right from the beginning. Later, when DPHE masons started to motivate villagers for further sinking of the pipes of the existing tubewells villagers were found to be interested in this measure. Therefore, in both cases it was observed that due to lack of coordination between the government and the implementing agency, the true picture of community participation in the provided options could not be obtained. Hence, coordination between different stakeholders plays a dominant role in the sustainable implementation of a project. Although this was found to be difficult, an effort was made to assess the perception of the community regarding the alternative safe water options provided.

Table 14. Community perceptions of the alternative safe water options

Perception			
Bhagolpur	No. of households	Kamarpara	No. of households
1. Not very helpful, DTW would be good	14 (27)	1. Not very helpful; installation of more DTW would be good	38 (68)
2. Need better new options	11 (22)	2. DTW is far away, so problematic	5 (9)
3. Not very helpful	8 (16)	3. Distribute more three-pitcher options would be helpful	8 (14)
4. No idea	11 (22)	4. Alternative options are Good	5 (9)
5. Distribute more three-pitcher options	4 (8)		
6. RWH cannot provide water for round the year and the water is also dirty	3 (6)		
Total households	51		56

The figures within parentheses indicate percentage

Table 14 reveals that in Bhagolpur villagers were not very interested in the existing options. A significant number of respondents (22%) had no knowledge about the alternative options. Generally respondents from this village had no practical difficulties (i.e. death due to arsenicosis disease or the presence of arsenic affected-patients) and were not taking this problem seriously, although a majority of the respondents (59%) considered this problem to be one of the most severest in their locality. This notion of severity, according to the villagers, is based on their perception that there may be some problems in the near future.

The perception of respondents about community-based safe water options was not encouraging. Although BRAC has set up village water-committees wherever necessary, in fact none of the committee members were taking responsibility for the operation and maintenance of the free demonstration units provided. It was observed in many places that these community-based options were not in operation. This was either because of minor faults that in fact cost little money to fix, or routine maintenance of the options that would need physical labour to replace or regenerate. It may well be the case that since villagers did not have to pay anything to obtain these demonstration units, they lost interest after a couple of months even if at the beginning they were very enthusiastic about them. Due to this potential problem, BRAC is planning to ensure some community contribution in their future projects to create a sense of ownership by the community over the provided options. This will also help ensure continuous use and regular maintenance. Individual household-based options that do not require much maintenance, for example the three-pitcher option, were becoming more popular among community people.

Although socioeconomic conditions and the general perception that arsenic is a major problem were different in the two villages studied. The expectations of the villagers from alternative safe water options to alleviate the arsenic problem were almost similar. In fact, the difference between the villages in terms of the importance attached to having alternative safe water options to avoid future problems, if any, was not very significant; 86% in Bhagolpur and 96% in Kamarpara (Table 15).

Table 15. Importance of safe water options to the people of the community

Alternative options needed	No. of respondents	
	Bhagolpur	Kamarpara
Yes	44 (86)	54 (96)
No	4 (8)	2 (4)
No idea	3 (6)	-
Total	51 (100)	56 (100)

The figures within parentheses indicate percentage
Significant at 10% level[3]

In Kamarpara very few respondents (4%) did not consider arsenic to be a problem in the near future. This small percentage had been drinking water from the same source for generations without any difficulties. On the other hand, concentrations of arsenic-affected families were situated in particular areas and did not spread to other parts of the village during the last 4-5 years. This had created the false belief that the disease might not spread in other areas. But in Bhagolpur, the respondents of the last two categories (14%) (i.e. no need and no idea) were not living permanently with their family members because of their business commitments and therefore were not very keen on the problem of arsenic and its mitigation options.

A remarkable difference was also observed in the nature of respondents' to alleviate the arsenic problem in the two study villages. More than 54% of the respondents of Kamarpara village mentioned that they expected the government to solve the problem (Table 16). Although BRAC provided a number of safe water demonstration units in this village at free of cost, the villagers thought that the government provided them. They believed that anything that is free comes from the government as NGOs never distribute things free of charge. They basically wanted more free options from the government or some kind of government help to alleviate the problem. The same thing was revealed when they were asked whether they were interested to pay (at least partially) for different improved or better mitigation options. About 64% of the respondents of Kamarpara mentioned that they did not want to pay for any type of alternative safe water options; they believed that at some point they would definitely get at least something

[3] d-test: d = 1.904, significant at 10% level ($p<.1$) and insignificant at 5% level ($p<.05$)

from the government (Table 17). There may be another reason for their not being willing to pay for safe water options. This village is frequently visited by a large number of visitors (from home and abroad) which might make villagers think that they would get something free considering their importance to visitors.

Table 16. Expectation of the villagers to solve arsenic problem

Expectation to solve the problem	No. of respondents	
	Bhagolpur	Kamarpara
Government	6 (12)	30 (54)
NGO	27 (53)	16 (28)
Government + NGO	12 (24)	10 (18)
Don't know	6 (12)	-
Total	51 (100)	56 (100)

The figures within parentheses indicate percentages
Significant at 1% level[4]

On the other hand, villagers of Bhagolpur expect more NGO involvement (53%) to solve this problem because of the latter's repute for honest and quick action (Table 16). About 73% of the respondents of this village showed their willingness to pay for better arsenic-free safe water sources (Appendix 1). From Table 16, it is observed that at least 12% of the respondents of this village did not have any idea as to who could be expected to solve the arsenic problem, which indicated that they were not concerned about it.

When the expectations of the villagers to solve the arsenic problem were categorised in terms of expectation from the government and others (basically NGOs), the difference was found to be highly significant ($p<0.01$) among the respondents of the two study villages.

Expenditure Vs. willingness to pay for alternative safe water options

It has been observed that the economic factor is the main determinant for many of the response patterns of development interventions. An attempt was made to find out whether there was any relation between the monthly expenditure of the respondents and their willingness to pay for alternative options to alleviate the arsenic problem.

[4] d-test: $d = -4.580$, significant at 1% level ($p<.01$)

Table 17. Monthly expenditure Vs. willingness to pay for safe water options

Willingness to pay for options	Monthly expenditure (Taka) Kamarpara		
	≤ 3,000	> 3,000	Total
Want to pay	2	14	16
Don't want to pay	23	13	36
Total	25	27	52
[5]Test x2=9.75, p<0.005			
Willingness to pay for options	Monthly expenditure (Taka) Bhagolpur		
	≤ 3,000	> 3,000	Total
Want to pay	4	33	37
Do not want to pay	6	4	10
Total	10	37	47

[6]Test x2=8.18, p<0.005

From the table it is observed that in both the villages willingness to pay for alternative safe water options was highly dependent (p<0.005) on monthly income levels of the respondents.

Focus group discussion (FGD)

A number of FGDs were held in each of the villages with different types of villagers. The following is a brief description of these discussions.

Focus group discussions at Bhagolpur village of Sonargaon upazila

Bhagolpur is situated in Sonargaon *upazila*, which is close to the Dhaka-Chittagong highway. It is very close (about half an hour drive by car) to Dhaka, the capital city of Bangladesh. Arsenic in the water was first detected in this village by BRAC in late 1999 and they tested each and every tubewell for arsenic contamination. According to BRAC's results all but one of the tubewells were arsenic-contaminated beyond acceptable limit of 0.05 mg/l and the average depth of the tubewells was 75 feet. The majority of the villagers are businessmen. As regards culture, the people of this village were found to be different from other typical villages of rural Bangladesh. From BRAC's long experience in this village it was observed that it was difficult to motivate people to accept innovations that originated outside of their community. Although arsenic in tubewell water was first detected in this village more than a year before, villagers still remembered all the messages about arsenic that had been given to them by BRAC at the time of testing.

[5] χ^2= 9.75, χ^2tab = 7.88 at 5% level (p<.005)
[6] χ^2= 8.18, χ^2tab = 7.88 at 5% level (p<.005)

However, the villagers mentioned that although they were concerned about the provided alternative safe water options they are scared about the hazard of arsenic poisoning. The majority of them were still drinking from the arsenic-contaminated tubewells. The present study identifies the following reasons for these perceptions:

- Almost all the respondents of Bhagolpur mentioned that since there were no arsenic patients in the village they were not taking this problem seriously. Its long incubation period made villagers careless about the disease. Many of them anticipated that better options and medication for the disease would be invented by the time symptoms showed up. They also mentioned that they have been drinking water from the same sources without any difficulties and they thought that this would hold true for the future as well. The irregular pattern of attack of the diseases even within the same families also made villagers careless regarding further spread of the disease. Many villagers even mentioned that this might be a ploy by the pipe-manufacturing companies to sell more pipes to them.

- Many of the villagers expressed different concerns about the arsenic problem. They mentioned that in the near future there might be a problem i.e. they might get affected with arsenicosis. In principle they would welcome some solution to the problem; in practice, however, the options provided by BRAC were not very popular to the villagers and they expressed their wish for a better solution, preferably the further sinking of the existing tubewells.

- Proximity to urban centres and frequent movement to the capital and other major business towns made people feel superior and this may be why they did not want to accept any new idea or information that was coming from outside the village.

- Many people from this village work abroad. But majority, in fact, are businessmen - these two characteristics in particular make the village more affluent in comparison to the other study village. On average the economic condition of the villagers was better and therefore their nutritional status was also comparatively higher than the other village. As the villagers themselves mentioned, they felt less vulnerable to this disease.

- Although the majority of the respondents of this village considered arsenic as a problem in near future yet the percentage of people still drinking arsenic-contaminated tubewell water was higher in this village. Villagers also mentioned that the information provided both by government and NGOs was not enough. They believed door-to-door campaigns as well as more visual presentations of the consequences of the disease would be more realistic in sensitising people.

- Villagers expect more NGO involvement in solving the problem. They were found willing to pay for better and improved options. Tubewell masons of this village provided a different sort of information: they were advocating further sinking of tubewells pipes to get arsenic free water. The masons told the villagers that it was possible to get arsenic free water from about 300 feet depth. The villagers initially accepted this opinion, especially when they observed a couple of success cases; but in most other cases the masons could not get arsenic-free water from the same depth. This made villagers frustrated and caused them to question the viability of investing more money in such an uncertain measure. Villagers were eager to know both from the NGO workers and also from scientists, the depth at which arsenic-free water could be found from the same source. However, there is no consistent evidence available to scientists to state at which depth groundwater would be arsenic free and for what time period.

- Villagers also mentioned that they have little faith in the technical viability of treating surface water and in the quality of the treated water from the options provided. Many of them also mentioned that they do not have confidence in the messages provided by the local NGO project staff.

- Community spirit was not strong among the villagers. Although this was a typical village in terms of rural village definition of Bangladesh, but the characteristics of the people of this village were different from those of other villages. For example, the tendency to communicate with neighbours and community cohesion was not present in this village. Most of the villagers are businessmen and they tend to communicate less with other members of the community. For example, many respondents mentioned that they do not like to collect water from another person's house; rather they consider it as a prestige issue.

- The villagers mentioned that community-based options to alleviate arsenic problem would not be feasible for them; they would prefer home-based arsenic free treatment units. The three-pitcher system, for instance, seems to be popular to many villagers.

Focus group discussion at Kamarpara village of Jhikargachha upazila

Arsenic was first detected in this village by the Department of Public Health Engineering (DPHE), government of Bangladesh in 1993 through sporadic sampling taken while developing a countrywide arsenic concentration pattern in tubewell water. The total number of households in this village is about 210 and the number of arsenicosis patients identified is 40.

About 91% of the tubewells of this village is contaminated with arsenic. Two out of the nine arsenic free tubewells of this village are deep tubewells and were installed by the government. It was a combined decision by DPHE, UNICEF and the implementing NGO (BRAC) that deep tubewells would not be included as a safe water option for this action research project as it was not yet scientifically-proven whether this option would be arsenic-free or not in the long run. The results of the FGDs are presented below:

- Although in the beginning all the alternative safe water options provided were widely accepted by the community. After about a month the villagers started to use these options hesitatingly - very few people, in fact, were found currently using them. It has been observed that, except for a few people, villagers who were still using these alternative safe water options were using them for cooking and washing purposes.

- In Kamarpara, arsenicosis has broken out only in the two *paras* (a small cluster of settlements within a village; a village may have several *paras*) where the concentration of arsenic in tubewell water is comparatively high (BRAC survey 1999) and people generally have very low income. People from other areas of the village were alarmed to see these patients but gradually begun to believe that their area would not be affected since the disease had not spread over the last 4 to 5 years. There is a firm belief among the villagers that there will be no problem in the near future. Because they have been drinking water from the present sources for generations without any observable effects.

- Except for a very few families living close to these wells, none of the villagers collect water regularly from deep and green tubewells. Almost all the villagers mentioned that they do not have enough manpower to collect water from distant places. Women and children are reluctant to fetch water over long distances because of the time and labour involved and also because of bad road conditions particularly during the rainy season. Some of them mentioned that they sometimes fetch water from red-marked tubewells without informing anyone at home.

- There is a traditional practice in this area that men never collect drinking water. They mentioned that they usually do not collect drinking water. Because of religious perceptions and cultural traditions, rural women avoid any sort of contact, including visual contact, with unknown male persons and non-relatives. This discourages men from fetching water from places where women usually do, for example deep tubewells in this case. Villagers also mentioned that if some men *do* fetch water, other men taunt them for 'obeying the wife's command' or for doing 'a woman's work'. Therefore, men usually do not participate in collecting water from common places, unless there is no other option.

- A number of social problems were found to occur at the initial stage when arsenicosis was first detected in the village: for example, the arsenic-affected patients were kept aside, their marriages tended to founder, etc. These problems no longer existed when they learnt that the disease was neither contagious nor hereditary.

- Initially all the alternative safe water options provided were widely accepted by the community, for the following reasons:

  - ⇨ People were frightened of the possibility of being affected by arsenicosis;

  - ⇨ People thought that the alternative safe water options would be something different and interesting, so they used these options continuously for at least a couple of weeks;

  - ⇨ A fresh motivational programme and the presence of arsenic-affected patients particularly in Kamarpara, helped people avoid drinking arsenic-contaminated water; and

  - ⇨ Continuous broadcasts on national radio and television explaining the potential effects of this disease also helped people to accept alternative safe water options or to avoid drinking arsenic-contaminated water.

ALTERNATIVE SAFE WATER OPTIONS AND COMMUNITY ACCEPTANCE

The aim here was to assess and identify the factors influencing community participation for the provided alternative safe water options. Household survey and focus group methods were used in the two different villages to understand the dynamics of different response patterns of community participation.

In this chapter the survey findings are analysed in relation to the following questions:

- ⇨ What are the factors responsible for community participation?
- ⇨ What are the barriers to community participation?
- ⇨ How far has community participation been achieved?

Factors responsible for community participation

It has been observed that the following general factors varied greatly when the results of the respondents were analysed. From this analysis as well as from personal observations, the following general reasons can be identified behind a differential community response pattern of the people of the two villages. The reasons identified were: educational level, occupational structure, age of respondents, level of exposure to the outside world, exposure to the problem (i.e. visual symptoms of the problem), economic difference, specific and clear government policy, dependence on external support or grants (either from government or from elsewhere), media coverage and a constant motivational programme, physiographic condition (i.e. temperature, rainfall, surface water availability, etc.), and level of faith or trust in the information provided by local project workers.

The following is a diagrammatic view of the interaction between the variables responsible for community participation. Note that the power structure and leadership characteristics of community people play an important role when making decisions about their welfare.

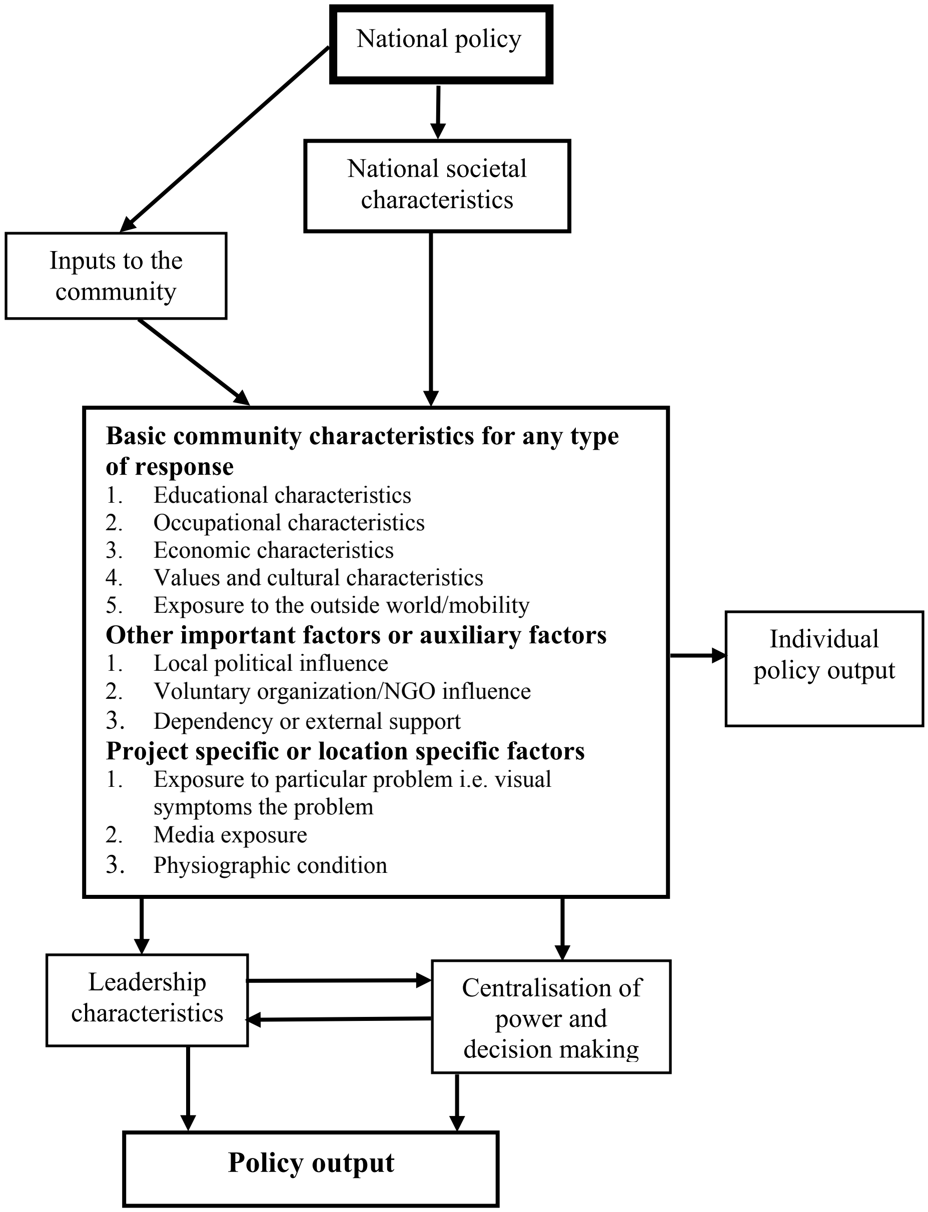

Figure 11. Variables in community decision-making (modified from Clark, TN. 1973)

Here it can be pointed out that this pattern of interaction was true of the period before the introduction of deep tubewells by DPHE in Kamarpara and the information on increasing the depth of existing tubewells provided by the local tubewell masons in Bhagolpur. With the introduction of these innovations and information, people's interest in the options waned.

Despite a number of dissimilarities (as mentioned above) among the people of the two villages, a common interest was displayed in their willingness to accept alternative safe water options. This attitude referred mostly to either deep tubewells or options that are cheaper, easier to operate, and require less maintenance. The willingness to accept options and the dissimilarities in terms of attitudes have produced different response patterns for community participation in the provided options. Other factors may influence these response patterns and need to be understood through further study. Because of the constraints of time and resources it was not possible to cover all these aspects in detail.

Barriers to community participation and acceptance of alternative safe water options

From an analysis of the survey findings and the results of the FGDs, as well as from personal field observations, the following general points were identified on the safe water options provided which impacted on community participation in one way or another.

Government policy

A clear government policy is considered to be one of the major influencing factors in implementing any development programme. Since all the alternative safe-water options were new and very little was known about them, even to the policy-makers and implementers themselves, it was difficult for scientists and policy-makers to develop plans for certain mitigation options.

Poor economic conditions

Poor economic conditions were found to be an important factor behind the villagers not accepting some of the options. The current situation in the rural areas of Bangladesh is either that most of the villagers already have a tubewell or that they are sharing tubewells with neighbours. At the same time it is true that getting water from tubewells is very easy because there is hardly any maintenance involved - whereas regular maintenance, which may also involve a complex process, is required in the case of all the provided options. This has made rural people reluctant to accept them.

Taste of water

The taste of water from the provided options was different from the tubewell water; this was an important factor behind the villagers' not taking the options seriously. At the same time, it is to be noted that initially people were aware of the difference between water from deep and that from shallow tubewells – now, however, they are used to it. This attitude of the villagers clearly indicated that since they were familiar with the taste of ground water (through the use of shallow tubewell water), the taste of deep tubewell water was easily acceptable. People also mentioned that those who regularly drink water from deep tubewells usually do not like to drink water from any other sources.

Quality of water

In most cases the quality of pond water deteriorates particularly during the driest part of the year and therefore, villagers lose their trust of drinking water from PSFs and RWHs.

Physiographic variations

Water for rainwater harvesters is available only for a very few months both in Kamarpara and Bhagolpur villages. Due to this physiographic variation, respondents particularly in Kamarpara were not optimistic about RWHs. Villagers also mentioned that this could be only a partial solution to their problem as rainwater is not available throughout the year. On the other hand, villagers believe that rainwater collected off a roof would be contaminated with bird droppings and other kinds of dirt and they were not eager to collect drinking water from this source.

Coordination between different stakeholders

The installation of deep tubewells in Kamarpara and the information regarding the sinking of deeper tubewells provided by the local masons in Bhagolpur made villagers particularly interested in these options. Due to this reason, the main intention of the project i.e. the acceptance of different options by the community, could not properly be achieved. Therefore, cooperation and coordination between different stakeholders are essential for the sustainable implementation of the project activities.

Reliability of the technical options

In many cases villagers expressed their concern about the validity of the provided options (particularly regarding the bacteriological condition of water and efficient removal of arsenic); later this was found to negatively affect the community response patterns to the options.

The community's own judgement on problems

It was observed that initially villagers believed arsenicosis to be a contagious and a hereditary disease; this perception no longer existed once they understood the facts. It was observed that people accepted this message within a short time. However, this does not mean that people accept the provided alternative safe water options. The long-term practice of drinking tubewell water was found by the community to be convenient in terms of operation, ease of maintenance and cost-effectiveness. In addition, the irregular and slow spread of the disease did not help people perceive that there was a problem. These are some of the factors responsible for this low acceptance of the alternative safe water options by the community.

Complexity in the process of obtaining water

A fairly complex process is involved with all the provided options. For example, in the PSF, one has to pump water from a pond before taking water from the PSF. But in most cases people were not interested in pumping water. In many cases this has resulted in a confrontation between the villagers and the caretakers, who tried to enforce the system i.e. to pump a little water from the pond before taking water from the PSF. On the other hand, caretakers also mentioned that they do not want to become involved in a clash with villagers, as a result of which many of the PSFs were not being used by villagers.

How far has community participation and acceptance of the provided options been achieved?

This research was carried out in a BRAC-UNICEF-operated arsenic mitigation project area where a limited number of free demonstrations were provided to the communities. These options included only a very few people in each of the villages covered by the project. The intention was to provide ideas about the options to the rest of the villagers who would then decide which of these options were suitable for them. In the case of costly options these were demonstrated to the people of several villages at a time. Therefore, in many cases it was difficult to get respondents' first-hand perceptions of these options; rather, they expressed their views and ideas based on hearsay or on a single visit to these options. This arrangement affected community participation particularly because of a lack of personal experience of the options. Hence, in most cases it was observed that people were not very interested in the options. Until and unless communities are consulted and involved in the different stages i.e. the selection, construction, operation and maintenance of options, it will be difficult to achieve long-term sustainability of the safe water options.

A continuous motivational programme about the arsenic problem as well as some financial contribution from the villagers would be instrumental for people to accept these alternative options. It has been observed from many development projects that without any kind of financial commitment or personal benefit, people do not feel a sense of ownership or interest in project activities. This has often resulted in less participation and maintenance.

Increasing the level of awareness is linked directly to the recovery of finances. Although people in the affected areas are mostly aware of the arsenic problem, generally the awareness is still low. The majority of the people in the project area are not affluent. The history of installing tubewells is not very long. When people suddenly came to know that their tubewells were no longer safe for drinking purposes due to the presence of arsenic, many of them became frustrated. Moreover, except for the three-*kolshi* all other options are completely new to the people of this area. Thus, the problem is that people with limited finances are reluctant to spend money on something that they do not know to be appropriate for them.

Coordination between government and NGOs is an important factor both for earning community trust and for the sustainable implementation of any development project. In this case lack of coordination between government and BRAC was observed in the study villages, which hampered the community's acceptance of the options provided.

CONCLUSION

Bangladesh is one of those countries that is most likely (through the use of tubewells) to achieve their rural water supply target as set by the International Drinking Water Supply and Sanitation Decade. It has achieved one of the highest levels of service in any developing country; 45% based on one hand-pump per 75 people (UNICEF, 1999). A huge effort was needed to transform the behavioural patterns of the rural people to change the drinking water source from surface water to groundwater i.e. tubewell water. Both government and non-governmental organizations have worked tirelessly for the last 25-30 years to achieve this. As a result of this success the number of deaths due to diarrhoeal disease was reduced remarkably. But the value of this achievement is now being undermined by the discovery of arsenic (above the permissible limit) in tubewell water. Although there is a long debate over the causes of arsenic contamination in groundwater it is nevertheless true that the achievement of bringing safe drinking water to this huge population is now questionable.

To face this new threat, a number of alternative safe water options are available in Bangladesh. Some of these options are based on treating surface water and some are based on treating the arsenic-contaminated water. It is important to have different alternative safe water options available not only to be able to evaluate and select the best options for a particular community, but also because of the physiocultural and socioeconomic variations among communities.

It has been observed that communities are not homogeneous in terms of expressing their views and accepting the options. Different communities have addressed the problem in different ways. For instance, in Bhagolpur people were found to be reluctant to address the problem, as a result of which the initiative to develop community-based options did not work. On the other hand, in Kamarpara people were initially eager to collect water from the provided options and in that village some of the community-based options worked well.

The concentration of arsenic in tubewell water of both the study villages was found to be almost the same but the awareness level about arsenic and the perception of the safe water options were different for the people of the two villages. Variables such as age, education, occupation, monthly income, perceptions of the problem, and expectation to solve the problem were analysed in order to find out the reasons for this variation among the community. A statistically significant difference was observed in the use of safe water options and their perceptions of the problem. For example in Bhagolpur more than 80% of the respondents were still using arsenic-contaminated water. The absence of any practical evidence (arsenic-affected patients) in the village, the long term practice of drinking tubewell water without any difficulties, better nutritional conditions, the long incubation period of the disease, the cumbersome process of obtaining water from alternative water sources - these were some of the factors which made the people of this village skeptical about the disease and subsequently reluctant to use alternative options.

On the other hand, more than 85% of the people of Kamarpara were drinking arsenic-free water. The presence of arsenic-affected patients in this village motivated people to drink arsenic-free water. Although initially people were collecting water from the provided safe water options, when the government introduced deep tubewells in this village people abandoned these options. It was decided initially that deep tubewells would not be included in this project because it is not yet decided scientifically whether they are arsenic-free in the long run. Therefore, coordination among different stakeholders and the development of uniform messages about the problem for the people of the affected areas are considered important to earn community trust as well as community participation. Respondents (14%) from this village who live far away from the deep tubewells were still drinking arsenic-contaminated water but not continuously. They mentioned that sometimes they tried to collect water from deep tubewells. An in-depth investigation is needed into why these people were still drinking arsenic-contaminated water, in spite of observing the practical problems of drinking such water.

An interesting distinction was observed between the two villages in terms of solving the arsenic problem; people in Kamarpara expected government involvement in solving the problem. Frequent visits by arsenic experts (from home and abroad) to observe the situation and the presence of a high number of arsenic patients in the village, made them optimistic about getting more free government support to solve the problem – this was also reflected in their not being willing to pay for alternative options. On the other hand, people in Bhagolpur were from the very beginning reluctant to address the arsenic problem. But at the same time considering the possibility of future disaster, they wanted to have better alternative options. They showed interest in financial contribution according to one’s capacity. Therefore, they wanted more NGO involvement in finding a quick solution and also the proper use of their financial contributions. Many villagers were aware of the corruption and the long bureaucratic procedure in the government structure.

Using tubewell water is a long-term practice of the people of both the study villages. Because they have found this source to be both cost-effective and convenient in terms of operation and maintenance. On the other hand, cumbersome processes are involved with all the provided options.

Physiographic and seasonal variations were also found to be important limiting factors for community acceptance of the options. For instance, people of Kamarpara did not show much interest in the RWHs. In Bhagolpur, people were not very much in favour of the construction of PSFs because they use ponds extensively for fish culture. This means that they need to use fertilizers and pesticides to kill predator fish in the ponds. In Kamarpara, it was also observed that although some households had one alternative safe water option provided by BRAC, they were reluctant to use the provided option - instead they were even collecting water from deep tubewells that were quite far away. Therefore, alternative options should be provided - although not for free and after proper consultation with local people to get their full assurance of cooperation and use.

Despite the dissimilarities, there was a similarity among the villagers in terms of their willingness to have alternative safe water options, and avoid any possible health hazards. This similarity, combined with the differences in terms of choice of options and willingness to pay for them, has produced a differentiated response pattern of community participation. In most cases the willingness to pay extended either to a deep tubewell or better options for which operation was easier and less maintenance was involved. Further study is needed to deepen our understanding of these factors and to find out if other factors also influence this response pattern.

This study has shown that the differences in the response patterns of the villagers to the arsenic problem and the solutions proposed are not random. They themselves related to variables such as the relative economic condition and mobility of the populations. Research has to take into account these variables and locate the introduction of new options within a wider social context.

Finally, it can be said that the situation of arsenic poisoning in rural areas of Bangladesh is like the ebbs and flows of a river. When villagers get fresh motivation or are faced with newly-affected people in their vicinity, they make an effort to collect or obtain arsenic-free water for a couple of weeks or months. Soon, however, they go back to being reluctant to collect arsenic-free water. To thoroughly convince people, a well-structured motivational programme (such as that which was successful in converting 97% of the population to tubewell water) that in turn draws upon the prior identification of different community factors, is needed to make arsenic-free, safe drinking water a priority in rural areas of Bangladesh.

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Assessment of the effectiveness of the safe water options

A number of alternative safe water options are now in operation as demonstration units. The idea behind constructing these demonstration units is to raise the awareness level of the community people about this alternative safe water option which would later help in developing a system of involving community members in choosing, financing, and implementing safe water systems on their own.

Alternative safe water options which have been implemented in the field and assessed for this research project are: Pond Sand Filters (PSF), Rainwater Harvesters (RWH), Three *Kolshi* filters, and Safi filters. These have been assessed with reference to initial and running costs, ease of implementation, requirement for maintenance or ongoing supervision, provision of an intermittent or continuous supply, susceptibility to bacteriological contamination, and acceptability to the local community.

The matrix below shows ratings of each of these factors rated on a scale of 1 to 5. The maximum possible is 45 and a higher rating is better.

Parameters	PSF	RWH (old)	Safi filter	Three-*kolshi* filter
Initial cost	1	2	4	5
Running costs	4	5	3	5
Ease of implementation	1	1	5	5
Technical effectiveness	2	4	1	4
Maintenance required?	4	4	1	2
Monitoring required?	2	3	1	1
Continuity of supply	4	2	1	4
Susceptibility to bacteriological contamination	2	4	2	2
Social acceptability	1	1	3	5
Total	21	27	21	33

It can be seen from this that all of the options have their limitations. At present the Three-*Kolshi* filter is proving to be the best option for its ease of use, low cost and simplicity.

Initial reports implying that the layer of iron filings becomes a solid mass over time must be investigated further to ensure that the filter remains effective. If this is the case, the method of regeneration and the effectiveness of this process must be determined. The potential for leaching of trace metals from the iron filings is also uncertain. Finally, it may be necessary to sterilise the filter materials before use to avoid secondary contamination of the water with bacteria during filtration.

The RWHs and the PSF are both thought to be too costly to be taken up locally.

The Safi filter initially seemed to be a promising technology for treatment of arsenic-contaminated groundwater; however, over time the majority of the filters supplied ceased to be effective. Professor Safiullah is currently working to solve the problems of the Safi filter and to produce an alternative porous media column filter. If proven to be effective these filters may be useful in the future.

Table 1. Socio-demographic and other characteristics compared in two Study villages

Age	No. of respondents B	No. of respondents K
10-20	2 (4)	10 (18)
20-30	13 (25)	13 (23)
30-40	18 (35)	15 (27)
40-50	13 (26)	9 (16)
50+	5 (10)	9 (16)
Total	51 (100)	56 (100)

Education	No. of respondents B	No. of respondents K
Illiterate	9 (18)	18 (32)
Literate	42 (82)	38 (68)
Total	51 (100)	56 (100)

Main occupation	No. of respondents B	No. of respondents K
Business	42 (82)	7 (12)
Agriculture	-	39 (70)
Van puller	-	2 (4)
Service	7 (14)	-
Student	2 (4)	8 (14)
Total	51 (100)	56 (100)

Monthly expenditure (Tk)	No. of respondents B	No. of respondents K
Up to 1500	2 (4)	6 (11)
1001-3000	8 (16)	23 (41)
3001-5000	30 (59)	24 (43)
5001+	11 (21)	3 (5)
Total	51 (100)	56 (100)

Main problem of the area	No. of respondents B	No. of respondents K
Arsenic	30 (59)	45 (80)
Sanitation	5 (10)	4 (7)
Financial problem	10 (20)	7 (13)
Jobless	6 (11)	-
Total	51 (100)	56 (100)

Drinking water: present source	No. of respondents B	No. of respondents K
RWH	2 (4)	3 (5)
Red tubewell	39 (76)	8 (14)
Green tubewell	5 (10)	9 (16)
Deep tubewell	-	31 (56)
3-Pitchers	3 (6)	5 (9)
RWH + Red tubewell	2 (4)	-
Total	51 (100)	56 (100)

Cooking water: present source	No. of respondents B	No. of respondents K
RWH	2 (4)	3 (5)
Pond water	37 (7)	33 (59)
Red tubewell	9 (18)	6 (11)
Green tubewell	3 (6)	3 (5)
Deep tubewell	-	5 (9)
3-Pitcher	-	4 (7)
Not tested tubewell	-	2 (4)
Total	51 (100)	56 (100)

Radio/TV ownership		No. of respondents B	No. of respondents K
Radio	Yes	43 (84)	21 (38)
	No	8 (16)	35 (62)
Total		51 (100)	56 (100)
Television	Yes	40 (78)	14 (25)
	No	11 (22)	42 (75)
Total		51 (100)	56 (100)

The figures within parentheses indicate percentage

Table 2. Arsenic related information compared in the two study villages

Arsenic test results	No. of respondents B	No. of respondents K
Arsenic tested	51 (100)	56 (100)
Not tested	-	-
Arsenic-contaminated	49 (96)	51 (91)
Not contaminated	2 (4)	5 (9)
TOTAL	51 (100)	56 (100)

Using for drinking and cooking	No. of respondents B	No. of respondents K
Still using	41 (80)	8 (14)
Not using	10 (20)	48 (86)
TOTAL	51 (100)	56 (100)

Arsenic patients	No. of respondents B	No. of respondents K
Arsenic patient	-	15 (27)
No patient	51 (100)	41 (73)
TOTAL	51 (100)	56 (100)

Arsenic is a contagious and hereditary disease	No. of respondents B	No. of respondents K
Yes	11 (22)	2 (4)
No	40 (78)	54 (96)
TOTAL	51 (100)	56 (100)

Knowledge about safe water options	No. of respondents B	No. of respondents K
Know about the options	44 (86)	56 (100)
Don’t know	7 (14)	-
TOTAL	51 (100)	56 (100)

Arsenic in tubewell water is problem	No. of respondents B	No. of respondents K
Yes	46 (90)	54 (96)
No	5 (10)	2 (4)
TOTAL	51 (100)	56 (100)

Expectation to solve the problem	No. of respondents B	No. of respondents K
Government	6 (12)	30 (54)
NGO	27 (53)	16 (28)
Govt.+NGO	12 (24)	10 (18)
Don’t know	6 (12)	-
TOTAL	51 (100)	56 (100)

Willingness to pay for options	No. of respondents B	No. of respondents K
Want to pay	37 (73)	16 (29)
Don’t want to pay	10 (19)	36 (64)
Alternative options available	4 (8)	4 (7)
TOTAL	51 (100)	56 (100)

Alternative options needed	No. of respondents B	No. of respondents K
Yes	44 (86)	54 (96)
No	4 (8)	2 (4)
No idea	3 (6)	-
TOTAL	51 (100)	56 (100)

Source of information about arsenic	No. of respondents (multiple answer) B	No. of respondents (multiple answer) K
Radio	1	35
Television	39	33
NGO	49	54
Government	0	8
Teacher	0	24

The figures within parentheses indicate percentage

Table 3. Summary of the household survey

• Mean age of the respondents	No. of respondents	
Bhagolpur	30	
Kamarpara	35	
• Educational status	B	K
Literate	42 (82)	38 (68)
Illiterate	9 (18)	18 (32)
• Occupation	B	K
Business	42 (82)	7 (12)
Agriculture	-	39 (70)
• Number of tubewells	B	K
Arsenic contaminated	47	51
Not contaminated	4	5
• Monthly expenditure	B	K
Average expenditure (TAKA)	5000	3000
• Still drinking from contaminated wells	B	K
Drinking from contaminated wells	41 (80)	8 (14)
• Arsenic patient	B	K
No. of patient	-	15
• Safe options are needed	B	K
Yes	44 (86)	54 (96)
No	4 (8)	2 (4)
No idea	3 (6)	-
• Willingness to pay for options	No. of respondents	
	B	K
Want to pay	37 (73)	16 (29)
Don't want to pay	10 (19)	36 (64)
Alternative options available	4 (8)	4 (7)
Total	51 (100)	56 (100)

Radio/TV ownership		No. of respondents	
		B	K
Radio	Yes	21 (38)	43 (84)
	No	35 (62)	8 (16)
Total		51 (100)	56 (100)
Television	Yes	14 (25)	40 (78)
	No	42 (75)	11 (22)
Total		51 (100)	56 (100)

The figures within parentheses indicate percentage

APPENDIX 3

HOUSEHOLD SURVEY QUESTIONNAIRE

District: Upazila: Union: Village:

1. Information on identification

Name of respondent	Father/Husband name	Relationship with household head	Village	Household number

2. Information of respondents

Date of birth	Sex	Education	Occupation	Monthly income

3. How long have you been staying here?

4. What are the problem do you think should get the highest priority in your village?

5. Source of drinking and cooking water

Purpose	Source of water	Type of ownership and distance km.
Drinking		
Cooking		

1. Tubewell 2. Pond 3. Others (specify)

6. How long are you taking water from this current source? Before that what was the source for drinking and cooking water?

7. (If the respondent has a tubewell) When have you installed the tubewell?

8. Do you have radio or television?

9. What is arsenic? Have you ever heard of arsenic contamination in tubewell water? If yes, what is the source of information and when?

10. Have you tested your tubewell water for arsenic? When and where?

11. What is the test result?

12. (if the tubewell water is arsenic contaminated) Are you still using this water for drinking and cooking purposes?

13. If yes, why? Mention the reason(s).

14. If no, where from do you get water? How far is that?

15. Who usually collects water? Is there any problem collecting water from a distant place? If yes, what type of problems are you facing now?
16. Is there any arsenic patient in your family?
17. If yes, when and who detected it and what type of treatment methods are you following?
18. Do you think arsenic is a contagious and hereditary disease?
19. Do you have an idea about alternative safe water options? Is there any such type of option(s) available in you village?
20. Who is providing the alternative options and from when?
21. Do you think these options are good and suitable for your location?
22. If yes, what are the potential advantages?
23. If not, what are the potential disadvantages?
24. What type of alternative options do you think would be ideal for you?
25. Do you consider groundwater arsenic contamination is a problem? Why?
26. From whom do you expect more in order to help alleviating this problem (Government, NGOs or others)?
27. Do you think the information that you have received on is enough? If no, why?
28. If your tubewell is contaminated with arsenic, do you want to spend money for an alternative safe water option?
29. Whom do you seek help in case of emergencies or facing new problems in your village?

SEMI-STRUCTURED QUESTIONNAIRE FOR PRA EXERCISE

1. What is the name of this village?
2. Distance from nearest growth centre, union, *upazila*, district with cost and mode of transportation?
3. What is the population number of this village?
4. Educational profile of the village
5. Occupational profile of the village
6. Average yearly income of the people of the village
7. Nutritional status of the villagers
8. Number of tubewells in the village
9. What is the source of drinking and cooking water?
10. How many people do have radio or television?
11. Have you ever heard about arsenic contamination in the water of tubewells? If yes, do you think is it a contagious or hereditary disease?
12. What is the source of information?
13. Do you have any idea about how many tubewells are contaminated in the village?
14. Do you consider arsenic is a problem?
15. How many people are still drinking arsenic contaminated water?
16. What are the reasons?
17. Is there any alternative safe water options available in this village? If yes, what are the options? How long these are available in the village?
18. Are these options widely accepted by people of the communities? Is there any difference among different types of communities in terms of accepting or rejecting the alternative safe water options? If yes, what are the differences?
19. Do you think all the provided alternative safe water options are suitable for this village?
20. If no, what are the potential problems?
21. How many people are still using arsenic contaminated water for drinking and cooking purposes?
22. How many people are using alternative safe water options?

23. Is there any arsenic patient in this village? If yes, what is the present and previous source of drinking and cooking water?

24. If yes, do they face any social problems? If yes, what are the problems?

25. Do you have any suggestions how to avoid this problem?

26. From whom do you expect more in order to help alleviating this problem (Government, NGOs or others)?