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STUDY OF ARSENIC CONTAMINATION OF GROUND WATER IN SADAR BLOCK SARAN DISTRICT OF NORTH BIHAR, INDIA

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ABSTRACT

Bihar Plains, ground water is the most important source of drinking and irrigation water. The study areas of four villages Rasalpura, Doriganj, Sherpur & Telpa Saran have been selected. These four research areas are very close to the Ganga and Gandak rivers Sadar block of Chapra. Water samples of 120 private and government owned hand pumps were tested and calculate Mean, Standard Deviation, Standard error and Arsenic Contamination in Ground water. As far as the villages Of Chapra Sadar is concerned, the Rasalpura village area with its mean arsenic concentration showed the highest mean value from range 0.02-0.10 of site-1. The observed highest mean arsenic concentration was 0.04478 Mg/l. While, the lowest mean arsenic volume was observed from the range 0.005-0.025 with 0.0964 mean values. From Doriganj village, which is very close to the river system showed similarly trends of the distribution of mean arsenic concentration value. Here, the highest mean value was observed from site I (range 0.02-0.10) with 0.050160 Mg/l. while, the site-6 contributed least amount of the mean arsenic concentration (0.006630 Mg/l). At Sherpur village, the highest mean value of arsenic concentration was observed form site-I and its value was 0.04962 Mg/l. While, the minimum amount of the arsenic concentration was observed from the site-6 with the mean value of 0.008635. Here, site-2 constitutes high SD value (0.03692) and the site-6 showed least SD value (0.00922). At Telpa, so, in present research work, the arsenic concentrations are distributed mostly in the range of 0.02-0.01. At this range the arsenic concentration is very high. Now, almost in every site the range of arsenic distribution is not similar. This heterogeneous distribution of arsenic is due to the distance from riverine sources.

Keywords: ***Mean, Standard Deviation, Standard Error, Arsenic Contamination, & Water sources.***

INTRODUCTION

Arsenic in groundwater, as a major contaminant and a threat to health of human beings, has been a subject of intense and in-depth research, at national and global level, in affected countries. Significant progress has been made towards understanding the pattern of arsenic distribution and processes of its mobilization in groundwater. There have been detailed studies on health impacts of chronic ingestion of arsenic. Several alternative safe water options, such as, arsenic removal filters, dug wells, rainwater harvester, pond sand filter and arsenic-safe deep tube-wells are now being deployed in affected countries as mitigation measures. In spite of such efforts, access to safe water still remains a big challenge in providing safe drinking water to all. In Bihar where drinking water supply is mainly based on groundwater sources, both in rural and urban settings, Arsenic remains a major threat to public health.

Arsenic is a natural contaminant in groundwater at a global scale and is recognized as a severe problem in many parts of the world owing to its potential risk through drinking water exposure. The scenario of arsenic toxicity is alarming in different countries of Asia such as India, Bangladesh, Cambodia, China,Nepal, Pakistan, Taiwan, Thailand and Vietnam as well as in many Latin American countries. Arsenic concentration exceeding the maximum contamination levels set by the WHO and other national and international regulatory organizations are being identified in new areas every year. The use of groundwater contaminated with arsenic for irrigation is an additional concern due to the transfer from water to food chain and thus identified as additional pathway for arsenic ingestion by humans and livestock. The concentration of Arsenic (As) in groundwater of natural origin is recognized as a severe environmental problem in many parts of the world owing to its potential risk through drinking water exposure. Arsenic has been identified as a serious public health concern (Nordstrom 2002). Arsenic contamination in drinking water supplies reported from more than 70 countries posing a serious health hazard to an estimated 150 million people world-wide (Bhattacharya et al., 2004; Ravenscroft et al., 2009). Arsenic toxicity from prolonged exposure can lead to arsenicosis (skin alterations), cardiovascular diseases and eventually to a variety of cancers (Smith and Steinmaus, 2009) and is associated with increased mortality (Argos et al., 2018). In most cases, clinical symptoms usually develop after a long latent period of chronic poisoning from the ingestion of As. Guidelines for drinking-water quality established by the World Health Organization (WHO) include chemical and biological hazards from both natural and anthropogenic sources.

It was reported that the Ganga-Meghan-Brahmaputra (GMB) plain, which had an area of approximately 500,000 km2 and the population over 500 million, was at risk from ground water arsenic contamination. According to Public Health Engineering Department, Government of Bihar and UNICEF - Bihar, arsenic contamination of ground water was found in several districts of Bihar, viz. Patna, Saran, Vaishali, Katihar, Purnea, Araria, Supaul, Kishanganj, Madhubani, Sitamarhi, East and West Champaran, Khagaria, Begusarai and Bhagalpur. Extensive exposure to high level of arsenic in drinking water may cause serious health hazard.

Arsenic toxicity

Arsenic in groundwater that is used for human consumption water, poses the greatest threat to public health. Reliable data on exposure and health effects are rarely available, but it is clear that there are many countries in the world where arsenic in drinking water has been detected at concentrations greater than the WHO Guideline Value, 0.01 µg/l or the prevailing national standards. These include Argentina, Australia, Bangladesh, Chile, China, Hungary, Mexico, Peru, the United States of America and some countries in the South-East Asia Region. The arsenic crisis in Bangladesh has been described as one of the worst cases of mass poisoning in world history. W.H.O. has published guidelines for Drinking Water Quality in which a contemporary value for an acceptable maximum level of Arsenic was set at10µg/l for safe water. National standards range from7µg/l in Australiato50µg/l in Vietnam, Cambodia and Bangladesh.

Long-term oral exposure via drinking water can cause cancer of the skin, lungs, urinary bladder, and kidneys. With long term exposure the first changes are usually seen in the skin pigments (indicator of arsenic poisoning), then hyperkeratosis. Symptoms of chronic arsenic poisoning can take five to 15 years to appear and are apparently influenced by nutrition and general health standards. Increased risks of lung and bladder cancer and of skin lesions have been observed at arsenic concentrations of less than 0.05mg/l of drinking water.

Statement of the problem

Naturally occurring Arsenic, as a water quality issue in South Asia, began to attract international attention in theearly decade of the nineties, when widespread chronic arsenic poisoning cases became apparent in Bangladeshand later in West Bengal, India. Arsenic pollution in groundwater in this part of the subcontinent is a contentious issue. Investigations in to the causation of arsenic pollution require a multidisciplinary approach.

MATERIALS AND METHODS

One hundred and thirty-two tubewell water samples were collected from different locations of Saran district, Bihar, India, in the month of September to October, 2018. The samples were collected in pre-cleaned sterilized polyethylene bottles of one liter capacity following standard protocol. To avoid any contamination at the source, the samples were taken by holding the bottles at the bottom and drawn directly from the tubewell after water was allow running at least fifteen (15) minutes (Karthikeyan et al., 2010). The water samples were immediately refrigerated after collection and brought to the laboratory with extreme care and preserved for further analysis.

Methodology:

This research team formulated the Protocol, duly approved by Govt. of Bihar, Govt. of U.P., and UNICEF, fordetection of arsenic over large areas. This Protocol is specifically intended for use by all those involved witharsenic detection in hand pumps using field test kits. The methodology incorporated in the Protocol has the following significant components-

All the public hand pumps of the study area were tested for Arsenic content through Field Test Kits.

Each public and pump tested was marked, with a unique Identification Code at the time of testing. The 13-digit code was derived from the Census 2001. This information identified the State, District, block and village, and finally the serial number of the Hand pump.

There is an increasing need to map the level of arsenic concentration, trends of arsenic flow andtemporal changes occurring in its concentration levels. Recording the locations of Arsenic-affected handpumps, using Global Positioning System (GPS) units, was done, followed by mapping of the arsenicoccurrences. The other references used were Block Maps, Topographical Maps.

Use of field test kits as basic indicator of arsenic contamination

The initial assessment of ground water arsenic contamination has been done by Chemical of analytical grade were procured from M/S, Merck India Ltd; and used through the study without further purification. To prepare all reagents and standards, double distilled water was used. All glassware was cleaned by being soaked in 15% HNO_3 and rinsed with double distilled water. Each sample was analyzed three times and the results were found reproducible within ± 3 error limit. The sets of water samples were analyzed in the P.H.E.D. lab for water analysis Chapra, Saran.

The pH values of the water samples were examined at the site of sample collection with a portable pH meter (Eutech, pH Tester 30). Other parameters of these samples like SWL, Depth and lowering year of the tubewells have been downloaded, as secondary data from the official website of Public Health Engineering Department of Bihar The lowering year of the tubewells help us to determine the Age of the tube well with respect to the date of arsenic detection.

RESULTS

Arsenic contamination in Saran district is a huge problem affecting thousands of people every year. The range of infection is very large affecting various age groups of the inhabitants of this region. This problem is not new but the recognition of the situation is recent. As far as the contamination of underground water by arsenic in the remote areas of Saran district is the concern of the present research work. These all research areas are very close to the **Ganga and Gandak** River located in the Sadar block of Chapra. They have also divided into different sites for analysis of arsenic load with reference to underground water. Only four villages have been selected. These areas are

1. **Rasalpura 2. Doriganj 3. Sherpur 4. Telpa**

So, these areas do not contain direct influence of the any rivers like Ganga and Gandak. But, the flood continuously adds water, sediment and ions of arsenic in these areas. Such kind of classification is based on the transportation of arsenic load through the mainstream water flow. However, the flood activities and its water logging in a specific area lead to the accumulation of arsenic in certain length of the underground water. Hence, the proximity of the contamination is mainly affected by the availability of polluted water with Arsenic. However, the total sample collections depend upon the collection of water from tube wells and hand pumps. Hence, the underground water table can be collected and analysed regularly in the DLWQTL P.H. Division Laboratory Chapra, (Saran) Government of Bihar.

Table: 1. Mean, SD and SEM Values of Arsenic Concentration

Name of village Rasalpura (Chapra Sadar) Range (Mg/l) Arsenic Level (Mg/l)

	Mean	SD	SEM	Arsenic contamination
Site-1	0.02-0.10	0.04478	0.03265	0.00760
Site-2	0.01-0.10	0.04321	0.03654	0.00820
Site-3	0.01-0.10	0.03165	0.03281	0.00750
Site-4	0.005-0.05	0.01895	0.01784	0.00405
Site-5	0.005-0.05	0.02014	0.01853	0.00398
Site-6	0.005-0.025	0.00964	0.008848	0.00189

Table: 2 Mean, SD and SEM Values of Arsenic Concentration

Name of village Doriganj (Chapra Sadar) Range (Mg/l) Arsenic Level (Mg/l)

	Mean	SD	SEM	Arsenic contamination
Site-1	0.02-0.10	0.05016	0.03365	0.00689
Site-2	0.01-0.10	0.04555	0.03754	0.00792
Site-3	0.01-0.10	0.03155	0.03262	0.00721
Site-4	0.005-0.05	0.09885	0.01845	0.00399
Site-5	0.005-0.05	0.01899	0.01982	0.00432
Site-6	0.005-0.025	0.009960	0.00963	0.00178

Table-3 Mean, SD and SEM Values of Arsenic Concentration

Name of village Sherpur (Chapra Sadar) Range (Mg/l) Arsenic Level (Mg/l)

	Mean	SD	SEM	Arsenic contamination
Site-1	0.02-0.10	0.04962	0.03269	0.00697
Site-2	0.01-0.10	0.04621	0.03692	0.00622
Site-3	0.01-0.10	0.03022	0.03125	0.00825
Site-4	0.005-0.05	0.01856	0.01626	0.00401
Site-5	0.005-0.05	0.02014	0.01875	0.00532
Site-6	0.005-0.025	0.008635	0.00922	0.00206

Table-4 Mean, SD and SEM Values of Arsenic Concentration

Name of village Telpa (Chapra Sadar) Range (Mg/l) Arsenic Level (Mg/l)

	Mean	SD	SEM	Arsenic contamination
Site-1	0.02-0.10	0.04211	0.031478	0.00625
Site-2	0.01-0.10	0.04425	0.03568	0.00599
Site-3	0.01-0.10	0.02965	0.03067	0.00788
Site-4	0.005-0.05	0.01727	0.01532	0.00417
Site-5	0.005-0.05	0.01864	0.01774	0.00529
Site-6	0.005-0.025	0.007563	0.00822	0.00199

Note: ***(SD-Standard Deviation & SEM- Standard Error Mean)***

As far as the villages Of Chapra Sadar is concerned, the Rasalpura village area with its mean arsenic concentration showed the highest mean value from range 0.02-0.10 of site I. The observed highest mean arsenic concentration was 0.04478 mg/l. While, the lowest mean arsenic volume was observed from the range 0.005-0.025 with 0.0964 mean values. Here, site also constitute the lowest value of SD i.e. 0.008848. The highest SD 0.03654 was observed from site of the range 0.01-0.10. From Doriganj village, which is very close to the river system showed similarly trends of the distribution of mean arsenic concentration value. Here, the highest mean value was observed from site-1 (range 0.02-0.10) with 0.050160 mg/l). While, The site-6 contributed least amount of the mean arsenic concentration (0.006630 mg/l). Following the same trends, site-2 contributed maximum amount of SD while the site-6 had least amount of SD i.e. 0.00963.

At Sherpur village, the highest mean value of arsenic concentration was observed form site-I and its value was 0.04962 mg/l. While, the minimum amount of the arsenic concentration was observed from the site-6 with the mean value of 0.008635. Here, site-2 constitutes high SD value (0.03692) and the site-6 showed least SD value (0.00922) now. At Telpa, in present research work, the arsenic concentrations are distributed mostly in the range of 0.02-0.01. At this range the arsenic concentration is very high. Now, almost in every site the range of arsenic distribution is not similar. This heterogeneous distribution of arsenic is due to the distance from riverine sources.

DISCUSSION

The main sources of drinking-water for the people in the rural areas are private or government tube wells, tapping water from shallow table ranging from 50 to 200 feet. There are also some deep tube wells in the area which generally have low concentrations of arsenic. However, samples from some tube wells deeper than 200 feet showed arsenic levels of above 50 µg/l. The study indicates that the tube well with As concentration between (10-24) for the 10 µg/land (50-99) for the 50 µg/l cut-off levels respectively, that need to be reanalyzed and verified by laboratory analyses for cross validation. The positive cases identified by the field test kit were only 4.4 % and 3.6 % of the total tested tube well water samples for As cut-off levels at 50 µg/land 10 µg/l, respectively. It is to be mentioned here that As concentrations in about 70% of such positive tube well at the observed level were found to be higher than that of the WHO cut-off value. Such identification of the field kit is beneficial for its users, considering that long-term exposure to As-contaminated water even at 10 µg/L increases the risk of various As-related health hazards. (Smith et al. 2000).The study shows the potentially of using the relationship between the prevalence of AS contamination as a strong indicator to achieve success in identifying them As contaminated TWs correctly.The TW test results showed high dependence on the prevalence of As concentration in TW water. The risk of false detection by the Merck field test kit is comparatively higher where the prevalence of as is low and vice versa.

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