



A case study of arsenic and fluoride contamination in groundwater of Bhagalpur District

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ABSTRACT

Groundwater survey in the northern and southern part of the Ganges river of Bhagalpur district have been found to contain arsenic above the permissible limit, 0.05 ppm as per guidelines of WHO. This area of middle Ganga plain has high potential aquifers known for intensive arsenic contaminated groundwater extraction for irrigation. Most of the arsenic contaminated samples of this area contain arsenic more than permissible limit at the depth of 90 feet to 100 feet. The groundwater samples also contain iron. The soil characteristics of this area are coloured organic-rich argillaceous sediments. Some analysis have been carried out for fluoride in the southern parts of the Gangetic plain. The samples were found to contain fluoride more than permissible limit. Dugwells have been analysed for arsenic and fluoride. Dugwells may be arsenic safe water in arsenic affected areas. The interaction of groundwater with the surface water causes weathering as a result of which accumulation of arsenic in these aquifers takes place.

Keywords: aquifers, groundwater, arsenic, argillaceous, fluoride

INTRODUCTION

Severe arsenic contamination in groundwater have been reported from different parts of the country and the world [1-2]. Bhagalpur district of Bihar is a plain intersected by many Dhars, chours and tributaries. The Gangetic plain has huge amount of river sediments due to the perennial flood[3]. This area has a channelized natural water system. Gangetic plain is a shallow asymmetrical depression with a gentle eastern slope. Most of the rivers of northern Gangetic plain follow a southerly trend. The river Ganges is the main river in Gangetic plain flowing west to east and forms Bengal delta before falling into the Bay of Bengal. The land between the Ganga and the Koshi is called doab land. Naugachia subdivision of Bhagalpur district is surrounded by the Koshi and the Ganges and is known for intensive farming e.g. banana, maize, and litchi. Narayanpur, Nathnagar and Jagdishpur blocks of Bhagalpur district have been selected for arsenic and fluoride detection. The inhabitants of Jagdishpur block have visible symptoms of fluorosis where as Narayanpur and Nathnagar block residents have skin lesions due to arsenic contaminated groundwater.

The population have are facing the high risk of groundwater-arsenic contamination. The permissible limit for fluoride is 1.5 ppm. Regular intake of arsenic has caused human deaths in India due to arsenicosis. Arsenic in water bodies is also due to the use of its compounds in industrial and agricultural processes. The occurrence of arsenic in groundwater may be due to mineral arsenopyrite associated with sedimentary rocks and weathered volcanic rocks. Fossil fuel, mineral deposits, mining wastes and geo thermal areas are some of the sources due to which arsenic occurs in groundwater.

In groundwater and surface water environment, there are two states of arsenic is As(V) (arsenate) and As(III) (arsenite). At natural pH, the arsenite exists in solution as H_3AsO_3 and H_2AsO_3^- , while arsenate is present as H_2AsO_4^- and HASO_4^{2-} [4-5] Under high pH conditions, arsenite is strongly bound to soil compounds than

arsenate[6-7]. Arsenite is more toxic than arsenate and tends to be more mobile in the environment [8-9]. The mobility of arsenic is a function of its oxidation state[10].

Fluoride contaminated groundwater has also become a major cause of concern in this area where skeletal and dental fluorosis is very common. The permissible limit of fluoride is 1.5 ppm. Skeletal fluorosis gives rise to deformation of bone, bone fracture, osteoporosis, ligamentous calcification. Main causes of fluoride contamination in groundwater are cryolite, rock phosphates, use of phosphatic fertilizers, insecticides and disinfectants[11-12]. According to Bihar government 8,188 villages in 11 districts have excess fluoride in water. Bhagalpur district is facing this problem of excess fluoride in groundwater.

EXPERIMENTAL SECTION

The samples were collected from different blocks of Bhagalpur district and analysed the sample by merckoquent arsenic kit available in the laboratory. The samples were also analyzed by U.V double beam spectrophotometer pharo 300. The analysis of fluoride content was done by piccofluoride meter, ionselective electrode and U.V. double beam spectrophotometer. The result from ion selective electrode are in agreement with U.V. double beam spectrophotometer result.

RESULTS AND DISCUSSION

Table 1 clearly shows that samples A-2, A-6, A-10, and A-12 of Narayanpur blocks are arsenic contaminated. These samples contain arsenic more than permissible limit ranging from 0.1 ppm to 0.8 ppm. This area has not been analyzed for arsenic till now. So this has opened a vast scope of probe in this area. It is noteworthy that these samples have been found to contain iron also more than permissible limit. Gosaindaspur, Srirampur, Hardaspur, Purani sarai, Dogachhi and Dildarpur village groundwater samples have also arsenic content more than permissible limit, the population of these village showed visible symptoms of arsenicosis.

Table 1 Arsenic contamination in ground water samples of Naugachia Subdivision

Sample numbers	Distance from Railway station Narayanpur	Depth of tested tubewells & Dugwells	Amount of detected arsenic in tested samples (ppm)
A-01	1 km (west)	-	0.0
A-02	700 m (north)	100'	0.8
A-03	1 km (north)	90'	0.03
A-04	1.5 km(north)	100'	0.03
A-05	1.5 km(north)	100'	0.02
A-06	1.25 km (north)	100'	0.1
A-07	1 km(north)	70'	0.0
A-08	500 m(north)	100'	0.0
A-09	2 km(north)	140'	0.0
A-10	2km(north)	90'	0.5
A-11	4 km(north)	100'	0.0
A-12	500 m(north)	125'	0.1
A-13	1 km(north)	30'	0.0
A-14	1.5 km(west from Thana Bihpur Rly station)	100'	0.0
A-15	1 km(north from Thana Bihpur Rly station)	130'	0.0

Table 2 Arsenic contamination in ground water samples of Nathnagar block

Sample numbers	Distance from Railway station Nathnagar	Depth of tested tubewells & Dugwells	Amount of detected arsenic in tested samples (ppm)
A-1	7 km(north)	110'	0.02
A-2	9 km(north)	100'	0.05
A-3	6 km(north)	70'	0.00
A-4	6 km(north)	100'	0.02
A-5	4.5 km(west)	90-100'	0.02
A-6	4 km(west)	110'	0.1
A-7	5.5 km(west)	120'	0.02
A-8	5 km(west)	90-100'	0.1
A-9	6 km(north)	110'	0.5
A-10	8 km(north)	100'	0.5
A-11	7.5 km(north)	90'	0.8
A-12	7.5 km(north)	90'	0.2
A-13	8.5 km(north)	100'	0.8
A-14	8.5 km(north)	110'	0.9
A-15	8 km(north)	90'	0.1

Table 3 Fluoride contamination in ground water samples of Bhagalpur District

Sample numbers	Distance from Railway station Tekani	Depth of tested tubewells & Dugwells	Amount of detected fluoride in tested samples (ppm)
F-01	2.5 km(north)	110'	0.599
F-02	12 km (north-west)	120'	0.735
F-03	1.5 km(west)	90'	0.377
F-04	7.0 km(west from sabour station)	90,	0.106
F-05	5.0 km (north west from sabour)	90,	0.112
F-06	5.0 km (north-west from sabour)	90'	0.186
F-07	3.5 km (north from Tekani)	90'	0.391
F-08	2.5 km (north)	100'	0.808
F-09	1.5 km (east)	100'	0.309
F-10	2.5 km (north)	100'	0.435
F-11	1.0 km (north)	110'	0.363
F-12	4.0 km (east)	100'	0.027
F-13	4.0 km (east)	110'	0.264
F-14	4.25 km (east)	130'	0.448
F-15	4.25 km (east)	110'	0.309
F-16	1.5 km (east)	70'-80'	1.072
F-17	1.5 km (east)	100'	0.934
F-18	2.0 km (east)	90'	0.773
F-19	1.0 km (east)	100'	1.023
F-20	2.5 km (north)	70'-90'	0.594
F-21	2.5 km (north)	80'	0.544
F-22	2.5 km (north)	110'	1.594
F-23	2.5 km (north)	-	0.641
F-24	3.0 km (north)	110'	0.344
F-25	3.0 km (north)	110'	0.344
F-26	3.0 km (north)	110'	1.958
F-27	3.0 km (north)	120'	2.833
F-28	4.0 km (north-east)	130'	0.197
F-29	4.0 km (north-east)	150'	0.384
F-30	4.25 km (north-east)	125'-130'	0.399
F-31	4.25 km (north-east)	100'	0.142
F-32	4.25 km (north-east)	100'-125'	0.356
F-33	4.25 km (north-east)	100'	0.138
F-34	4.25 km (north-east)	90'-100'	0.234
F-35	4.25 km (north-east)	100'	0.506
F-36	5.0 km (north-east)	110'	0.218
F-37	5.0 km (north-east)	125'	0.335
F-38	5.0 km (north-east)	90'-125'	0.312
F-39	5.0 km (north-east)	110'	0.255
F-40	2.0 km(west from Narayanpur Rly staion)	125'	0.267
F-41	2.0 km(west from Narayanpur Rly staion)	115'	0.106
F-42	1.5 km(west from Narayanpur Rly staion)	125'	0.083
F-43	0.5 km (north from Narayanpur Rly station)	90'	0.077
F-44	2.0 km(north from Narayanpur Rly staion)	100'	0.085
F-45	0.75 km(north from Narayanpur Rly staion)	100'	0.084
F-46	3.0 km(north from Narayanpur Rly staion)	100'	0.160
F-47	-	-	0.074
F-48	1.0 km km(north from Narayanpur Rly staion)	30'	0.123
F-49	1.5 km km(north from Narayanpur Rly staion)	100'	0.089
F-50	4.0 km(west from Nathnagar Rly station)	110'	0.192
F-51	7.0 km north-west from Nathnagar Rly station)	110'	0.070
F-52	5.0 km(west from Nathnagar Rly station)	120'	0.065
F-53	5.0 km(north-west from Nathnagar Rly station)	90'-100'	0.050

The probe of fluoride was done with different samples of Jagdispur blocks were most of the samples contain high amount of fluoride ranging from 0.142 ppm to 2.833 ppm. Many samples exceeded the permissible limit of 1.5 ppm fluoride. Many patients suffering from skeletal and dental fluorosis are present in these villages. Some samples of dugwells were also tested and found to be free from arsenic and fluoride contamination. So dugwells water may be safe for drinking after necessary treatment. Besides this safe aquifers can also be traced.

CONCLUSION

Thus ground water samples of the doab land between the Ganga and Koshi are arsenic contaminated. Some water samples of the southern bank of the Ganga river is also arsenic contaminated. The aquifer at a depth of hundred feet

has been found to contain arsenic more than permissible limit. Besides this, the ground water samples of Jagdishpur block are fluoride contaminated.

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