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ELEVATION AND GROUNDWATER ARSENIC CONTAMINATION IN DARRANG DISTRICT OF ASSAM, INDIA

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ABSTRACT

Groundwater occurs almost everywhere beneath the land surface. Arsenic contamination in groundwater is a form of groundwater pollution. Arsenic is a chemical element with the symbol 'As' and atomic number 33. Arsenic in water is a vital problem in many countries around the world including Bangladesh, India and China etc. In India, groundwater arsenic contamination and health effect were first reported in 1997 in Chandigarh. Arsenic can be found in the groundwater of Brahmaputra valley in Assam. The aim of this research paper is to investigate the elevation and groundwater arsenic contamination in Darang district of Assam. Primary data have been collected and tested in 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 vertical distribution pattern of groundwater arsenic contamination with the help of Arc GIS 10.2.1. Digital Elevation Model has been prepared with the help of satellite data to show the relation between elevation and arsenic in groundwater.

Key words: Arsenic, Groundwater, Elevation and Distribution

Introduction

Arsenic is introduced into groundwater by natural and anthropogenic sources. Arsenic contamination in groundwater and related health hazards has serious concern in the Kamrup District of Assam. Melting point of arsenic is 817^0C .This metalloid is associated mostly with geological materials in ores as mesothermal as well as hydrothermal veins associated with nickel, cobalt and silver together with sulphides and sulpho-salts. Arsenic is natural contaminant in lead, zinc, gold and copper ores. Common arsenic bearing minerals with arsenic in the reduced form are orpiment (As_2S_3), Safforlite (CoAs), niccolite (NiAs), rammelsbergite ($NiAs_2$), cobaltite (CoAsS), enargite (Cu_3ass_4), gerdsorfite (NiAsS) glaucodot (CoFeAsS) and elemental rocks are the minerals where arsenic exists in the oxidation form. Inorganic arsenic dissolved in groundwater and organic arsenic present in food. Arsenic is ubiquitous element that found in atmosphere, soil and water. 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 ($HAsO_2$), 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 Darrang district of Assam

(ii) to investigate relation between elevation and arsenic contamination in groundwater of Darrang district of Assam

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Methodology

For vertical distribution pattern of arsenic contamination groundwater samples have been collected from different sources like private and public tube wells from different areas. 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 Darrang district of Assam.

Study Area

Darrang district has been selected for the study of vertical distribution of groundwater arsenic contamination. Darrang district was created with effect from july 1983 covering the sub division of Mangaldoi. Darrang istrict is situated in the central part of Assam and on the Northearn side of the river Mighty Brahmaputra. The district is situated between 20º9'North to 26º95'North latitude and 91º45' East to 92º22 East longitude. The district is bounded by Arunachal Pradesh (State) and Bhutan (Country) and Udalguri district in the North. The river Brahmaputra flows in the South. Sonitpur and Kamrup districts are in the East and West respectively. Darrang district covers an area of 1585 sq km. Darrang district consist of six revenue circles. Name of the circles of Darrang district of Assam are Dalgaon (215 Villages), Mangaldoi (140 Villages), Sipajhar (93 Villages), Pathorighat (84), Kalaigaon (25) and Khoirabari (7).Darrang district was recognized with 564 villages. Darrang district has total 75 Gaon panchayats. Darrang district has population of 9, 08,090 persons.

Result and Discussion

Vertical distribution pattern of groundwater arsenic contamination in Darrang district of Assam

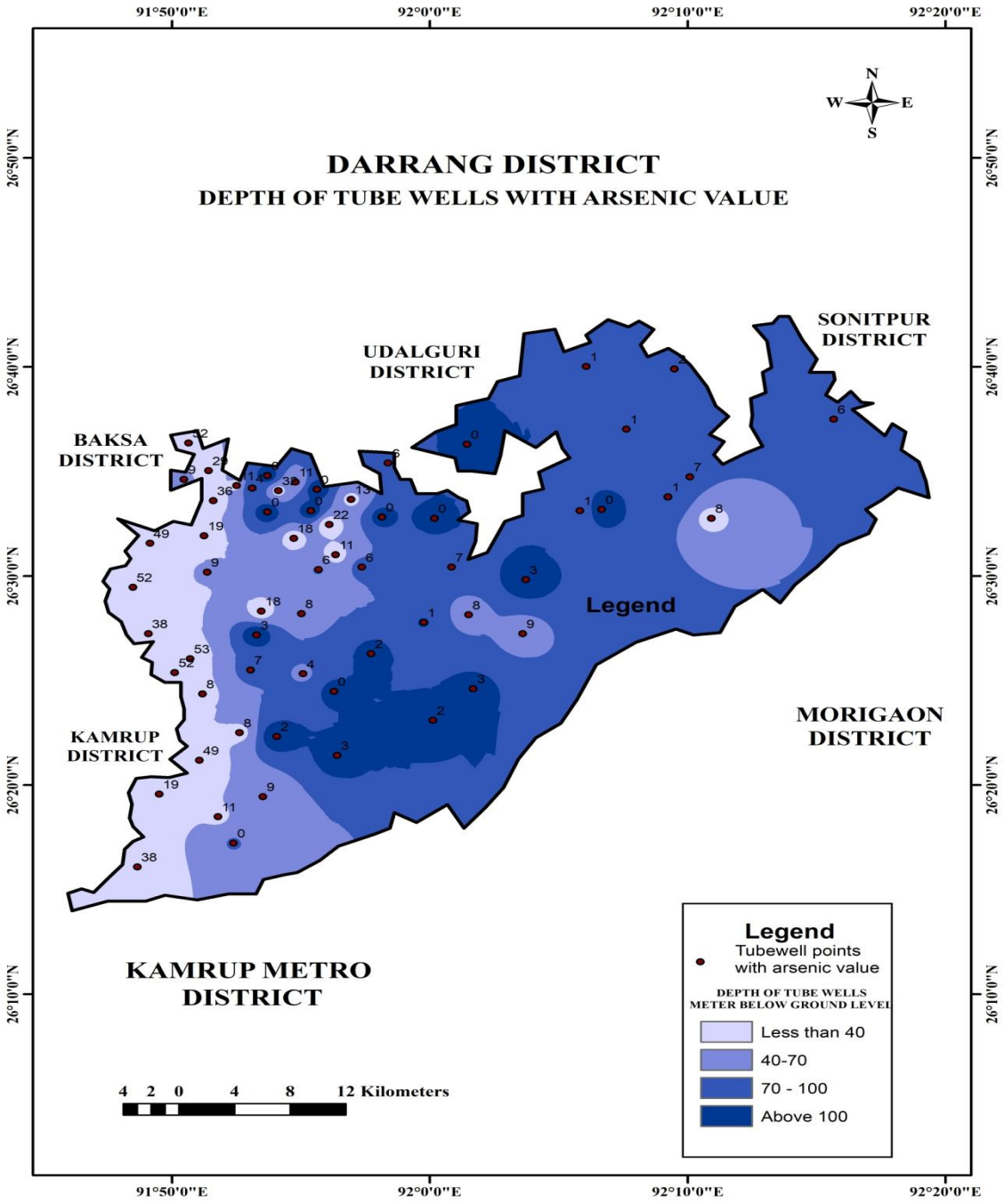


Figure 1: Depth wise distribution of arsenic contamination in groundwater of Darrang

Vertical distribution of arsenic contamination in Darrang district of Assam

Vertical distribution of arsenic contamination in Darrang district is not smooth. Table 1 will show the vertical distribution of arsenic contamination level in Darrang district of Assam.

Table 1: Vertical distribution of arsenic contamination in Darrang

Sl. No.	Depth in Meter Below Ground level	Average arsenic In ppb	No. of safe tube wells Arsenic Less than 10 ppb	Percentage of safe tube wells	No. of unsafe tube wells Arsenic greater than 10 ppb	Percentage of u wells
1	Less than 40	28	19	36.52	3	30
2	40-70	8	2	3.85	7	70
3	70-100	3	14	26.92	0	0
4	Above 100	1	17	32.69	0	0
			52	100	10	100

Source: Primary survey, 2021

In Darrang district dept of sample tube wells have been classified in four different categories. Depth of tube wells less than forty meters below ground level have been classified as first category. Average arsenic contamination in this class is 28 ppb. Under this category number of safe tube wells (arsenic less than 10 ppb) is 19 which are 36.52 per cent. Number of unsafe tube wells (Arsenic higher than 10 ppb) in this dept class is 3. About 30 per cent tube wells are unsafe in this depth. .Depth between forty to seventy meters has been classified under second class. Average arsenic contamination under 40to 70 meters dept is 8ppb. Only 2 samples (3.85 per cent) of tube wells are safe in this depth class. On the other hand 7 tube well samples (70 per cent) are unsafe in this depth. Depth between 70 to 100 meters below ground level is classified under third category. Average arsenic contamination in this depth is 3ppb. Number of safe tube wells (arsenic less than 10 ppb) under this depth is 14 (26.92per cent). No unsafe tube wells (Arsenic greater than 10ppb) can be found beyond 70 meter depth below ground level. Depth 100 meter below ground level is considered under depth class four. Average arsenic below 100 meter depth is 1 ppb. Seventeen safe tube wells (Less than 10 ppb arsenic) have been found in this layer which is 32.69 per cent. Number of unsafe tube wells (Arsenic contamination more than 10 ppb) in this layer is nil. Total 62 tube well arsenic sample have been collected and

analyzed. Average arsenic contamination is very high in shallow aquifer of Darrang district. Arsenic level is very high depth up to 40 meters below ground level. Deep aquifer has less arsenic contamination value and safe for drinking water in Darrang district.

Depth of tube wells and area under that particular groundwater of Darrang district of Assam

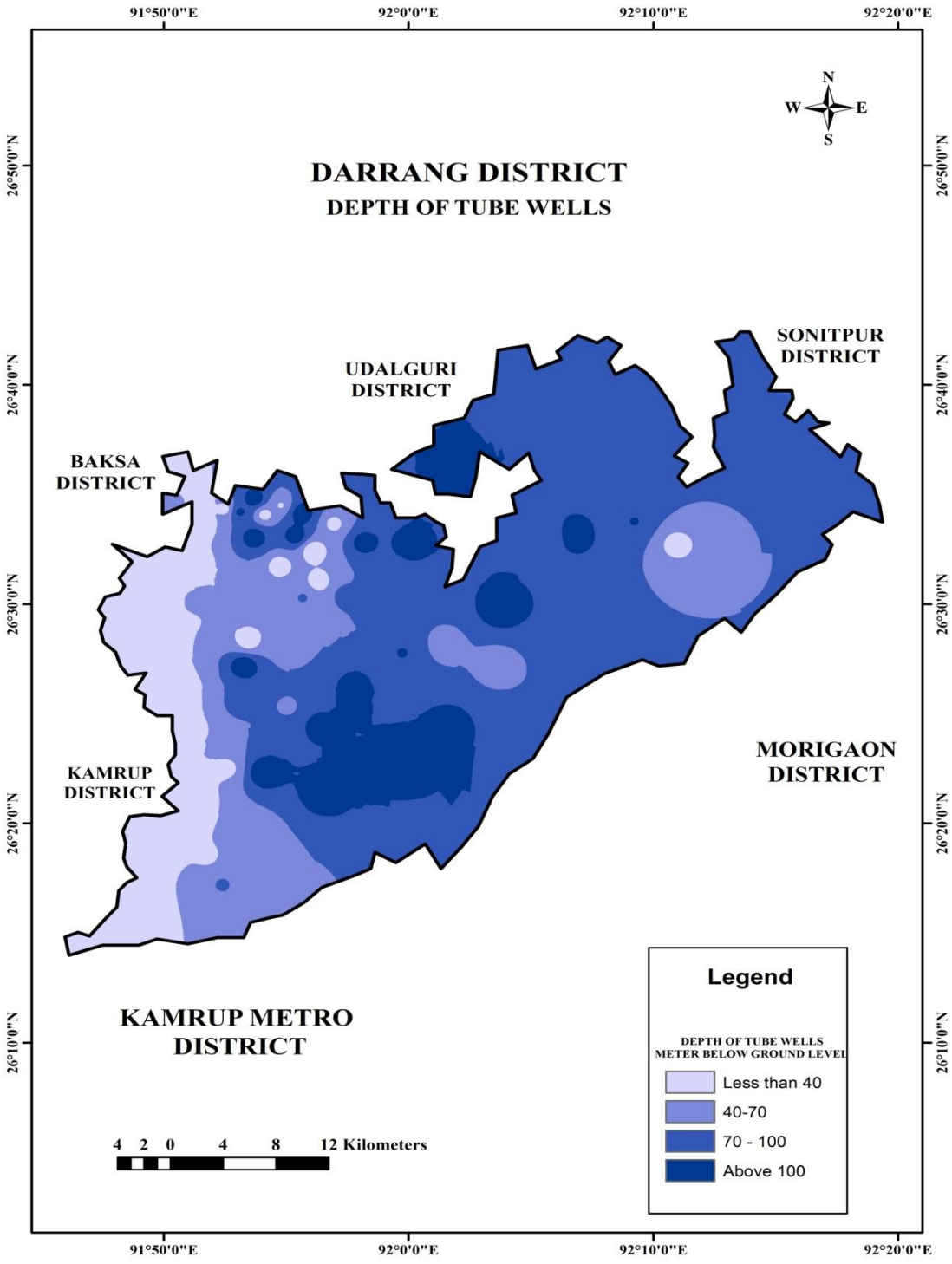


Figure 2: Dept of tube wells and area in Darrang district of Assam

Dept wise distribution of tube well in Darrang district

Depth wise distribution of sample tube wells in Darrang district have been studied on the basis of sample tube well data. Depth wise tube well distribution and groundwater area on that category will show on table 2. Groundwater in the study area present beneath the land surface in the pore spaces in regolith and in cracks in bedrock in all areas. Groundwater emerges at the surface from wells. The main way that groundwater is replenished is from the earth's surface, by infiltration of surface water down through the soil to become groundwater. Once surface infiltrates below the surface of the soil and keeps on moving downward by percolation, it has become groundwater

Table 2: Depth wise distribution of tube well samples in Darrang district

Sl. No.	Depth in Meter below Ground water	Number of tube wells	Percentage of tube wells	Area in sq km	Percentage of area
1	Less than 40	22	35.48	182	11.48
2	40-70	9	14.52	198	12.49
3	70-100	14	22.58	1095	69.08
4	Above 100	17	27.42	110	6.95
	Total	62	100	1585	100

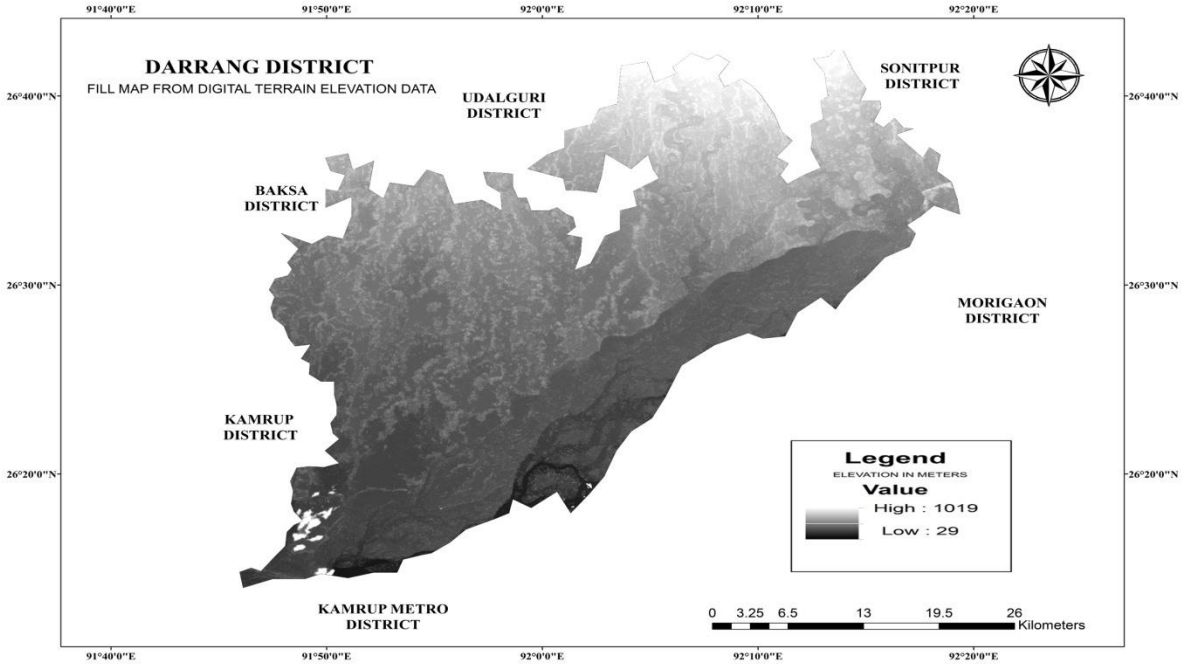
Source: Primary survey, 2011

Out of the total 62 tube well samples of Darrang district 22 samples have depth less than 40 meters below ground level. About 35.48 per cent tube wells of the study area have depth below 40 meters. Total geographical area under 40 meters dept of groundwater in Darrang district is 182 sq kilometers (11.48 per cent). Nine tube wells have been found in between dept 40 to 70 meters below ground level (14.52 per cent). Area of groundwater in between this depth class is 198 square kilometers (12.49 per cent). Out of all sample tube wells in Darrang district 14 samples have depth between 70-100 meters below ground level (22.58 per cent). Out of the total 1585 sq km area of Darrang district 1095 sq km area is under 70-100 meters depth (69.08

per cent). Seventeen tube wells of total sample area have depth higher than 100 meters (27.42). Groundwater area in this depth category is 110 sq km (6.95 per cent).

In Darrang district tube well depth are different in different region. In some areas of Darrang district tube wells depth is very shallow and in another area tube well depth is very deep up to 120 meters below ground level.

Elevation and groundwater arsenic contamination in Darrang district of Assam



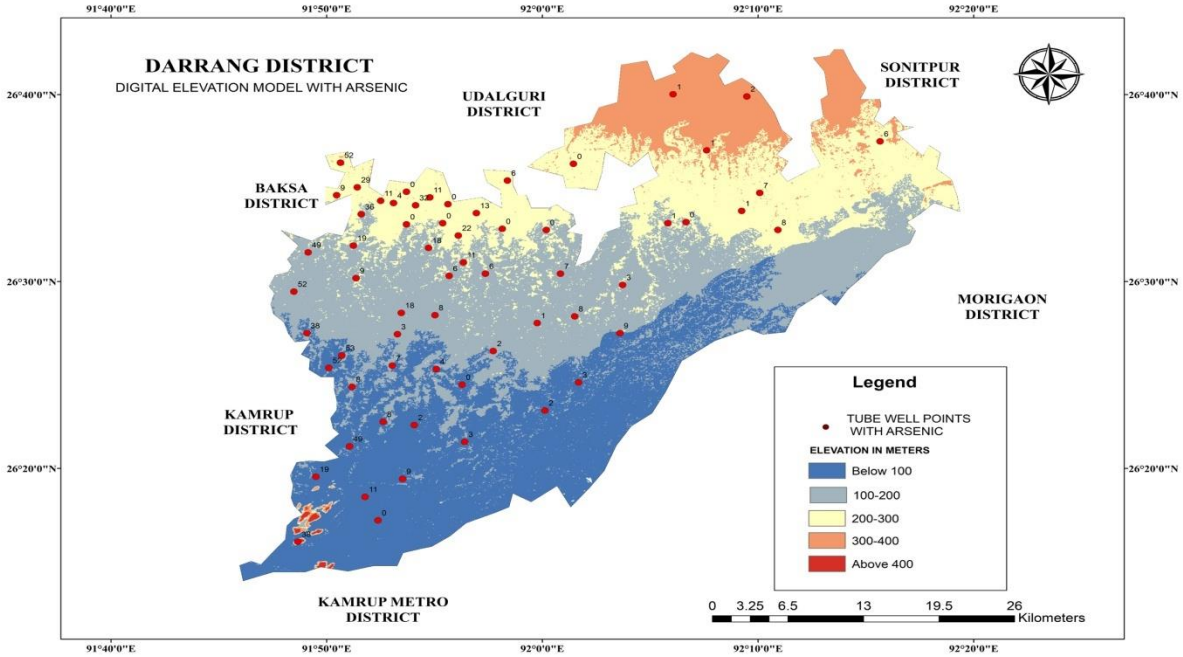


Figure 3: Digital Elevation Model and arsenic in Darrang district of Assam

Digital Elevation Model and arsenic in Darrang district

Digital Elevation Model of Darrang district have been prepared with the help of Shuttle Radar Topography Mission (SRTM) satellite imagery. Digital elevation model in the study area have been shown with the help of computer graphics representation of elevation data to represent the terrain. Groundwater arsenic contamination in different tube wells have been plotted to show the arsenic and elevation map of the study area.

Table 3 :Digital elevation model and arsenic

Sl. No.	Elevation in meter	Area in sq km	Area in Percentage	Average arsenic in ppb
1	Below 100	435	27.45	28
2	100-200	423	26.69	9
3	200-300	403	25.42	3
4	300-400	322	20.32	2
5	Above 400	2.0	0.12	0
		1585	100	

Source: Primary survey, 2021

Elevation of the study area has been classified in five categories. Elevation up to 100 meters from mean sea level is classified as first category. Elevation between 100 to 200 meters of the study area has been classified as second class. Elevation between 200 to 300 meters classified as third category. Three hundred to four hundred meters has classified as fourth category. Elevation greater than 400 meters has classified as fifth category.

Surface elevation of the study area ranges from 40 meters to more than 400 meters above mean sea level. About 435 sq km of the study area is under 100 meters elevation (27.45 per cent). Average groundwater arsenic contamination on that area is 28 ppb. Four hundred twenty three sq km (26.69 per cent) area of Darrang district is under 100 to 200 meters elevation. Average groundwater arsenic contamination on that area is 9ppb. In Darrang district 403 sq km

area (25.42 per cent) has elevation between 200 to 300 meters. Average groundwater arsenic contamination on that area is 3 ppb. About 32 sq km area (20.32 per cent) of the study area has elevation between 300 to 400 meters. Average groundwater arsenic on that elevation topography is 2 ppb. Above 400 meters elevation can found in 2 sq km area (0.12 per cent). Average groundwater arsenic contamination on that elevation is 0ppb. In Darrang district Average groundwater arsenic concentration is high in low elevation area. In high elevation area groundwater arsenic contamination is very low.

Conclusion

In Darrang district tube well depth are different in different region. In some areas of Darrang 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.

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