Assessment of Arsenic Concentration in Ground Water of Tube Wells in Selected Primary Schools’ at Palashbari Upazila of Gaibandha District
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Abstract
Arsenic contamination has been recognized as an acute national problem in Bangladesh. Tube wells, one of the most important sources of drinking water in Bangladesh, are contaminated by arsenic in 61 districts out of a total of 64. Children who are exposed to high levels of arsenic in their drinking water are 7 to 12 times susceptible than adults. This study was conducted to know the arsenic concentration level in primary schools’ tube wells. Twenty seven schools were selected at Palashbari upazila of Gaibandha district under Rangpur division. Econo Quick test kit was used to measure arsenic concentration. Global Positioning System (GPS) was used to indicate the geographic location. Fifteen were Sallow Tube Well no. 06 and eleven were Deep Tube Well no. 06 among the examined tube wells. Arsenic concentration of these studied tube wells were ranged between 0 to 200µg/L. Except two all are below (0 to 10µg/L) the WHO maximum permissible level (50µg/L). Among these two one lies marginal level (50µg/L) and another crosses the level (200µg/L). Arsenic concentrations of these tube wells were not high. So, there could be considered as a safe source of drinking water for the pupils of these primary schools.

Key Word: Arsenic, Concentration, Contamination, Drinking water, Primary School

Introduction
Bangladesh is fighting with the largest mass poisoning of a population in history because groundwater used for drinking has been contaminated with naturally occurring inorganic arsenic (Smith et al. 2000). Arsenic contamination of groundwater in Bangladesh was first detected in 1993 (Khan et al. 1997). Recent findings of the British Geological Survey (BGS,1999) show that groundwater of 61 surveyed districts, out of a total of 64, is contaminated with arsenic (BGS, 1999). However, survey results of the School of Environmental Studies (SOES) and Dhaka Community Hospital (DCH) show that 47 districts are contaminated (SOESDCH, 2000). Tube wells are the single-most important source of fluid (drinking water) in Bangladesh (Asadullah and Chaudhury, 2008). Tube-wells have been used in Bangladesh since the 1940s (UNICEF, 1999). According to 2001 population census, 88% of rural households use tube wells as the main source of drinking water. Even in the early 1970s drinking from open water bodies was a common practice. However, surface water is often contaminated with bacteria and a major cause for waterborne diseases such as cholera, dysentery, typhoid, and diarrhoea. Unsurprisingly, these water-related illnesses in young children were the leading cause of morbidity and mortality (Asadullah and Chaudhury, 2008).

Infants and children suffered from acute gastrointestinal disease resulting from bacterial contamination of stagnant pond water (Smith et al. 2000). Consequently, during the 1970s the United Nations Children’s Fund (UNICEF) worked with the Department of Public Health Engineering to install tube-wells to provide what was presumably a safe source of drinking-water for the population. These wells consist of tubes with 5 cm in diameter and are inserted into the ground at depths of usually less than 200 m. The tubes are then capped with a cast. Bangladesh had surpassed its goal of providing 80% of the population by 2000 with access to ‘’safe’’ drinking-water in the form of tube-wells, ring-wells and taps (UNICEF, 1998).

Tube well construction strongly accelerated in the 1980s. Around 11 million tube wells were installed during the period, a vast majority being in private ownership (Geen et al. 2005). This initiative has helped control water-born diseases, but in many areas it has had the unintended side-effect of exposing the population to another health problem – toxic arsenic in ground water. However, the problem of arsenic contaminated water has only recently come to light due to the increasing number of tube-wells used over the past 20 years and the subsequent increase in the number of individuals drinking from them (Smith et al. 2000).

Arsenic toxicity has been recognized as an acute national problem. The World Health Organization (WHO) maximum permissible level is less than 50 (µg/L) of arsenic. Intake of arsenic over the permissible level over a period of several years leaves a person at risk of developing arsenic related diseases. So far, 40,000-100,000 people have already developed visible pigmentation of skin, skin lesions, swollen limbs, warts, gangrene, and cancer and/or invisible damage to lungs, kidneys, and other internal organs, loss of feeling in the hands and legs. Prolonged exposure to inorganic arsenic can lead to hallucinations, agitation, emotional lability, memory loss, gangrene and skin as well as internal (lungs, bladder and kidneys) cancer (ATSDR, 2005).
No affordable technology exists that can either remove arsenic from drinking water or at least reduce it to a level at which it has no adverse effect on human well-being (Asadullah and Chaudhury, 2008). Therefore, majority of the affected population continues to remain exposed to the crisis. There are a number of studies documenting the adverse effect of arsenicosis on physical wellbeing of adults (Asadullah and Chaudhury, 2008). While the adverse effect of arsenicosis on adult health is well-documented, little is known on the consequences of the catastrophic health crisis caused by drinking metal-contaminated groundwater.

Children who are exposed to high levels of arsenic in their drinking water are seven to 12 times more likely to die of lung cancer and other lung diseases in young adulthood (Smith et al. 2006). There are at least four reasons why educational development of children is likely to be hampered owing to exposure to arsenicosis. First, children who have continuously drank from Arsenic contaminated tube-wells are likely to have worse health status and under-perform in schools compared to the peers who have grown up in arsenic unaffected households. Second, arsenicosis at home may cause adverse income shocks. Third, there is an emerging body of medical evidence documenting a direct impact of arsenic exposure on the intellectual development of children. Lastly there is evidence that, when exposed to arsenic at early ages, children can develop visible symptoms such as pigmentation and arsenical skin lesions by the time they reach secondary school age (Asadullah and Chaudhury, 2008).

Most children are exposed to arsenic largely through fluid intake at home and in school. School performance of children from affected households could be undermined for an additional reason. With nearly-complete awareness regarding the health implications of arsenicosis, affected households are increasingly seeking access to arsenic-free tube wells. Traditionally, children are sent to fetch water which cuts into study hours at home would adversely affect school performance of children.

This study therefore aims to test for the water of tube wells to know the arsenic concentration level in selected primary schools at Palashbari upazila of Gaibandha district which was supported by United Nations Children’s Fund (UNICEF).

**Materials and Methods**

**Study area**

Palashbari upazila of Gaibandha district under Rangpur division is located at 25°11’N to 25°19’N latitude and 89°14’E to 89°35’E longitude. It is bounded by Pirganj (Rangpur), Sadullapur and Gaibandha sadar upazilas on the north, Gobindaganj upazila on the south, Gaibandha sadar and Sughatta upazila on the east and Ghoraghat upazila on the west with an area of 190.67 sq km.

![Figure 1: Showing the study area, Palashbari upazila of Gaibandha district in Bangladesh](image)

**Data collection**

Selected twenty seven schools were visited during September to October, 2011 and data of Water Point Type, Water Point Depth (feet), Water Point Status, Arsenic concentration (µg/l) etc. was recorded. Water samples of these schools were tested by Econo Quick test kit. GPS (Global Positioning System) machine was used to indicate the geographic location of the study area. Every school’s geographic locations (Latitude and Longitude) were set up by the GPS machine.

**Arsenic Test KIT Components**

- Two reaction bottles
- Two white caps with white turrets for holding test strips
- Three plastic spoons (one large pink spoon for reagent 1, one smaller red spoon for reagent 2, and one smaller spoon for reagent 3)
- Arsenic test strips
- Reagent #1 (tartaric acid with rate enhancers)
- Reagent #2 (an oxidizer)
- Reagent #3 (zinc powder)
- Two red caps for mixing
- Easy read color chart
Arsenic Test Procedure
The analysis was performed in a closed reaction plastic bottle. The reaction bottle was rinsed two times by the sample water to be tested, and then the sample water was poured up slowly to the marked line on the bottle (50 ml). First, the water sample was mixed in the supplied reaction vessel with Reagent #1 (tartaric acid with rate enhancers), red cap securely was sealed and shake vigorously, and the bottle was positioned upright for 15 seconds to acidify the water sample. Uncapped the reaction bottle and then Reagent #2, an oxidizer, was added to remove hydrogen sulfide interference. Again recapped securely with the red cap and shake vigorously with the upright position of the bottle for 15 seconds. The reaction bottle was uncapped again and finally Reagent #3, Zinc powder, was added in the sample. Then the red cap was sealed securely and shake vigorously in a upright position the bottle uprights for 5 seconds again. Test strip was inserted into the turret line on the bottle (50 ml). First, the water sample was poured up slowly to the marked point of Zinc powder and includes the following reactions:

\[
\text{As}_2\text{O}_3 + 12\text{Zn} + 2\text{H}^+ \rightarrow 4\text{AsH}_2\text{(gas)} + \text{Zn}^{2+} + 6\text{H}_2\text{O} \quad \text{(pH=1.6)}
\]

\[
\text{Zn} + 2\text{H}^+ \rightarrow \text{Zn}^{2+} + \text{H}_2 \text{(gas)}
\]

The color chart was used to match the test strip pad color within the next 30 seconds. For the best color matching direct sun-light was avoided direct sunlight. The reacted test strip pad was positioned behind the punch holes (to view the centre of the test strip pad through the hole) to confirm precise color match and to direct arsenic level.

Data analysis
Collected data were analyzed using MS Excel 2007 package.

Results and Discussions
Among the selected twenty seven primary schools only six are Government Primary School and rest twenty one are Non Government Primary Schools. These schools located 25°13'02.1" N to 25°18'18.5" N latitude and 89°16'23.0" E to 89°28'27.6" E longitude (Table 1).

Table 1: Sampling information of different tube wells of selected primary schools

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Name of School</th>
<th>Latitude</th>
<th>Longitude</th>
<th>Water Point Type</th>
<th>Water Point Depth (Feet)</th>
<th>Arsenic (µg/L)</th>
<th>Water Point Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Shaindha Reg. Non-Government Primary School</td>
<td>25°14'12.7&quot;</td>
<td>89°19'25.7&quot;</td>
<td>STW6</td>
<td>30</td>
<td>0</td>
<td>Running</td>
</tr>
<tr>
<td>2.</td>
<td>Salmara Reg. Non-Government Primary School</td>
<td>25°13'48.2&quot;</td>
<td>89°20'22.5&quot;</td>
<td>STW6</td>
<td>38</td>
<td>10</td>
<td>Running</td>
</tr>
<tr>
<td>3.</td>
<td>Kariata Reg. Non-Government Primary School</td>
<td>25°13'02.1&quot;</td>
<td>89°20'14.8&quot;</td>
<td>STW6</td>
<td>60</td>
<td>0</td>
<td>Running</td>
</tr>
<tr>
<td>4.</td>
<td>Konabori Reg. Primary School</td>
<td>25°13'06.6&quot;</td>
<td>89°21'22.7&quot;</td>
<td>STW6</td>
<td>45</td>
<td>0</td>
<td>Choked Up</td>
</tr>
<tr>
<td>5.</td>
<td>Jalingi Reg. Non-Government Primary School</td>
<td>25°18'00.7&quot;</td>
<td>89°25'00.2&quot;</td>
<td>STW6</td>
<td>77</td>
<td>0</td>
<td>Running</td>
</tr>
<tr>
<td>7.</td>
<td>Laxmimari Government Primary School</td>
<td>25°17'19.9&quot;</td>
<td>89°24'38.1&quot;</td>
<td>DTW6</td>
<td>160</td>
<td>0</td>
<td>Running</td>
</tr>
<tr>
<td>8.</td>
<td>Forkondapur Reg. Primary School</td>
<td>25°18'02.2&quot;</td>
<td>89°24'24.0&quot;</td>
<td>DTW6</td>
<td>180</td>
<td>0</td>
<td>Choked Up</td>
</tr>
<tr>
<td>No.</td>
<td>School Name</td>
<td>Coordinates</td>
<td>Water Level</td>
<td>STW6</td>
<td>Water Level</td>
<td>Status</td>
<td></td>
</tr>
<tr>
<td>-----</td>
<td>------------------------------------------------</td>
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<td>------</td>
<td>-------------</td>
<td>----------</td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>Shampur Reg. Primary School</td>
<td>25°18'18.5&quot;</td>
<td>89°24'06.7&quot;</td>
<td>STW6</td>
<td>35</td>
<td>Choked Up</td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>Bujruk Bishnowpur Government Primary School</td>
<td>25°16'04.3&quot;</td>
<td>89°23'22.1&quot;</td>
<td>DTW6</td>
<td>155</td>
<td>Running</td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>Chondipur Reg. Non-Government Primary School</td>
<td>25°18'08.1&quot;</td>
<td>89°22'45.6&quot;</td>
<td>DTW6</td>
<td>110</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td>KyarPara Government Primary School</td>
<td>25°15'29.4&quot;</td>
<td>89°24'19.7&quot;</td>
<td>STW6</td>
<td>70</td>
<td>Running</td>
<td></td>
</tr>
<tr>
<td>13.</td>
<td>Balabomonia Ideal Reg. Non-Government Primary School</td>
<td>25°14'38.5&quot;</td>
<td>89°26'27.9&quot;</td>
<td>DTW6</td>
<td>120</td>
<td>Running</td>
<td></td>
</tr>
<tr>
<td>14.</td>
<td>Balabomonia ProdhanPara Reg. Primary School</td>
<td>25°14'37.2&quot;</td>
<td>89°27'13.0&quot;</td>
<td>STW6</td>
<td>65</td>
<td>Running</td>
<td></td>
</tr>
<tr>
<td>15.</td>
<td>Ghorabandha Purbopara Government Primary School</td>
<td>25°15'38.8&quot;</td>
<td>89°28'27.6&quot;</td>
<td>DTW6</td>
<td>135</td>
<td>Running</td>
<td></td>
</tr>
<tr>
<td>17.</td>
<td>Chalkbala Reg. Primary School</td>
<td>25°16'37.3&quot;</td>
<td>89°16'23.0&quot;</td>
<td>DTW6</td>
<td>80</td>
<td>Choked Up</td>
<td></td>
</tr>
<tr>
<td>18.</td>
<td>Pacchim Ramchondrapor Non-Government Primary School</td>
<td>25°16'17.0&quot;</td>
<td>89°16'50.9&quot;</td>
<td>DTW6</td>
<td>90</td>
<td>Running</td>
<td></td>
</tr>
<tr>
<td>19.</td>
<td>Pacchim Ramchondrapor Pacchimpara Reg. Primary School</td>
<td>25°16'09.6&quot;</td>
<td>89°16'29.8&quot;</td>
<td>STW6</td>
<td>26</td>
<td>Running</td>
<td></td>
</tr>
<tr>
<td>20.</td>
<td>Sultanpur Bariapara Reg. Primary School</td>
<td>25°17'03.1&quot;</td>
<td>89°19'09.4&quot;</td>
<td>STW6</td>
<td>25</td>
<td>Running</td>
<td></td>
</tr>
<tr>
<td>21.</td>
<td>North Sultanpur Bariapara Reg. Primary School</td>
<td>25°17'24.6&quot;</td>
<td>89°18'47.2&quot;</td>
<td>STW6</td>
<td>77</td>
<td>Running</td>
<td></td>
</tr>
<tr>
<td>22.</td>
<td>Beradanga Reg. Non-Government Primary School</td>
<td>25°15'57.7&quot;</td>
<td>89°18'28.1&quot;</td>
<td>DTW6</td>
<td>85</td>
<td>Running</td>
<td></td>
</tr>
<tr>
<td>23.</td>
<td>Nowana Nowda Reg. Primary School</td>
<td>25°16'21.8&quot;</td>
<td>89°19'33.5&quot;</td>
<td>STW6</td>
<td>70</td>
<td>Running</td>
<td></td>
</tr>
<tr>
<td>24.</td>
<td>Karatua Para Reg. Primary School</td>
<td>25°14'17.1&quot;</td>
<td>89°17'55.3&quot;</td>
<td>STW6</td>
<td>55</td>
<td>Running</td>
<td></td>
</tr>
<tr>
<td>25.</td>
<td>Hasbari Model Government Primary School</td>
<td>25°13'55.5&quot;</td>
<td>89°21'03.2&quot;</td>
<td>STW6</td>
<td>45</td>
<td>Choked Up</td>
<td></td>
</tr>
<tr>
<td>26.</td>
<td>Rangamati Government Primary School</td>
<td>25°18'08.5&quot;</td>
<td>89°20'09.1&quot;</td>
<td>Motor Pump</td>
<td>170</td>
<td>Running</td>
<td></td>
</tr>
<tr>
<td>27.</td>
<td>Durgapur Fazoria Reg. Primary School</td>
<td>25°15'57.7&quot;</td>
<td>89°22'25.6&quot;</td>
<td>DTW6</td>
<td>120</td>
<td>Running</td>
<td></td>
</tr>
</tbody>
</table>

STW6: Sallow Tube Well no. 06; DTW6: Deep Tube Well no. 06

Most of the (15) tube wells are Sallow Tube Well no. 06 (STW6) with a range of water depth 25 to 77 feet, one is motor pump with a water depth of 170 feet and rests of the (11) tube wells are Deep Tube Well no. 06 (DTW6) with a range of water depth 80 to 180 feet. Most of these tube wells are running and few are choked up (Table 1).
Figure 2: Showing the arsenic concentration (µg/L) in selected primary schools' tube wells

Arsenic concentration of these study tube wells ranges between 0 to 200µg/L. Most of the tube wells contain zero (0µg/L) arsenic concentration (Figure 2). Only one tube well’s arsenic concentration (200µg/L) crosses the WHO maximum permissible level which is 50µg/L for Bangladesh and one tube wells lies on marginal level (50µg/L).

Figure 3: District wise arsenic concentration (in µg/L)

Source: BGS and DPHE 2001

Arsenic concentration of these study tube wells were lower because there is a distinct regional pattern of arsenic contamination with the greatest contamination in the south and south-east of the country and the least contamination in the north-west and in the uplifted areas in the north-central Bangladesh. The
young (Holocene) alluvial and deltaic deposits are most affected whereas the older alluvial sediments in the north-west and the Pleistocene sediments of the uplifted Madhupur and Barind Tracts normally provides low arsenic level (BGS and DPHE, 2001). Gaibandha is the least affected district, the average arsenic concentration is 22µg/L (Figure 3). Even in areas of generally low arsenic concentrations, there are occasionally ‘hot spots’ where a cluster of wells with unusually high concentration (200 µg/L) of arsenic are found (BGS and DPHE 2001), (Figure 2).

**Conclusion and Recommendation**
Arsenic concentration of these studied tube wells was not high enough. It should be considered as a safe drinking water source for the pupils of these primary schools except two wells. The high concentrations in these two wells have to ban for drinking purpose but may be use for bathing, washing and toilet purpose.

To achieve the suitable quality of drinking water as well as the development of school’s children following steps should be taken-
- From a worldwide perspective, drinking water derived from aquifers showing similar characteristics to those of the Bengal Basin should be considered ‘at risk’ and need to be systematically tested for arsenic.
- Future studies therefore should aim at collecting additional data on past exposure at all levels of schooling.
- Furthermore, these studies should also involve collection of urine/blood samples from pupils to measure actual levels of arsenic exposure and their health status.

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