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Status Of Groundwater Arsenic Contamination And Human Health In Hajo Circle, Assam, India

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ABSTRACT

Arsenic is a chemical element with the symbol 'As'. Arsenic in water is a vital problem in many countries around the world including India. In groundwater arsenic can be found through the dissolution of minerals and ores. Brahmaputra River that is originated from the Himalayas is arsenic contaminated. Arsenic can found in the groundwater of Brahmaputra valley in Assam because Assam valley is highly ferrous. The aim of this research paper is to investigate the level of arsenic contamination in groundwater and its health impact. Primary data have been collected and tested in Tezpur University laboratory to know the value of arsenic in groundwater. Many water samples were contaminated with arsenic. Arsenic affects a broad range of organs and system including skin, nervous system, respiration system, liver, kidney, immune system etc. Arsenic poisoning occurs due to the high level of arsenic in the body. Interpolation method has been use to show the spatial distribution pattern of groundwater arsenic contamination with the help of Arc GIS 10.2.1. Hajo circle has arsenic contaminated groundwater. Many rural people of the study area use arsenic contaminated drinking water.

Key words: Arsenic, Contamination, Groundwater and Distribution Pattern

Introduction

Arsenic can be found in the groundwater of Hajo circle. Drinking water poses greatest threat to human health from arsenic. Groundwater is one of the safe and portable water of the world. In groundwater arsenic can be found through the dissolution of minerals and ores. Arsenic is naturally occurring chemical element that found in the earth crust with symbol As raised greatly concern from environment and health perspective. According to United States Environment Protection agency arsenic is a harmful substance and a group A- carcinogen. Arsenic is a group V heavy element which atomic number 33 and its atomic weight 74.9amu, specific gravity 5.73g/cm. Drinking water is one of the main source of arsenic. According to World Health Origination the limit of arsenic in drinking water is 10 million of a gram per liter (10µg/L) of water (WHO, 1996).

Arsenic occur in the environment in several oxidation states (-3, 0,+3 and +5) in both inorganic and organic forms. Trivalent arsenic can exist as arsenous oxide (As_2O_3), arsenious acid (HA_SO_2), arsenite ($H_2AsO_3^-$, $HAsO_3^{2-}$, AsO_3^{3-}) ions, arsenic trichlloride ($AsCl_3$) and arsenite (AsH_3). In natural waters, arsenic is mostly found in inorganic form as oxyanions of trivalent arsenite As III or pentavalent arsenic As V. both As III and As V compounds are highly soluble in water. Bureau of Indian Standards (BIS) arsenic concentration in drinking water should not exceed 50 ppb. World Health Organization value for arsenic in drinking water is 10 ppb.

Objectives

Based on the background outlined above, the objectives for the paper are:

(i) to understand the level of arsenic contamination in groundwater of Hajo circle of Assam
(ii) to investigate the impact of arsenic on human health in Hajo circle.

Methodology

For spatial distribution pattern of arsenic contamination groundwater samples have been collected from different sources like private and public tube wells from different areas of Hajo circle. The amount of arsenic present in the water has been analyzed by using arsenic test kit. Interpolation method has been used to show the vertical distribution of groundwater arsenic contamination in the study area. Primary data regarding impact of arsenic on human health has been collected with the help of field surveys through well design schedule.

Study Area

Hajo circle has been selected for the study of vertical distribution of groundwater arsenic contamination. Hajo circle is located in Kamrup District of Assam between $26^0 12^/$ and $26^0 22^/$ North latitude and $91^0 20^/$ and $91^0 35^/$ East longitude.

Result and Discussion

Spatial distribution pattern of Groundwater arsenic contamination in Hajo Circle of Kamrup, Assam

Following figure will show level of arsenic in different tube well samples (Figure 1).

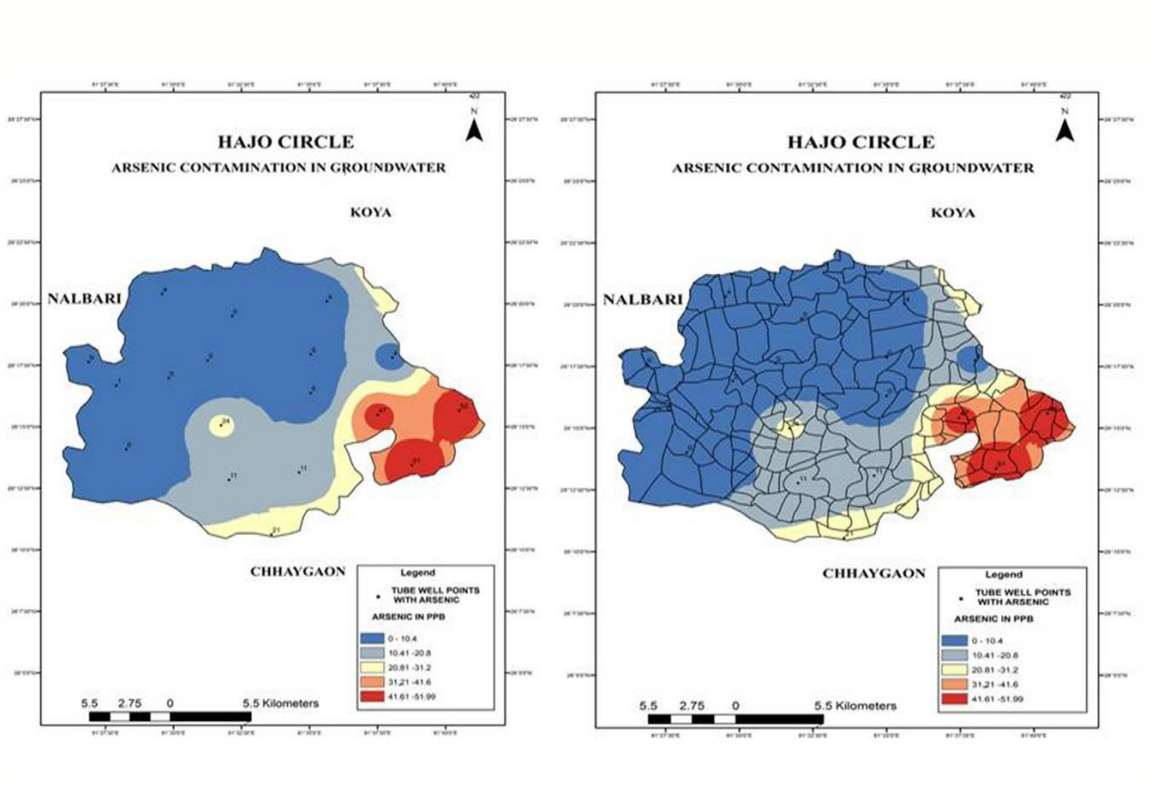

Figure 1: Spatial distribution of groundwater arsenic contamination in Hajo circle

Level of groundwater arsenic contamination

Level of groundwater arsenic contamination in the study area has been prepared with the help of tube well samples. Many areas of the study region have arsenic contamination in groundwater more than 10 ppb which is WHO maximum limit.

Table 1: Groundwater arsenic contamination in Hajo circle, Kamrup

Serial No.	Groundwater Arsenic in ppb	Area in sq km	Percentage
1	0.00-10.40	210	50.73
2	10.41-20.80	112	27.05
3	20.81-31.20	20	4.83
4	31.21-41.60	41	9.90
5	41.61-51.99	31	7.49
Total		414	100

Source: Primary survey, 2021

About 18 tube well samples have been collected and tested from Hajo circle to analyze the groundwater arsenic contamination on that area. Out of the total geographical area 210 sq km area (50.73per cent)

has groundwater arsenic contamination less than 10.40 ppb. About 112 sq km area (27.05 per cent) has groundwater arsenic contamination between 10.41-20.80 ppb. Groundwater arsenic contamination between 20.81-31.20 ppb can found in 20 sq km area (4.83 per cent). In the study area 41 sq km area (9.90 per cent) has arsenic contamination in groundwater between 31.21-41.60 ppb. Groundwater arsenic above 41.60 ppb can found in 31 sq km area (7.49 per cent). Hajo Tehsil has arsenic contamination more than 10 ppb which is WHO maximum limit.

Impact of arsenic contamination water on human health

Spatial distribution pattern of groundwater arsenic contamination in Hajo Tehsil or Circle have already prepared on the basis of tube well water sample.

In Hajo Tehsil or Circle four villages have groundwater arsenic more than 50 ppb which is BIS maximum limit for drinking water. All villages have been selected for survey. Following table will show survey profile of survey in Hajo Tehsil.

Table 2: Survey Profile of the epidemiological household survey, Hajo

Sl.No.	Village	Household Surveyed	Total Number of People	Number of people Effected
1	Bargaon	15	78	18
2	No.1 Dolibari	12	65	15
3	No.2 Dolibari	20	112	25
4	Rakshashini Char	03	18	03
	Total	50	273	61

Source: Primary survey, 2021

Health effect of arsenic in Hajo Tehsil or Circle

Epidemiological household survey has been conducted for study of arsenic related disease in the study area in Hajo Tehsil. Following table will show incidence of arsenic related disease in Hajo.

Table 3: Incidence of arsenic related disease in Hajo Tehsil

Sl. No.	Village	Respiratory Disease	Skin Disease	Cancer	Nervous System Disease	Heart Disease	Number of Effected people
1	Bargaon	05(27.77)	04(22.22)	06(43.34)	02(11.11)	01(5.56)	18(100)

2	**No.1 Dolibari**	**02(13.33)**	**03(20.00)**	**05(33.34)**	**04(26.66)**	**01(6.67)**	**15(100)**
3	**No.2 Dolibari**	**04(16.00)**	**03(12.00)**	**09(36.00)**	**04(16.00)**	**05(20.00)**	**25(100)**
4	**Rakshashini Char**	**02(66.66)**	**00(0.00)**	**00(0.00)**	**00(0.00)**	**01(33.34)**	**03(100)**
	Total	**13(21.31)**	**10(16.39)**	**20(32.78)**	**10(16.39)**	**08(13.12)**	**61(100)**

Source: Primary survey, 2021 (Figures in the parentheses indicates the percentage to the total number of effected people)

In Hajo Tehsil 61 persons have arsenic related diseases. Among all 61 persons 08 persons have heart disease, 10 persons have nervous system disease, 20 persons have cancer, 10 persons have skin disease and another 13 persons have respiratory disease. Number of cancer patients is high in comparison to other arsenic related disease in Hajo Tehsil.

Health status of arsenic effected persons in Hajo Tehsil

Health profile of the arsenic effected people has been investicated during household survey. Following table will show the health profile of the arsenic effected patients in Hajo.

Table 4: Health profile of the arsenic effected persons in Hajo

Village	Number of people Effected	No of Effected People with Normal BMI	No of Effected People with high/low BMI	No of People with Normal BP	No of People With high Or low BP	No of People With normal oxygen Level	No of People With low Oxygen Level in Per cent
Bargaon	**18(100)**	**7(38.88)**	**11(61.11)**	**6(33.34)**	**12(66.66)**	**13(72.22)**	**5(27.77)**
No.1 Dolibari	**15(100)**	**6(40.00)**	**09(60.00)**	**07(46.66)**	**08(53.34)**	**10(66.66)**	**5(33.34)**
No.2 Dolibari	**25(100)**	**10(40.00)**	**15(60.00)**	**09(36.00)**	**16(64.00)**	**21(84.00)**	**4(16.00)**
Rakshashini Char	**03(100)**	**02(66.66)**	**01(33.34)**	**01(33.34)**	**02(66.66)**	**02(66.66)**	**01(33.34)**
Total	**61(100)**	**25(40.98)**	**36(59.01)**	**23(37.70)**	**38(62.29)**	**46(75.40)**	**15(24.59)**

Source: Primary survey in Hajo circle, 2021 (Figures in the parentheses indicate the percentage to the total number of effected people)

BMI index is high among the patients in Hajo circle. BP is also high among the arsenic related disease patients. Oxygen level is high among the patients which have respiratory disease.

Incidents of death due to arsenic contamination disease in last five years in Hajo

Table 5: Incidents of death due to arsenic contamination disease in last five years

Sl.No.	Village	No of People died due to arsenicosis in last five years	Cancer	Heart disease	Other
1	Bargaon	10(100)	5(50.00)	3(30.00)	2(20.00)
2	No.1 Dolibari	12(100)	4(33.34)	5(41.67)	3(24.99)
3	No.2 Dolibari	18(100)	7(38.88)	8(44.45)	3(16.67)
4	Rakshashini Char	1(100)	1(100)	0(0.00)	0(0.00)

Source: Primary survey in Hajo circle, 2021 (Figures in the parentheses indicate the percentage to the total number of effected people)

About 41 people were died due to arsenic related disease among survey villages in last five years. About 17 persons were died due to arsenic related cancer.

Age-sex wise distribution of arsenic effected persons in Hajo Tehsil

In Hajo circle 61 arsenic effected people have been found during survey. Among all 48 are male and other 13 are female. About 36 persons are under 15-59 age group in Hajo Tehsil.

Table 6: Age-sex wise distribution of arsenic effected persons in Hajo

Village	Number of people Effected People	Male	Female	Age less than 14	15-59	60 and Above
Bargaon	18(100)	12(66.66)	6(33.34)	3(16.66)	11(61.11)	4922.23)
No.1 Dolibari	15(100)	13(86.66)	2(13.34)	5(33.33)	9(60.00)	1(6.66)
No.2 Dolibari	25(100)	21(84.00)	4(16.00)	3(12.00)	13(52.00)	09(36.00)
Rakshashini Char	03(100)	2(66.66)	1(33.33)	0(0.00)	3(100)	0(0.00)
Total	61(100)	48(78.68)	13(21.31)	11(18.03)	36(59.01)	14(22.95)

Source: Primary survey in Hajo circle, 2021 (Figures in the parentheses indicate the percentage to the total number of effected people)

Level of socio-economic development among arsenic effected villages in Hajo Tehsil

Following table will show level of socio-economic development among the arsenic effected villages in Hajo circle.

Table: 7: Variations in the level of Socio-Economic Development among villages in Hajo

Villages	Number Of Literates X_1	No. of Household With Pucca House X_2	Level of Education HSLC(%) X_3	Income More than 20000 pm(%)X_4	Expenditure More than 10000pm (%) X_5	Composite Z Score value
Bargaon	39	9	25.64	10	9	3.35
No.1 Dolibari	32	7	23.07	6	4	-0.006
No.2 Dolibari	76	11	35.71	5	2	2.56
Rakshashini Char	8	0	5.55	1	1	-5.91

Source: Primary survey, 2021

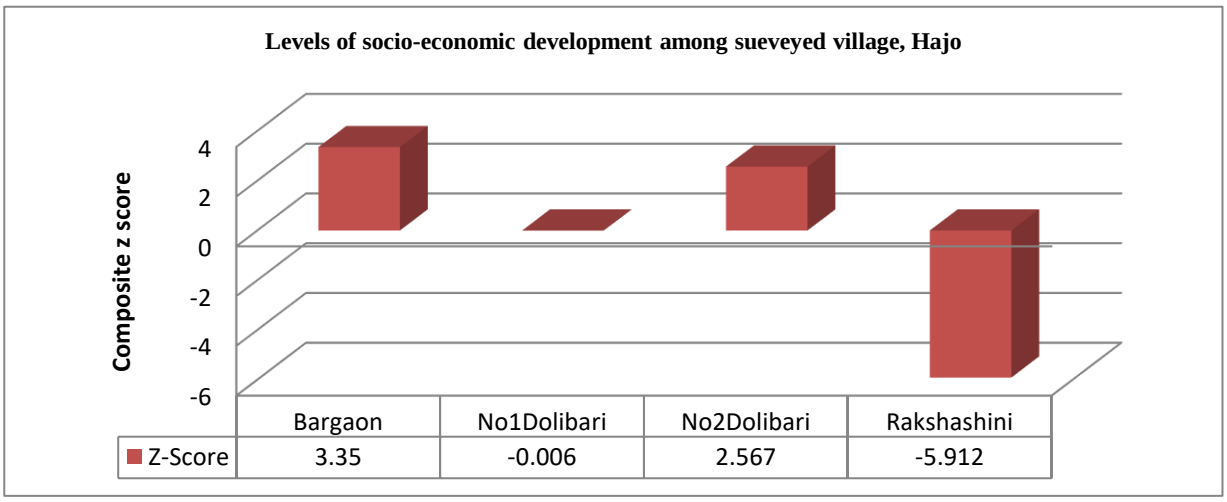

Figure 2: Levels of socio economic development among surveyed villages in Hajo

Among the arsenic affected villages Bargaon village is socio conically developed than other villages. Rakshashini Char villege is least developed among all villages.

Disease Burden of Hajo Tehsil in Kamrup district of Assam

Disease burden of Hajo tehsil or circle has been calculated using Disease Burden formula. According to 2011 census Hajo circle has population of 2, 62,531 persons. Among all population 61 persons were identified as arsenic patients. Number of persons examined in Kamalpur tehsil was 273 persons.

$$\text{Disease Burden (D.B)} = \sum_{i=1}^{17} Ni.Pi \quad \text{where, } Pi=Ri/ni$$

Ni= Total population of the circle

Ri= Number of patients identified in the circle

Ni= Number of persons examined in the circle

In Kamalpur circle,

Ni=262531

Ri=61

Ni=273

$$D.B.= \sum_{i=1}^{17}$$

= (17-1+1) (58,660.77)

= 9,97,233

Conclusion

Many people fro Hajo circle drink arsenic contaminated water.Arsenic poisoning can occur due to arsenic contamination in dringking water. A groundwater arsenic level is different in different places. In study area tube well depth are different in different region. In some areas of Kamrup district tube wells depth is very shallow and in another area tube well depth is very deep up to 120 meters below ground level. In the study area groundwater is contaminated with arsenic and other organic matter. The area under arsenic concentration is also changes with time. With the passage of time arsenic contamination area also increases due to pressure in the groundwater. As a result of this incident of arsenic contaminated diseases also increases. More number of people are now affected with arsenic contaminated diseases in the study area. So it is very important to study temporal change in arsenic engulfed area and incident of arsenic contaminated diseases.

References

Akter, A., Ali, M.H. (2011). Arsenic Contamination in Groundwater and its Proposed Remedial measures, Int. J. Environ, 8(2), 433-443.

Chakrabarti D., Mukharjee C., Sengupta, S., Rahman, M., Chowdhury, K., Lodh, D., Chandra, R., Chakraborti, A., and Gautam, K. (2003). Arsenic Groundwater Contamination in Middle Ganga Plain, Bihar, India: A Future Danger?, Environmental Health Perspective, 3(9),1194-1201.

Chakraborty, D., Rahman, M., Das, B., and Munil, M. (2010). Status of Groundwater Arsenic Contamination in Bangladesh: A Fourteen Year Study Report, Water Research, 44 (19), 5789-5802.

David, A. and Jones, J. (1977). Arsenic Contamination of Water Wells in Vova Satia, American, Water Association, 69 (12), 653-657.

Dutta, J. (2013). Fluoride, Arsenic and Other Heavy Metals Contamination of Drinking Water in the Tea Garden Belt of Sunitpur District, Assam, India, International Journal of Chem Tech Research Coden , 5 (5), 2614-2622.

Sarma, T. and Saikia, S. (2020): Spatial Distribution of Groundwater Arsenic Contamination in Gopeswar and Its Neighbouring Villages of Kamrup District of Assam, Journal of Critical Review,Vol-7, No-19, New Delhi, pp-711-715

Sarma, T. et. Al (2020): Spatial distribution pattern of Jhum cultivation and Land use Land cover status, Assam, PalArch's Journal of archaeology of Egypt/Egyptology,Vol.17, No10, 2317-2323

Sarma, T. et Al (2020):Madan Kamdev Temple and its Archaeological Remains,India PalArch's Journal of archaeology of Egypt/Egyptology,Vol.17, No 06, 6815-6826

UNDP (2006): Beyond Scarcity: Power, Poverty and the Global Water Crisis, New Work, USA: UNDP

Sarma. T. and Saikia. S. (2020): Health and Social Impact of Arsenic Toxicity in Rural areas of Kamrup District, Assam, India, Journal of Xian shiyou University, Vol-1, Issue- 02, pp- 107-114