An Assesment of Arsenic Contamination of Tube-well Water in 17 No Ward of Chattogram City, Bangladesh

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Abstract: **Arsenic contamination of groundwater has now resulted in world-wide human health problems affecting millions of people across a large number of countries such as India, Pakistan, Thailand, China, Nepal and also in Bangladesh. In 1998-1999, DPHE & BGS, United Kingdom conducted a study which identified 61 districts out of total 64 in Bangladesh as arsenic affected. In 2008, CUET and the IEBC have been made a joint survey in 41 wards of Chattogram city and they have been found arsenic in shallow tube well water in 13 city wards which exceed WHO guidelines values of 0.01mg/l for drinking water. The present study was carried out to identify the Arsenic (As) contaminated tube-wellsin 17 no West BakaliaWard under Chattogram City Corporation. This work was done using HACH EZ Arsenic Test Kit in the field and then compared with Bangladesh Drinking Water Standard (0.05 mg/l) and WHO guidelines value (0.01 mg/l). It is revealed from the study that mostly 69.23% tube-wells are deep and 30.76% are shallow. Maximum depth of tube-wells is 650 feet and minimum depth is 70 feet. Among 169 samples, Arsenic is detected in 2.36% water samples and remaining 97.64% are Arsenic free. The maximum value of arsenic is found in the range of 0.25~0.05mg/l at Police Bit, Rahatturpul area.**

Keywords**: Arsenic; Chattogram, Tube-well; Field test kit; Bangladesh Drinking water standard; WHO guideline**.

I. INTRODUCTION

Arsenic is a ubiquitous element in the nature and widely distributed in air, water, soils, rocks, plants and animals in variable concentrations. Arsenic is toxic substance to human health and toxicity depends on the amount of arsenic intake, which is classified into acute, sub-acute and chronic toxicity respectively. Skin lesions, i.e. diffuse melanosis followed by spotted melanosis, hyperpigmentation, and keratosis, are common and are the first recognized health effects [1].Most of the ingested arsenic is excreted from the body through urine, stool, skin, hair, nail and breath. In excessive intake, some amount of arsenic is accumulated in tissues and inhibits cellular enzyme activities. Inhalation, ingestion and skin contact are the primary routes of human exposure to the arsenic. Chronic arsenic ingestion from drinking water is known to cause skin cancer, and there is substantial evidence that it increases risk for cancers of the bladder, lung, kidney, liver, colon, and prostate[2].

Arsenic pollution of ground water resources threatens the health of millions of people, particularly in the densely populated river deltas of the Southeast Asia. Major alluvial and deltaic plains and inland basins of Southeast Asia composed of young sediments (Quternary; thousands to tens of thousands of years old) are particularly prone to developing groundwater arsenic problems[3].Bangladesh has been facing issues with arsenic in the groundwater for decades. In 1993, the first case of arsenic poisoning was detected in Dhaka Community Hospital. In 1997, the first national-scale map of Arsenic concentration in Bangladesh's groundwater was produced which showed that 45% of the areas of Bangladesh had arsenic concentrations greater than 50 mg/l which exceeded national standard[4].The presence of arsenic contamination throughout Bangladesh is extensive, as evidenced through the findings in 1998, where 41 of the 64 districts in Bangladesh had concentrations of arsenic in groundwater exceeding 50 mg/l. By 2005, another study reported that 50 of 64 districts in Bangladesh had groundwater arsenic concentrations exceeding 50 mg/l [5].

In the year 1998 and 1999, British Geological Survey (BGS) and Department of Public Health Engineering (DPHE), Bangladesh conducted a national hydro chemical survey of well water in Bangladesh and found alarming amount of arsenic contamination in ground water of Bangladesh. Considering the Bangladesh standard limit of arsenic in drinking water (0.05 mg/l), about 27% of all shallow tube wells installed in 61 plain districts of Bangladesh could be remarked as contaminated with arsenic. The Corresponding figures for deep tube wells sunk to a depth of 150 meters and above, were 5% and 1% for arsenic contamination of 0.01 mg/l and 0.05 mg/l, respectively. It was widely believed that Bangladeshi peoples were getting exposure to arsenic because of the extensive use of arsenic contaminated groundwater for drinking and irrigation purposes since the 1960s. But the major cities in Bangladesh such as Chattogram were not covered by the survey, though groundwater is extensively used in these cities Consequently, in 2008 Chattogram University of Engineering & Technology (CUET) and the Institution of Engineers Bangladesh, Chattogram Centre (IEBC) jointly conducted a samples survey in Chattogram City Corporation (CCC) area where 41 numbers of ward

(administrative sub-divisions) are located [6]. From the CUET-IEBC survey, arsenic had been found in shallow tubewells of 13 city wards, of which 7 wards exceeded Bangladesh standard values of 0.05mg/l for drinking water and marked as red zones. Among these 7 alarming wards, the maximum arsenic concentration (0.3~0.4 mg/l) was found in wardno 17 (West Bakalia)and 40% tubewells were affected with arsenic[6]. However, that study did not cover all tubewells of the affected ward, only ten samples of each ward of Chattogram city were collected and analysed. So, this study aims to assess all tubewell water of 17 no ward to investigate the present status of arsenic contamination of ward no 17 which is named as West Bakalia ward.

Objectives of the Study:

The specific objectives of this study are:

- To determine arsenic concentration in all shallow tube wells water in the studied area.
- To compare the results of arsenic concentration level with WHO guide line value 0.01(mg/l) and Bangladesh standard 0.05 (mg/l).
- To identify existing arsenic contaminated zones in the studied area.

Study Area:

Ward no 17 named West Bakalia ward is selected as the Study area which is surrounded by East Bakalia (No.18), East Sholoshor (No.6), Sholokbohor (No.8), South Bakalia (NO.19), and Dewanbazar (No.20). Total area of this ward is 2.56 sq.km where approximately 2, 35,000 inhabitants are living and the literacy rate of the inhabitants is about 64.57%. Considering a huge number of people using water from tube well, assessing quality of water becomes very important. The location of the ward including shallow and deep tube well location has been illustrated in Fig 1.

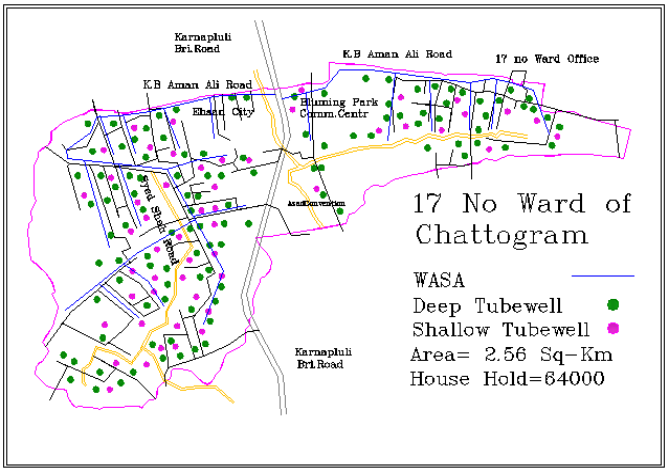

Fig: 1 Study Area Map of 17 No West Bakalia Ward of Chattogram

II. METHODOLOGY

Definition of Shallow & Deep Tubewells

According to "CUET and IEBC" paper [7], the definition of shallow and deep tube wells are:

Shallow Tubewells

Local people in general consider a tube-well as shallow, when the well diameter is about 1.5 inch (about 38 mm) and the depth is less so that water from it can be extracted manually by hand pump. In Chattogram, generally, shallow tube-wells find water within a maximum depth of 150 ft. (about 46 meters).

Deep Tube-Wells

Tube-wells sunk in deep aquifer, having a diameter greater than 1.5 inch, depth greater than the average tube-well and when motorized pumps are used for extracting water, the tube-wells are termed as deep tube-well. Deep tube-wells sunk in deep aquifer, on the other hand, have a varying depth of about 200 feet to 700 feet (about 60 to 215 meters).

In this study, tube-wells exceeding the depth of 150ft and having a diameter above 1.5 inch are considered as deep tube wells.

Collection of Water Sample

Water sample were collected in 250 ml mineral water bottles. About 170 empty bottles were collected, washed and dried. The bottles were washed again with the sample water before collection of the sample. The water was then tested in the field using HACH EZ Arsenic Test Kit. A number of field test kits are available in the market. HACH EZ Arsenic Test Kit was therefore used for field-testing of water samples from the tube-wells.

Field Testing of Water Samples

The water sample was tested in the field by using HACH EZ Arsenic Test Kit. The kit operated according to the procedures and instructions of the manual provided by the manufacturer. After finding the samples result, the Arsenic concentration level was compared with the WHO guideline value and Bangladesh standard. HACH EZ Arsenic Test Kit and its color chart is shown in figure 2. The arsenic field test picture is shown in figure 3.

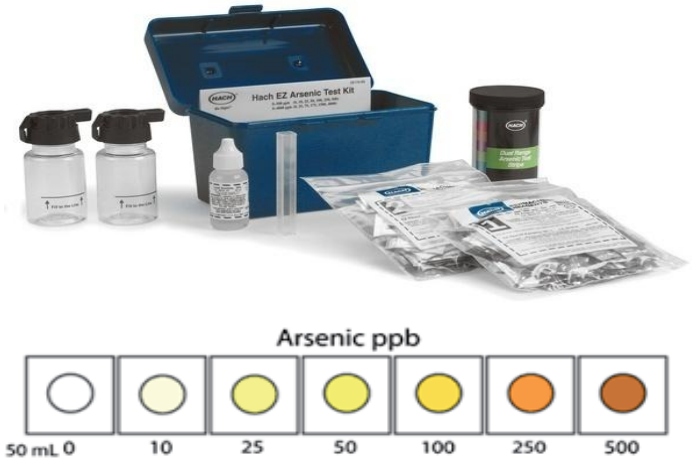

Figure 2: HACH EZ Arsenic Test Kit and Colour Chart

Fig 3: Arsenic Field Test Picture

III. RESULTS

Arsenic concentration was determined in 17 no ward of Chattogram city. A total of 169 tube wells were assessed for arsenic determination. For each tube well, information about depth and years of use were collected along with the type of tube well and arsenic concentration. Arsenic was determined by HACH Arsenic Kit. Generally arsenic has not been found in deep tubewells and from this study also it had been found that all deep tubewells (117) were free from arsenic. For this reason, the results of 52 shallow tube wells are shown in Table: 1 below.

Table 1: Arsenic concentration in shallow tubewell:

SL No	Tubewell Type	Name of Owner	Location	Depth (ft)	Use from the year	Arsenic content (mg/l)
1	Shallow	Md Siraz	BogarBill,RasulbagAbasik	100	2017	0
2	Shallow	Nurul Hakim	BogarBill,RasulbagAbasik	110	2018	0
3	Shallow	Saiful Colony	BogarBill,RasulbagAbasik	120	2010	0
4	Shallow	NurAkter	BogarBill,RasulbagAbasik	100	2017	0
5	Shallow	MdYeasir	Rasulbag, Block-E	150	2010	0
6	Shallow	Hasan	CanmiaMunsir Lane, Bakalia	100	2012	0
7	Shallow	Ali Neowaz	CanmiaMunsir Lane, Bakalia	100	2018	0
8	Shallow	Mohiuddin	D C Road, Taher Colony Block	150	2010	0
9	Shallow	Sonet	D C Road, Taher Colony Block	120	2015	0
10	Shallow	Yeakub	D C Road, Abu Colony	120	2014	0
11	Shallow	Hossain	Chairman Goli, Santinagar, BogarBill, Dewanbazar,	115	2015	0
12	Shallow	Mostofa-1	R A Chowdhury Abasik, Ramzan Ali Chowdhury Road	150	2017	0
13	Shallow	Mostofa-2	R A Chowdhury Abasik, Ramzan Ali Chowdhury Road	120	2017	0
14	Shallow	Sahzahan	Uzir shah Lane, Cherager Bari	125	2012	0
15	Shallow	SamzKabirMonzil	Uzir shah Lane, Cherager Bari	110		0
16	Shallow	Kabir	Uzir shah Lane, Cherager Bari	95	2003	0
17	Shallow	Nurul Islam	HaziNurSowdagor Bari	70	2004	0
18	Shallow	Sowkat	HaziNurSowdagor Bari	80	2015	0
19	Shallow	Mohammad Indris	HaziNurSowdagor Bari	100	2015	0
20	Shallow	Sekander	HaziNurSowdagor Bari	150	2005	0
21	Shallow	Mahmuda	MahmudaBaper Bari, Rahattarpul	120	2008	0
22	Shallow	Jamir Sowdagor	MahmudaBaper Bari,	135	2018	0.01-0.025 mg/l

SL No	Tubewell Type	Name of Owner	Location	Depth (ft)	Use from the year	Arsenic content (mg/l)
			Rahattarpul			
23	Shallow	Zamal	MahmudaBaper Bari, Rahattarpul	115	2015	0.00-0.010 mg/l
24	Shallow	Mostafiz	MahmudaBaper Bari, Rahattarpul	120	2020	0
25	Shallow	Monzo	MahmudaBaper Bari, Rahattarpul	120	2015	0
26	Shallow	Nasir Colony	Haziful Rahman lane, Poraton 4 Tola	100	2012	0
27	Shallow	Liton Colony	Haziful Rahman lane, Poraton 4 Tola	90	2012	0
28	Shallow	Sirazul Islam	Haziful Rahman lane, Poraton 4 Tola	100	2015	0
29	Shallow	Forkan	Haziful Rahman lane, Poraton 4 30Tola	120	2012	0
30	Shallow	NurulAbser	Haziful Rahman lane, Poraton 4 31Tola	120	2010	0
31	Shallow	NurBegam	Sayad S32hah Road, Nira32pod Building	150	2010	0
32	Shallow	Surovi Tower	SuroviAbasik	135	2018	0
33	Shallow	Sopnonil	SuroviAbasik	130	2008	0
34	Shallow	Haziyusof company	BoroKoborstan, Yousuf Company Goli, Rahattarpul	120	2015	0
35	Shallow	Kasem	BoroKoborstan, Yousuf Company Goli, Rahattarpul	145	2017	0
36	Shallow	Usman goni	ZorinaBaperBari,Hozorot Tajuddudin Shah Mosque, Rahattapul	125	2018	0
37	Shallow	Rezaulkarim	Waziullah Master Bari	150	2010	0
38	Shallow	KabirSaheb	Police Bit, Rahattarpul	110	2010	0.025-0.050 mg/l
39	Shallow	AltafMenson	Mostafa Abasik	150	2004	0
40	Shallow	Hazera Feles	Mostafa Abasik	140	2012	0
41	Shallow	KazimulSaifuddin	SalbonAbasik	110	2016	0
42	Shallow	Sobor (SP Colony)	Mazar Road (Deputy road)	60	2015	0.00-0.010 mg/l
43	Shallow	Liton	Mazar Road (Deputy road)	150	2019	0
44	Shallow	Munshi Mia	Mazar Road (Deputy road)	150	2012	0
45	Shallow	Md. Nasir	Bow Bazar	250	2004	0
46	Shallow	Md. Kalam	Bow Bazar	75	2016	0
47	Shallow	Anwar Hossain	Bow Bazar	85	2003	0
48	Shallow	ShiponHoque	Bow Bazar	150	1999	0
49	Shallow	AbedaKhatun	Khalpar,Bakalia	128	2008	0
50	Shallow	KepayetUllah	Khalpar,Bakalia	100	2019	0
51	Shallow	Iftekhar Ahmed	Khalpar,Bakalia	90	2009	0
52	Shallow	Golam Mortuza	Khalpar,Bakalia	95	2011	0

Water samples from 117 deep tubewells from the study area were collected similarly and similar information as shallow tubewells were gathered for arsenic analysis of all deep tubewells. No arsenic was found in deep tubewells of 17 no ward.

IV. ANALYSIS OF ARSENIC CONTAMINATION

Arsenic concentration may be grouped into 2 major categories: i) Safe Level (less than 0.05mg/l) ii) Contamination Level (greater than 0.05mg/l).

Safe level is categorized into three categories: a) 0 b) WHO permissible level (<0.01 mg/l) and c) BD Standard Maximum Contamination Level MCL (< 0.05 mg/l) [8].These groupings and the results of study area are presented in Table 2.

Table 2: Analysis of Arsenic Concentration

Major Group	Arsenic Magnitudes (mg/l)	Detailed Classifications	Number of Tube wells
Safe Level	0	0	165
	< 0.01	WHO Permissible Limit	2
	< 0.05	Bangladesh Standard Limit	2
Contamination Level	0.05-0.1	Moderate Contamination	None
	0.1-0.3	High Contamination	
	> 0.3	Severe Contamination	

According to Table 2, arsenic concentration values of all samples of this ward are in safe level (0 to 0.05 mg/l). The results of arsenic analysis are presented in Table 3 below.

Table 3: Results of Arsenic analysis

Deep tubewell (Above 150 feet depth)		Shallow tubewell (From EGL to 150 feet depth)	
No of tubewell	Value of Arsenic (using Kit)	No of tubewell	Value of Arsenic (using Kit)
117	0 mg/l	48	0 mg/l
		2	0.00-0.010 mg/l
		1	0.01-0.025 mg/l
		1	0.025-0.050 mg/l

From the analysis, 165 tubewells of the studied area are free from arsenic, 2 tubewells are within WHO permissible Limit and 2 tubewells exceed WHO standard limit but within Bangladesh Standard Limit. This is represented in percentage form in figure 4.

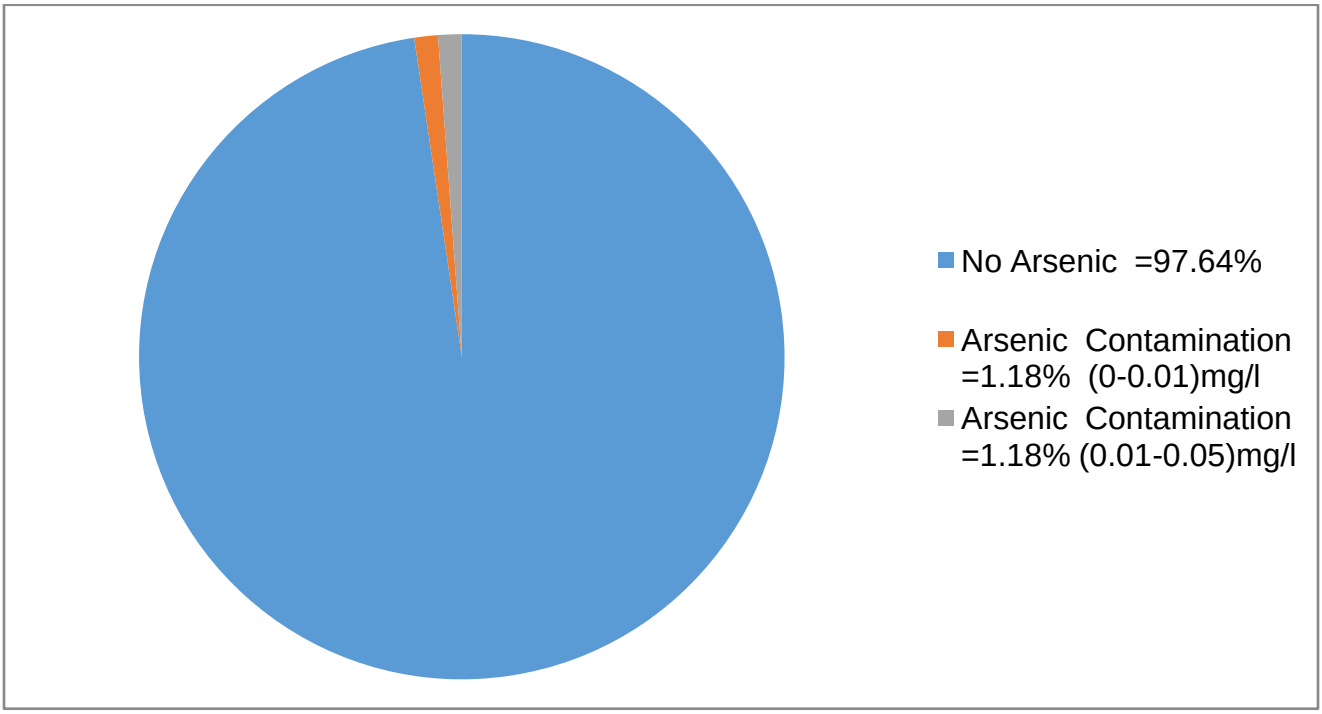

Figure 4: Percentage of Arsenic Analysis

V. CONCLUSION

Arsenic is a slow poison. It may take five to fifteen years to reach the last stage of Arsenicosis. Therefore, arsenic test of tubewells must be done at regular intervals. From this arsenic study of 17 no ward of Chattogram city, Arsenic is not found in deep tubewells that means beyond the depth of 46 meter (about 150 feet). Arsenic is found in 4 Tube wells; among these 2 Tube wells are within WHO permissible limit and other 2 Tube wells arsenic value exceed WHO limit but within Bangladesh Standard Limit. The maximum arsenic value is found in the range of 0.25~0.05mg/l in Police Bit, RahatturPul area. So, people living in this area must make conscious about it. However, we cannot paint red of four tubewells which we found arsenic because the arsenic value did not exceed Bangladesh standard limit (0.05 mg/l). Moreover, during this study, information about WASA line coverage is gathered. Maximum area is enclosed by WASA at present except the following area:Police Bit (RahattarPul Area), Bagan Bari, Mostafa R/A (RahattarPul Area), half of Rasulbag R/A, half of Sayed Sha Road, Ratter pul A. Khalik, Chan Mia Munshi R/A, BagarBil, Shalbon R/A. Though the percentage of arsenic is quite low (2.36%) in these area, it is harmful for people consuming tubewell water for their health.

So, this study recommends that the mentioned area must be under the supply of WASA as early as possible so that people can avoid tubewell water atleast for drinking purpose.

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