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STUDY ON THE ARSENIC CONTAMINATION AND MITIGATION IN COMILLA DISTRICT

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ABSTRACT

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The presence of arsenic in ground water pulled through tube wells has become a serious health hazard for the rural people. Massive public health engineering service programs have been launched to provide safe drinking water for the people in the country through GO/NGO agencies. The technologies used by different agencies such as rice husk method, one and two bucket unit method, arsenic removal unit and indigenous others to remove arsenic from groundwater are evaluated in view of bio-technical concepts. The salient results showed that 84% instruments used for the purpose of removing arsenic were not appropriate and standardized. But the performances of all these technologies were varied from 23 to 76% as for its effectiveness as measured by humanic symptoms. The technical acceptability of the mechanisms was also found to vary from 49 to 83% in different areas of Comilla district. The wide gap of performance and effectives found mostly due to errors with equipments and operations. It is recommended that the improvement covering selection and appropriate instrumentation of the process can reduce arsenic contamination and enhance removal or mitigation of the hazards by up to 30% in the study area which needs intensive training on the technically acceptable equipment and processes.

Key words: *arsenic hazards, arsenic water contamination, arsenic mitigation, technical processes*

INTRODUCTION

The arsenic hazards were first reported to exist in the Bengal Basin in 1978 and in West Bengal in 1982, while it has been found to occur at Baragharia Union of Chapai Nawabganj district of Bangladesh in 1993, Center for Environmental and Geographical Information Services (CEGIS 1997). According to CEGIS and MPO (1995) the concentration of arsenic varied from 0.02 to 0.5 mg/l exceeding the WHO (1997) standard of 0.01 mg/l and the Bangladesh standard of 0.05 mg/l. Arsenic compounds of arsenide and arsenate are highly toxic and can cause skin cancer, kidney and liver failure, respiratory problems. The major symptoms include dark brown spots on the body, thickening of the skin of the palm and feet, and warts on hands and legs. Arsenic salts are colorless, tasteless and naturally occurring in the sub soils, seeped into the groundwater for years. Human get affected by arsenic mainly through ingestion with drinking water. The World Health Organization (WHO) has set a provisional guide line of 0.01mg/l and Bangladesh guide line value is 0.05mg/l in drinking water WHO (1997). Arsenic is widely distributed throughout the earth's crust. It is introduced into water through the dissolution of mineral ores and concentration in ground water in some areas is elevated as a result of erosion from the respective rocks. Industrial effluents also contribute arsenic to water in some areas. Combustion of fossil fuels is a source of arsenic in the environment through dispersed atmospheric deposition. Inorganic arsenic can occur in the environment in several forms but in natural water and thus in drinking water, it is mostly found as trivalent arsenite As-III or pentavalent arsenate As-V (Prasad 1994).

In the context, the present piece of research was undertaken with broad target of understanding and explaining the situation of the arsenic contamination and mitigation in Comilla district. The specific objectives of the study were to i. identify the arsenic concentration status of different Upazila of Comilla district; ii. Assess the performance of arsenic removal instruments used in the areas; and iii. Identify an equipment process system for the aim of solving the arsenic problem in the areas. It is expected that the findings of the study and its recommendation will give keen information on the performance of GO/NGO attempts in the way of mitigating the arsenic toxicity downing it to the critical concentrations in drinking water.

MATERIALS AND METHODS

The methods and materials for the study including the descriptions of the study sites, and its characteristics, equipments used, arsenic status in Comilla are sequentially mentioned here.

Description of the study sites

The study area selected for this study was Comilla district where arsenic affected people and arsenic concentration were reported to be higher (Ahmed 2003). The selected Upazila of this district was Laksam (Fig. 1) and the village surveyed was Eruani. Comilla is located in the Eastern border side of the country. The adjacent districts are Brahmanbaria, Chandpur, Feni, Noakhali and Narayangonj. Tripura State of India is located in

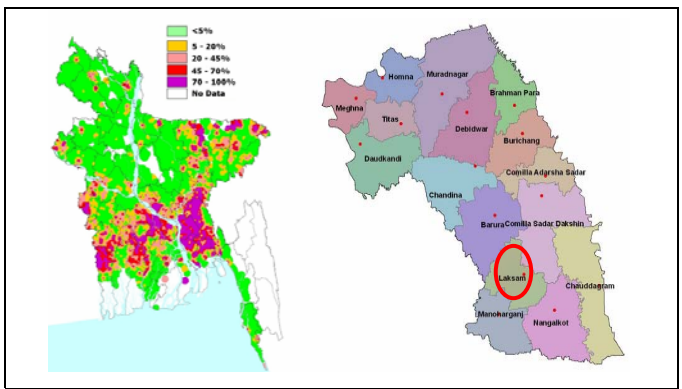


Fig. 1. Arsenic affected Upazila of Bangladesh and Comilla

the eastern side of Comilla. One of the big river of Bangladesh namely The Meghna flows through this district. Comilla covers an area about 3085 sq. km. Laksam is one of the Upazila of this district and occupies about 15% of the total area of this district. A map showing arsenic contamination spots of ground water in different parts of Bangladesh and Comilla District are shown in the Fig. 1.

Arsenic status in Comilla

Average Arsenic concentrations (BGS/MML 1999 and DPHE 2000) at different Upazila of Comilla district are shown in Table 1. The data show that arsenic concentration in the Laksam Upazila was higher followed by Meghna. The least concentrations were found in Homna followed by Chauddogram.

Table 1. Mean arsenic concentration at different Upazila in Comilla district

Serial	Upazila	Arsenic content in ppb
1	Laksam	200
2	Meghna	110
3	Nangalkot	41
4	Debidwar	46
5	Daudkandi	60
6	Brahmanpara	89
7	Chandina	30
8	Burichang	35
9	Chauddagram	25
10	Homna	20

Site Characteristics: Eruani is a big village in Laksam Upazila having a population of 7500. Eruani village is specially chosen because of contamination of arsenic is relatively higher. Almost all the tube well water contains above the WHO allowable limit of arsenic concentration. Again, there is no alternative of drinking water that they can use easily. Two methods are followed for collection of field data. One was field interview and other was collection of water samples from tube wells. The background information was collected from the department of public health at Comilla and Dhaka Community Hospital.

Equipment: The popularly used equipments and simple mechanisms of arsenic removal initiatives selected randomly in the areas and thus used for the study as a standard are given in the Fig. 2. as per recommendation of Das (1999), Jalil and Ahmed (2001), Mallick and Das (2003), Prasad (1994), Qin-Liang (1998), Khan (2004) and Das (1998).

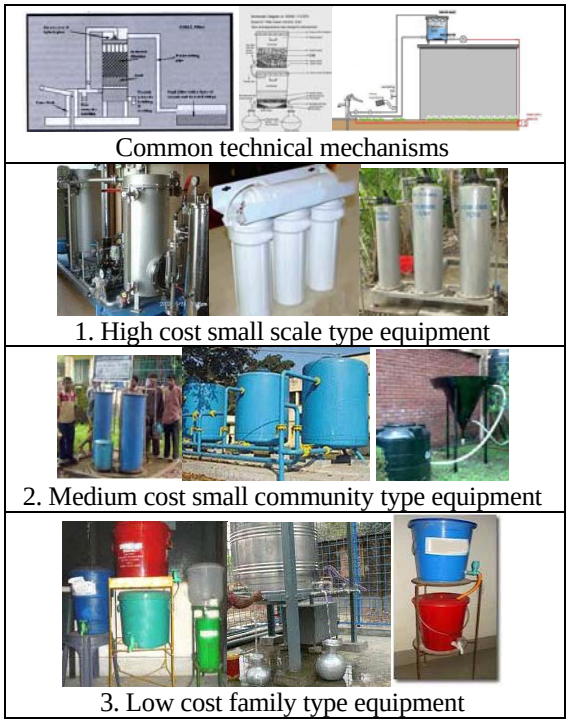


Fig. 2. Arsenic removing equipment prototypes used for study purpose

RESULTS AND DISCUSSION

The results of the studies conducted here on the use of arsenic removal equipments, arsenic problems are mentioned in tabular or graphical formats. The results are presented sequentially as Use of arsenic removal equipment, Socio-economic character relations, Performance of the equipment as per site, Choice of arsenic removal technology, Water supply and sanitation conditions are mentioned and interpreted.

Use of arsenic removal equipment

The results obtained on the mean Arsenic concentration at different Upazila in Comilla as per instrument categories are given in the Table 2. and Fig. 3, 4, 5 and 6.

Table 2. Mean arsenic concentration at different Upazila in Comilla

	Effectiveness %			
Upazila	1. High cost small scale type	2. Medium cost small community type	3. Low cost family type	Mean
Laksam	57	66	41	62
Meghna	48	71	47	55
Nangalkot	51	62	59	57
Debidwar	33	69	51	51
Daudkandi	47	74	49	54
Brahmanpara	28	58	61	49
Chandina	45	64	57	55
Burichang	34	53	55	47
Chauddagram	51	83	51	62
Homna	44	65	48	52
Mean	44	67	52	54

The results as given here show that the medium cost community type machines were more used in Chauddogram, high cost in Laksam and low cost in Brahmanpara Upazila.

Socio-economic character relations

According to the interview of the tube well owners and local people, it was found that most of the people of the study area have a low level income approximately 2000 to 3000 BDT per month having an intention of using low cost instruments (Fig. 3 and 4). Basically people are poor and illiterate. Arsenic contamination problem is only a known word for them. They have no idea about arsenic problem, its cause, effect and solution of the problem. Most of the interviewed families have more than 5 members. The adults are basically involved for earning by doing private jobs, cultivation or small business. They could not continue their education due to economic problem. The awareness about arsenic problems of the local people is very poor. Most of the people have no communication media like television, radio etc. There were some pilot projects to keep people aware about arsenic problem but it was not enough for them.

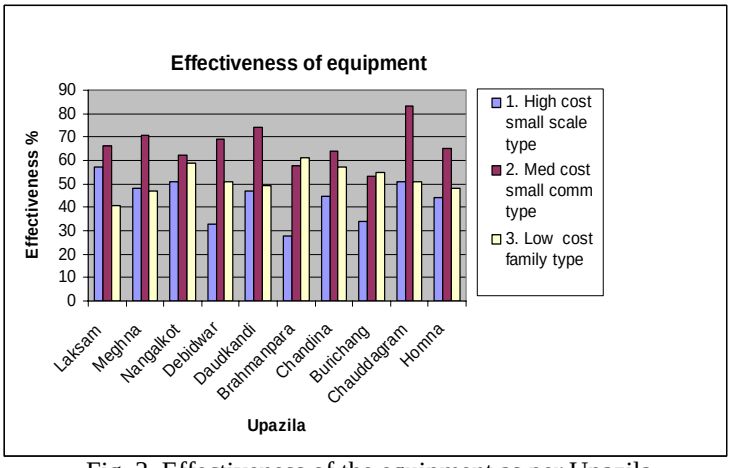


Fig. 3. Effectiveness of the equipment as per Upazila

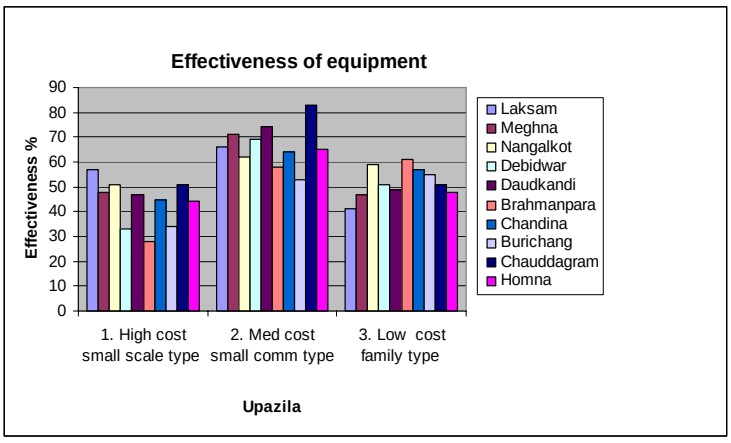


Fig. 4. Effectiveness of the equipment as per Equipment type

The symptoms and signs that arsenic causes appear to differ between individuals, population groups in specific ecological areas Chronic arsenic poisoning as occurs after long duration exposure through drinking water is different to acute poisoning. Several arsenic contamination and mitigation programs were formulated

on instrumentation process based on the symptom analysis (Mallik and Das, 2003; and Khan 2004). Immediate symptoms on poisoning typically include vomiting, esophageal and abdominal pain, and bloody "rice water" diarrhea. It has been thought that effectiveness of the whole process depends on the precision and identification of problems (Ahmed *et al.* 2002). Long exposure to arsenic via drinking water causes cancer of the skin, lung, urinary bladder and kidney as well as other skin changes such as pigmentation changes and thickening (hyperkeratosis). Increased risks of lung and bladder cancer and of arsenic associated skin lesions have been observed at drinking water arsenic concentrations of less than 0.05mg/l. Absorption of arsenic through the skin is minimal and thus hand washing, bathing, laundry etc. with water containing arsenic do not pose human health risk. Following long term exposure, the first changes are usually observed in the skin pigmentation changes and then hyperkeratosis, hypertensive and cardiovascular disease, diabetes and reproductive effects (WHO 1997). The water collected from different parts of the country was examined for arsenic content. It has been observed that every one in three shallow tube wells is producing water with arsenic in excess of acceptable limits. It is also observed that 59 districts within 64 have arsenic above maximum permissible limit in shallow tube wells (DPHE 2000).

Performance of the equipment as per site

The results obtained from the study on the effectiveness of the machines as per area reveal that Chauddagram and Laksam Upazila (Fig. 5) showed better performance as intensive training on its use was done and the users operated it in a comparatively more satisfactory level.

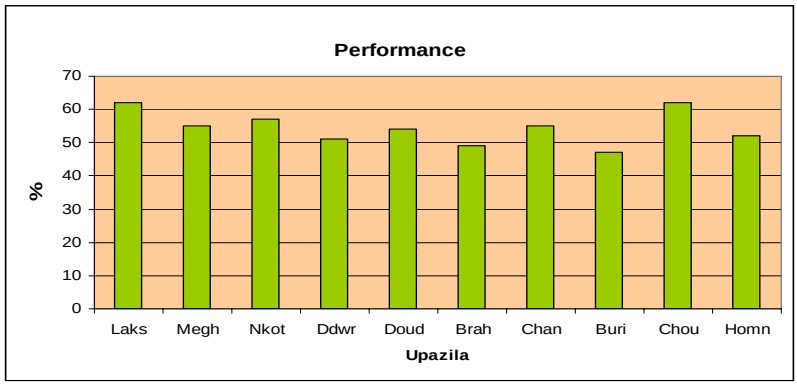


Fig. 5. Performance of the equipment

Choice of arsenic removal technology

In Comilla district, several arsenic removal technologies such as passive sedimentation, rice husk method, one bucket unit, two bucket unit etc. are already used by government and non-government organizations as a pilot project. The choice of arsenic removal technology very much depend on the availability of ground and surface water as well as rain water. The over lifting of ground water from shallow water table become a great problem for installation of Shallow Shrouded Tube well and Very Shallow Shrouded Tube well. Among all the options, pond sand filter is considered to be the best because it serves several families economically. Dug well can be chosen as a good alternative but it should be sanitary protected. For this cost becomes high which may be beyond the capacity of low income people. The Tara pump is a good one as alternative technology. The reliability of this technology is high because the depth of the tube well is comparatively high. Skilled persons can use the Canada Bangladesh Filter and some chemicals are required to purify the water. But these are not available in the study area although this technology can provide a significant amount of water.

Ahmed *et al.* (2002) stated that the cost of installation, operation and maintenance of different equipment varied greatly as per technical mechanisms and person or community coverage. As to the no. of families per unit it ranges from 1 to 1000, but the cost also varies from Tk 1 to Tk 95.

The results obtained on performance of machines as given in the Fig. 6 show that medium cost semi-manual community type equipments become effective by about 70% which may be due to its easy operation and its better arsenic removal efficiency.

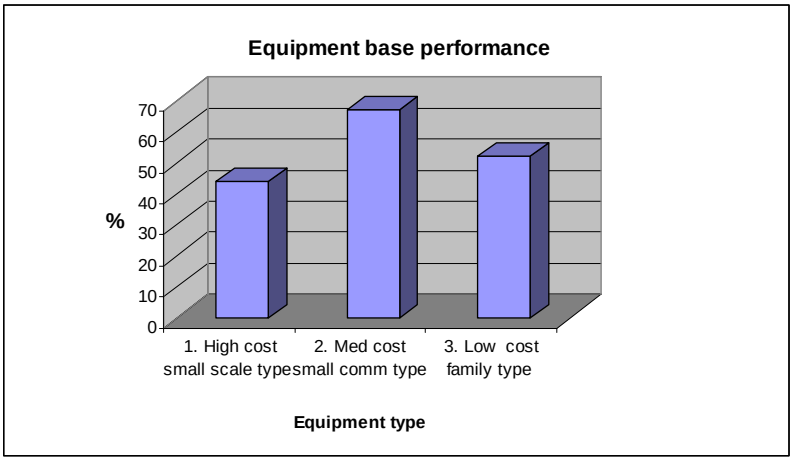


Fig. 6. Mean Performance of the equipment

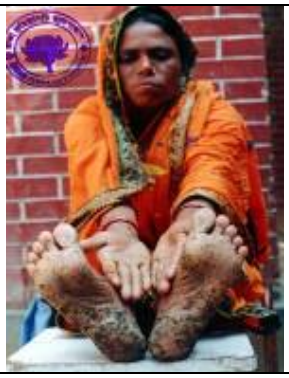
The arsenic poisoning from the contamination of ground water was found to be very chronic in nature. Most of the time the victims did not complain of the symptoms until they were detected through screening. The above symptoms were also very difficult to identify from other clinical conditions. The technology used to identify the arsenic cases were by external

manifestations especially with the presentation on the skin called Melanesia (blackening of skin) and kurtosis (hardening of palms and soles) with the history of consuming arsenic contaminated source water. Fig.7 shows the typical arsenic affected people in the study area with kurtosis.

Assessed severity stage 1:
Lesion initiation on hand palm
Equipment and process effectiveness status >60%, arsenic concentration <30%

Assessed severity stage 2:
Lesion prominent on hand palm Equipment and process effectiveness status 40-60%,
arsenic concentration 30-40%

Assessed severity stage 3:
Lesion prominent on hand and leg palm Equipment and process effectiveness status 30-40%,
arsenic concentration 40-60%



Assessed severity stage 4:
Equipment and process effectiveness status <30%
Lesion becoming black wart on hand palm
arsenic concentration >60%

Fig. 7. Arsenic visual symptom grades showing % of effectiveness after using arsenic removed water

Water supply and sanitation conditions

Almost every household has a hand tube well for the water supply in the study area of Eruani village. Most of the tube wells were constructed privately. These wells were sufficient for the supply of water to the people. But as most of them were constructed to a shallow depth (17–27 meter), due to change of the season the people feel the depression of water table during dry seasons. It was found that almost all the shallow tube well water was arsenic contaminated. The values exceed the allowable limit with respect of BDS and WHO standard. For this reason few families of this village were using filtration methods like Slow sand filter, Three Pitcher filter and dug well methods to fulfill the demand of water for drinking and cooking. For other purposes they use the water without filtration. A few people were found to use the pond water for cooking and bathing. Most of the people of this village are using arsenic contaminated water and most of the family of this village has sanitary latrine next to their house.

CONCLUSION

Most people in the study area are unaware of the arsenic problem. Water users, especially women, prefer Safi Filter to Three Pitcher Filter and among the alternative technologies Pond Sand Filter is preferred. People in the study area believe that the Government should pay for the arsenic mitigation measures to keep the price of arsenic removal technologies within the buying capacity of the consumers. According to the findings of the results it may be concluded that medium cost community level Arsenic removal equipment may be more effective in mitigating the arsenic problem in the area. However, strong arsenic hazard awareness and equipment operation training programs are of vital importance for solving the water contamination, arsenic removal and mitigation problems in the study area. The users should be oriented through method demonstration of community plants established with support from Government. It is an urgent need to study the arsenic mitigation engineering problems. High-tech instrumentation and extremely indigenous processes did not gain effectiveness and popularity due to higher costs and less faith respectively.

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