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Geomorphology, Quaternary Morpho-Stratigraphy and Spatial Distribution of Arsenic Contamination in Groundwater, a Case Study of Katwa-II, Burdwan, West Bengal

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Abstract:
Arsenic contamination in groundwater is a serious environmental problem in Bengal Basin. In case of Burdwan District it is characterized by contamination in shallow groundwater arsenic is mainly located in the eastern part of this district along the Bhagirathi River, although some other places of Damodar fan delta (south-eastern part of Burdwan District) is affected by arsenic contamination. Various studied relating to the Arsenic contamination conducted by several Geologist, Geomorphologist, Environmentalist etc., most of their worked is mainly emphasized on the geologic controls on arsenic contamination in ground water as a result importance's of fluvial geomorphology in a greater way ignored or less investigated by them. Late Quaternary stratigraphy, geomorphology and sedimentation in the Bengal Delta and the Damodar fan-delta have partly controlled groundwater arsenic contamination (Acharayya S. K. & Shah, B. A., 2012). Contamination is extensive in the low-lying areas of Bhagirathi–Ganga delta, located mainly to the east of the Bhagirathi River. A few isolated As-contaminated areas occur west of the Bhagirathi River and over the lower parts of the Damodar river fan-delta (Acharayya S. K. & Shah, B. A., 2007). The present study is mainly focused in the role of geomorphology and Quaternary morpho-stratigraphy in controlling arsenic contamination over Katwa-II of Burdwan District along the western part of Bhagirathi- Hooghly River.
Keywords: Arsenic contamination in groundwater, Bengal Basin, Damodar fan delta, geologic controls on arsenic contamination, Late Quaternary stratigraphy.

1.0 Introduction:

Arsenic contamination in groundwater of the Bengal Basin, including Bangladesh and West Bengal of India has been recognized as the worst case of groundwater contamination in the world (Smith et al., 2000; BGS and DPHE, 2001). Mostly east of the River Bhagirathi- Hooghly, the main distributaries of the Ganges in India) and, Bangladesh in 1993 (Swartz et al., 2004), were found to have groundwater with As concentrations exceeding the World Health Organization (WHO, 1993,12001) drinking water safe limit of 10 μg/L. Some worst affected areas also occur over the eastern part of Burdwan District. It is a major environmental problems affecting Burdwan District of West Bengal. The arsenic pollution is extensive at shallow depth in the low-land organic- rich Holocene sediment characterizing the Bengal Delta (Acharyya S. K. & Shah B. A., 2010) and this kind of elevated As is associated with the widespread reducing hydrochemical conditions (Bhattacharya et al., 1997) in grey-coloured sediments of Holocene age (McArthur et al., 2001) at depths <100 m (Bhattacharya et al., 1997; BGS/ DPHE, 2001; van Geen et al., 2003b). It is widely accepted (Fendorf et al., 2010) that arsenic is released to groundwater by microbially mediated (Islam et al., 2004) reductive dissolution of the Fe oxy-hydroxide coating (Nickson et al., 1998) of sedimentary particles, in the presence of organic matter (Harvey et al., 2002; McArthur et al., 2004; Neumann et al., 2010). The role of geomorphology in controlling arsenic contamination over the Katwa-II Block, Burdwan; west of the Bhagirathi River is the topic of our present study.

2.0 Study Area:

The study area is located in between three river systems of Ajoy, Damodar and Bhagirathi or Hooghly River. Administratively this area belongs to the Katwa-II Block of Katwa Sub-division, eastern part of Burdwan districts of West Bengal, India. Geomorphologically the study area is situated along with the western part of Bhagirathi River; and covered the several small portion of geomorphological region. Katwa-II experiences a climate which is transitional between CWg_3 and AW_1 types, where 'C' stands for 'warm temperate rainy climates with mild winter', 'W' for 'dry winter not compensated for by total rain in the rest of the year', 'g_3' for 'eastern Ganges type of temperature trend'. Average temperature in hot season is 30^{o}C while at the cold season is 20^{o}C. And average rainfall is 150 millimeter. Soil of this region is alluvium in nature; it is mainly formed by the deposition of Bhagirathi River in the east, although Ganger Khal, Khari Nadi developed their recent deposition along their courses, it is also characterized by fertile alluvial soil

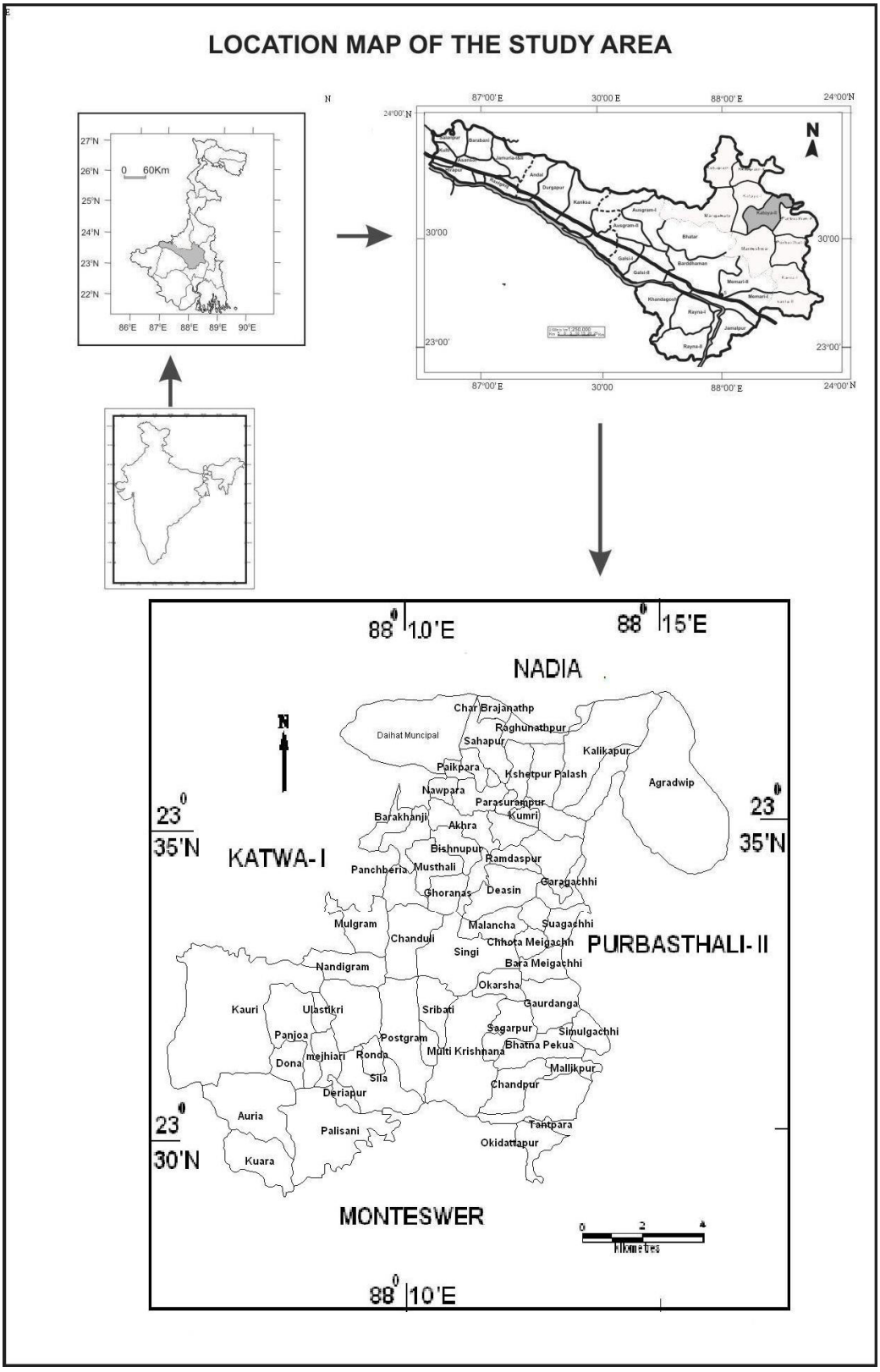

Fig: 1- Location Map of the Study Area

3.0 Objective of the Study:

The objective of this study is to

1) Preparation of Geomorphic map of the study area.

2) Understanding the distribution of groundwater arsenic contamination of the study area
3) Understanding the role of geomorphology and Quaternary morpho-stratigraphy in locating arsenic contamination in groundwater.

4.0 Database and Methodology:

For the fulfillment of our study we have collected several topic related data in different form such as for the preparation of the base geomorphic map we have collected SOI Toposheets (79A/2, 79A/3, 79A/6 of 1974 with a scale of 1:50,000) as a base map, several geomorphological and Quaternary Morpho-Stratigraphic map (Pal S., 1992; Acharyya S.K. & Shah B. A., 2007) which was updated from Remote sensing data collected from GLCF and verified by several field visits and we have delineate the study area into several geomorphological region. House and village level arsenic contaminated data from public Health Engineer Department, prepared by Smriti Shriti Sangha (NGO) Water Testing Laboratory on tubwells and from State Water Investigation Department (SWID), Burdwan collected and during the field visit with Germin GPS; we have correlated their geographical location (absolute location) for preparation of the arsenic distribution map of the study area. At the same time several reports were collected from Block Disaster Management Office. For the mapping purpose QGIS-8.0, Global Mapper-14 & MapInfo-0.7 have been used. Several statistical methods have been used for analysis of the collected data; in this purpose Ms-Excel 2007.

5.0 Regional Geomorphic set-up of Katwa-II:

The inter-fluvial zone of Burdwan district of Ajoy and Damodar are divisible into four-stepped geomorphological regions (Pal S., 1992). In the west of the deltaic part consist of Laterite Plain and Older Alluvial Plain of Pleistocene and early Holocene ages, Deltaic Plain of Holocene and Younger Deltaic Plain of recent deposits respectively (Acharyya et. al.2000). The Bhagirathi River has scoured its recent and immediately older deltaic basins, which have been progressively accreted by the ancient counterparts of the Ajoy, Damodar and Dwarkeswar rivers (Fig.1) during the Quaternary sea level fluctuations (Acharyya S.K. & Shah B. A., 2007).

Regionally, the area pertains to the Ganga-Meghna-Brahmaputra delta of Pleistocene age overlain by Holocene flood plain deposits (Alam et al., 1990). There are sharp lateral contrasts in age between the terraces and the Holocene flood plains (Ravenscroft, 2003) due to the effect of river incision during the Pleistocene sea level low. Maximum incision occurred 18000 years ago when world sea level was ~120m below the present level and the main rivers may have cut down > 100m along the axial courses (Umitsu, 1993) and formed a broad plain ~ 50m below the present surface of the modern coastal plains(Good bred and Kuel, 1999, 2000). As a result, rapid sedimentary infilling took place in fining upward sequences with coarse sand and gravel at the base and carbonaceous silt and clay upwards, laid down by braided and meandering channels (Acharyya S.K. & Shah B. A., 2007).

Katwa-II Block of the western part of Burdwan district is a repetitive alluvial plain with reliefs raging from 24m to 4m above mean sea level (MSL). After detailed analysis of topographical maps, Geomorphologic and Quaternary Morpho-stratigraphic Map of West Bhagirathi River (Pal S., 1992); Acharyya S.K. & Shah B. A., 2007, 2010) we have classified Katwa Block-II into Older Deltaic Plain (Kusumgram Plain, Pleistocene–Holocene), Valley-Cuts in Older deltaic Plain, Deltaic Plain (Holocene), Valley-Cuts in Deltaic Plain (Holocene), and Younger Deltaic Plain (Recent)

5.1 Older Deltaic Plain (Pleistocene-Holocene):

The Bhagirathi River has scoured its recent and immediately older deltaic basins, which have been progressively accreted by the ancient counterparts of the Ajoy, Damodar and Dwarkeswar rivers (Fig.) during the Quaternary sea level fluctuations (Acharyya S.K. & Shah B. A., 2007). Deltaic Plain (older) is a part of Kusumgram Plain, the geomorphic features of the Kusumgram Delta Plain are revealed by the presence of abandoned channels bifurcating from the Damodar River around Silla (Mallick and Niyogi1972; Niyogi 1975), mainly located at the central part of Burdwan District and in case of Katwa-II it is located in the southern part of the block, it is composed by a series of coalescing old delta formed by ancient counter part of Ajoy and Damodar characterized by gently sloping and an ancient radiating channel system together with some fain meander scars and their associated features started from 47m and gradually comes down to 20m above M.S.L. (Pal S., 1992).

The filled valley-cuts (older) are nothing but a valley formed on the deltaic plain (older). This valley gradually becomes narrower towards west. They are filled mainly with the materials eroded from the upper deltaic plain (Pal S., 1992)

The Deltaic plain (older) and older Filled Valley-Cuts (older) together form the Older Deltaic Plain and characterized by a calcareous concentrated clay soil (Pal S., 1992)

Table: 1- Geomorphological Regions of Katwa-II (After Pal S., 1992, Acharyya S.K. & Shah B. A)

Geomorphological Region	Subtypes	Location of the area (Village Name)
Older Deltaic Plain (ODP) (Pleistocene-Holocene)	Deltaic Plain (Older) and Filled Valley Cuts (Older)	Kauri, Panjoa, Dona, Mejhiari, Kurchi, Ronda, Ulastikri, and parts of Postgram, Nandigram, Sribati, Auria. .
Deltaic Plain, (Holcene)	Ganga Deltaic Plain (Younger)	Islampur, Birbegun, Nwapara, Benga, Barakhanji, Akhra, Bishnupur, Musthali, Ramdaspur, Jamuna Pat, parasurampur, Kumri, Bara Kulgachhi, Chhota Kulgachhi, Garagachhi, and parts of Suagachhi, Khaspur, Amdanga, Jagadanandapur, Panchberia, Baikuntapur, Mulgram, Chanduli, Singhi, Malancha, Chhotomeiga, Garudanga, Sagarpur, Saraibati, Nandigram, Chandanpur, Malikpur.
	Filled Valley-Cuts (Younger)	parts of Suagachhi, Khaspur, Amdanga, Jagadanandapur, Panchberia, Baikuntapur, Mulgram, Chanduli, Singhi, Malancha, Chhotomeiga, Garudanga, Sagarpur, Saraibati, Kuara, Palisani, Deriapur, Sila, Ronda, Postgram, Natungram, Natungram, Chandanpur, Okidattapur
Younger Deltaic Plain (YDP), (Recent)	Recent Terraces with meander belts, Swamps, point bars and cut-offs	Along the Bhagirathi, Agradeep, Daihat MNC, Sahapur, Char Braja, Raghunathpur, Kabirajpur, Kaliapur and parts of Paikpara, Islampur, Birbegun, Makhaltor, keshetpur and gazipur.

5.2 Deltaic Plain (Holocene):

East of the Older Deltaic Plain lies the Deltaic Plain, this occurs generally at an altitude between 7.5m to 24m above M.S.L. (in District Gazettier of Burdwan, Biswas A., 1982). This includes narrower belts along Eastern parts of Monteshwar, Kalna, Memari, Burdwan, Katwa and Purbasthali. The lower delta plain includes both the deltas of Damodar and Ganga located at the southeast and eastern part. River Ajoy does not form any delta similar to that of Damodar and Ganga delta.

The ganga delta plain occupies the eastern part of the area unlike other deltas it is largely flat having a slope of 0.1m. / k.m. towards south. Presence of big meander scars bordered by usually wide natural levees is a characteristic features of this plain (Acharyya S.K. & Shah B. A., 2007).

Filled-Valley-Cuts (Younger) are nothing but valleys formed on the upper deltaic plain (Older) and were partially filled up by sediments which correspond to the lower deltaic plain (younger) as well the most notable features of these valley cuts are there sudden limit along the boundary of the upper deltaic plain and the Ganga Delta. According to S. Pal (1992) the valleys merge imperceptibly with the Ganga Deltaic Plain and absence of calcareous concentration in the Ganga Delta Plain is an important characteristic which help to delineate its boundary with the former deltaic plain.

5.3 Younger Deltaic Plain (Recent Fluvial Deposits and Features Such as Natural Levees, Point bars, Cut-Offs, Back-Swamps):

Recent sediments are deposited in and around the present day channel and their immediate neighborhood. This region is associated with various levees, active /abandoned channels,cut-off meander loops, ox-bow lakes, back swamps and inter-levee depressions /flood basins mostly aggraded are common (B.Biswas, 2010). Here the only exception in the geomorphologic characteristic which has developed up to 5 to 12 km. wide meander belt, bounded by 0.5 km. to 0.7 km. high scarp at some places within the Ganga deltaic plain (Pal S., 1992). It covers parts of Kalna (I & II), Purbasthali (I & II), Katwa (I & II). The general landform of this belts are cut-offs along with point bars, ridges and swales. Natural levee are less common. Most of the cut-off is just like narrow strips of water along with thalweg, remaining areas are being filled up by silt and clay (Acharyya S.K. & Shah B. A., 2007). The arsenic affected areas shown in Fig. 3 (Unpublished Report of PHE Govt. W.B.) are developed over a meander scroll of the Bhagirathi River, connecting Prubasthali–Man-da–Betar Bill–Phulea (Figs.2, 3) that had breached natural levee and spread over YDP (Acharyya S.K. & Shah B. A., 2007).

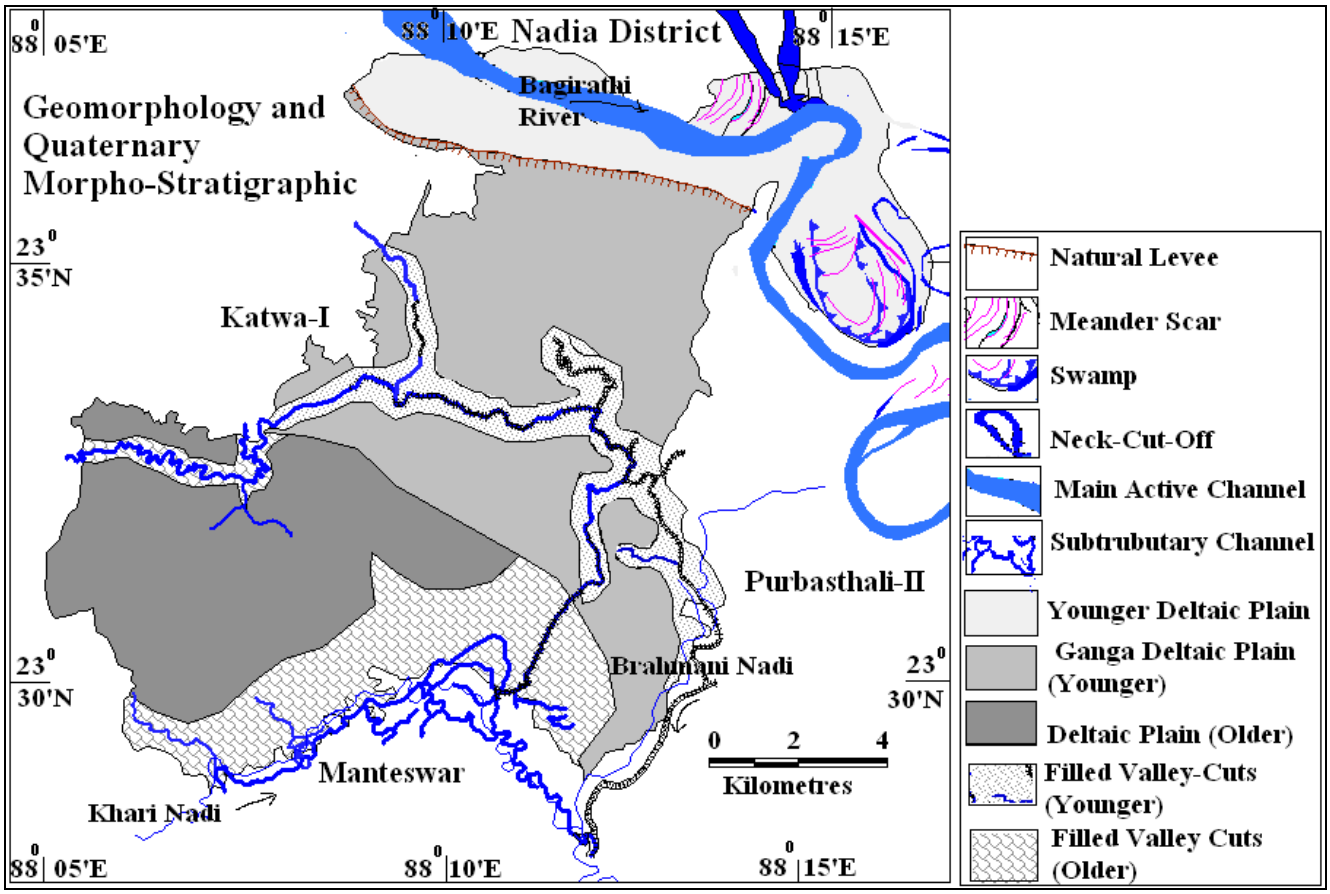

Fig- 2: Geomorphology and Quaternary Morpho-Stratigraphic Units of Katwa-II Block

6.0 Spatial Distribution of Arsenic Concentration in Groundwater of Katwa-II Block:

On the basis of the data collected it has been found that the average range of Arsenic contamination in ground water in this block belongs to 0.0005 mg./l. to 0.0036 mg./l. in 2011. We have divided into 3 categories on the basis of natural break in As contents, such as High, Moderate and Low.

6.1 High Concentration of As in Groundwater (As >0.01mg/l):

There is only one village which contains arsenic concentration in groundwater above the W.H.O. as well as Indian standard of permissible limit of arsenic concentration in drinking water. The name of the village is Gazipur and its arsenic concentration in groundwater is 0.09 mg/l.

6.2 Moderate Concentration of As in Groundwater (As 0.001 mg/l to 0.01 mg/l):

Bara Meigachhi, Auria, Kuara Malacha, Chadpur, Ghumria, these villages spread in a random manner, but the special characteristics of these distribution is that these villages are closely to Saini Khal and Brahmani Nadi; connected with Bhagirathi.

6.3 Low Concentration of As in Groundwater (As <0.001mg/l):

Most of the villages belongs to this categories these are Chhotokulgachhi, Ramdaspur, Bara Kulgachhi, Musthali, Deasin, Khasur, garagachhi, Gourdanga, Amul, Kauri, Suagachhi, Chhoto Meigachhi, Bhatna Pekua, Palisanai, Ronda and here average As value range is 0.0009 mg./l. to 0.001 mg/ lit

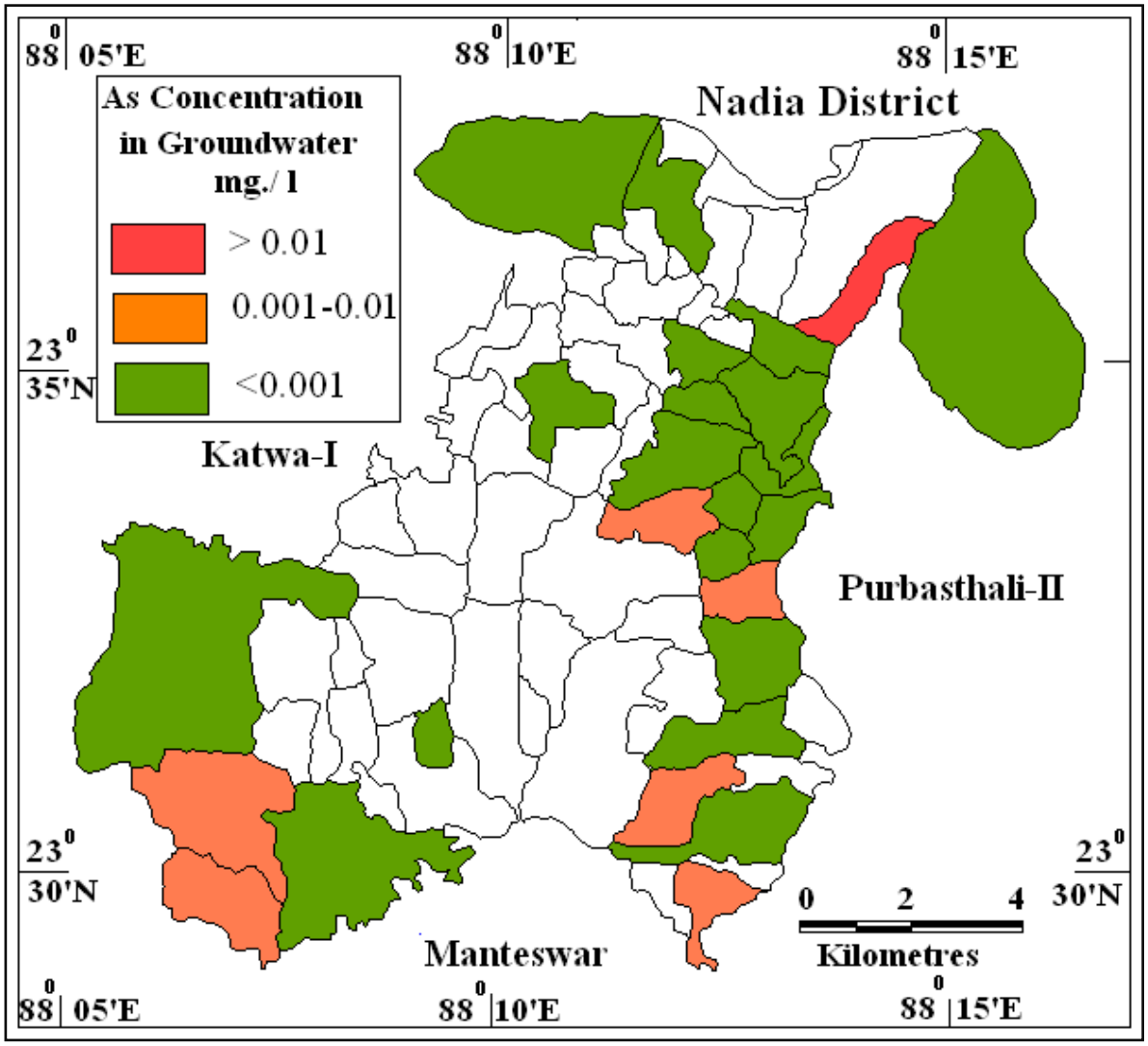

Fig- 3: Arsenic Contamination in groundwater Katwa-II Block
Source: SWID, Burdwan and PHE Office, Katwa-II Block

7.0 Result and Discussion:

Arsenic pollution in groundwater is known from many fluvio-deltaic tracts of the World like Hanoi City and the upper end of the Red River delta (Berg et al. 2001), as well as, from flood- and delta-plains of the Mekong River in Laos and Cambodia (Polya et al.2005). Parts of Indus flood- and delta-plains in Pakistan are also strongly contaminated (Nickson et al.2005; Ramay et al. 2004–2005). In this way, arsenic problem is common to several lower flood- and delta-plains in South and East Asia (Acharyya S.K. & Shah B. A., 2007). The mode of occurrence and mobility of arsenic in sedimentary aquifers is mainly influenced by local geology, geomorphology, hydrogeology, and geochemistry of sediments and water, as well as anthropogenic activities, such as, mining and land use (Bhattacharya et al., 1997; BGS and DPHE, 2001; Smedley and Kinniburgh, 2002). As in groundwater contained in alluvial aquifers in Bangladesh and West Bengal is not random, rather it is controlled by regional hydrogeologic setting and geologic–geomorphic units of the country (Ahmed et al., 2004; Shamsudduha et al., 2006a).

Arsenic-contaminated tube wells are located in Holocene Newer Alluvium entrenched channels and floodplains which are characterized by grey to black coloured organic-rich argillaceous sediments (Shah B. A., 2010) and the Older Deltaic Plain within the Bengal Delta mainly made up of the Pleistocene sediments, are free of arsenic problem it is not exception in this case of Katwa-II. Holocene sea level rise and development of reducing conditions at organic-rich swampy lands are directly linked to epicenters of arsenic distributions (Shamsudduha M. Uddin A. 2007). Surface elevation and topographic slope seem to control the distribution of arsenic because

higher levels of dissolved arsenic occur mainly within the present-day topographically low areas (Shamsudduha M. Uddin A. 2007).

Table-2: Groundwater arsenic analysis of Katwa-II Block of 2011

Village	No. of Sample	Arsenic Level in Groundwater mg/l			Depth (Meter)
		<0.003	0.003-0.01	>0.01	
Gazipur	16	15	-		55-61
Garagachha	8	7	1	1 (0.09)	55
Suagachi	9	7	2		48-61
Ramdaspur	10	10	-		55-62
Borokulgachhi	17	14	3		48-62
Khaspur	3	3	-		55
Deasin	13	9	4		55-58
Chotokulgachi	15	13	2		62
Daihat (MC)	5	4	1		24-100
Auria	1	1	-		-
Dona	2	2	-		-
Kurchi	2	2	-		-
Uluastikri	1	1	-		-
Amul	2	5	-		-
Ronda	3	3	-		-
Agradwip	3	3	-		6.1
Sahapur	7	7	-		15-64
Musthali	5	5	-		-
Jamuna Pat	4	4	-		-
Malancha	3	2	1		56
Bara Meigachi	6	5	1		-
Gaurdanga	5	5	-		-
Chandpur	4	2	2		52
Ghumuria	2	1	1		-
Palisani	4	4	-		-
Kuara	7	5	2		-

Source: SWID, Burdwan and PHE Office, Katwa-II

7.1 Older plain (Older) and Arsenic Distribution:

The upland terraces within the Bengal Delta mainly made up of the Pleistocene sediments, are free of arsenic problem. These uplands extend as regionally persistent palaeo-interfluve areas dissected by Holocene sediment filled palaeochannels (Acharyya S.K. & Shah B. A., 2007). The immediately overlying unoxidized calcrete-bearing unit is dominantly made up of relatively finer and fining up-ward alluviums, which have been correlated to the Kusumgram formation or the ODP morpho-stratigraphic unit (Acharyya S.K. & Shah B. A., 2007). This geomorphological region is characterized by safe groundwater in terms of low arsenic contamination in groundwater.

7.2 Deltaic Plain (Holocene) and Arsenic contamination in Groundwater;

Holocene sea level rise and development of reducing conditions at organic-rich swampy lands are directly linked to epicenters of arsenic distributions (Shamsudduha M., Uddin A. 2007). This region is characterized by low to moderate level of arsenic contamination in groundwater. From the above analysis it is clear that Deltaic Plain (younger) is safe. Surface elevation and topographic slope seem to control the distribution of arsenic because higher levels of dissolved arsenic occur mainly within the present-day topographically low areas (Shamsudduha M., Uddin A. 2007) as well as Shah B. A. have argued that abandoned channels, swamps and active channels in Ganga Plain are perennially or seasonally water filled where the aquifers are presumed to be enriched in biomass and thereby organic carbon (Shah B. A., 2010). So from the above analysis it is clear that this way we have

found that Filled-Valley-Cuts (younger) are characterized by low in elevation and swampy area with moderate level of arsenic contamination in groundwater.

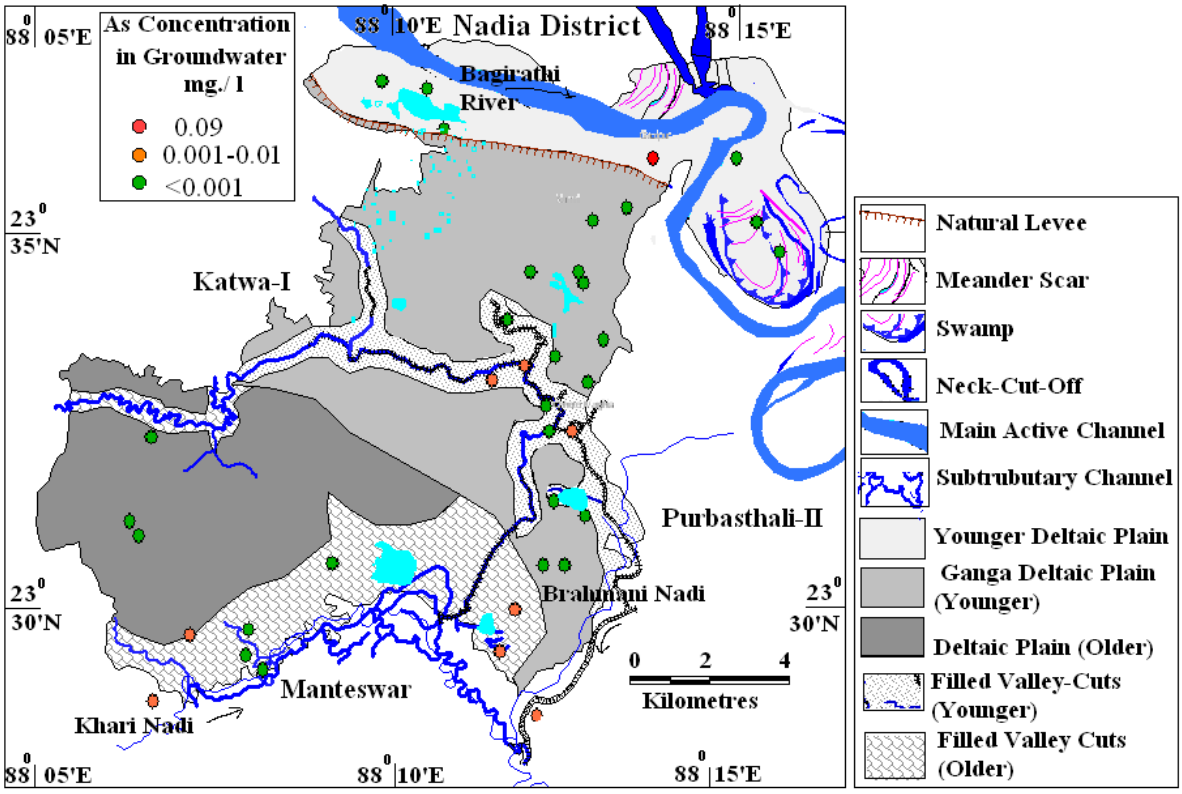

Fig- 4: Geomorphological Region, Quaternary morpho-stratigraphy and Arsenic Contamination in Groundwater.

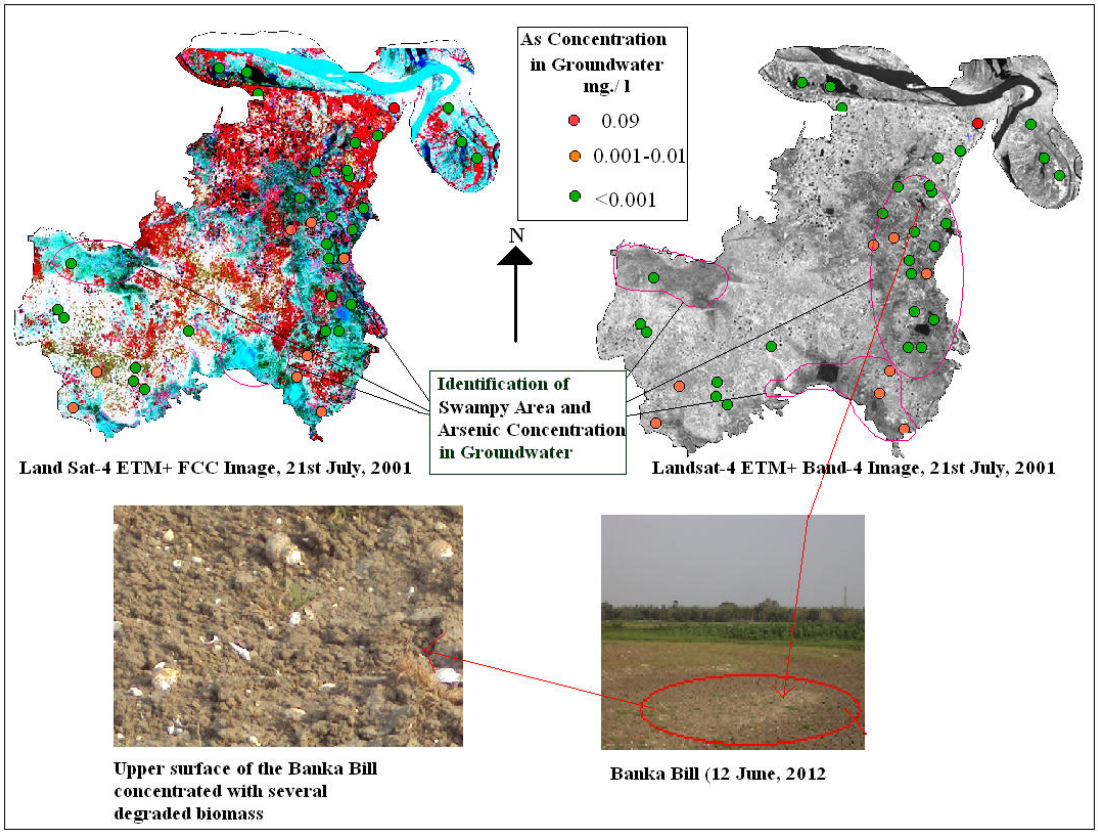

Fig- 5: Bills and Swampy area and its relation with arsenic contamination in groundwater

7.3 Younger deltaic Plain (Recent) and arsenic contamination in groundwater:

Younger Deltaic Plain region is characterized by recent terraces with meander belts, swamps, point bars and cut-offs and high arsenic contamination in groundwater. Arsenic-contaminated tube wells are located in this region of Newer Alluvium entrenched channels and floodplains, which are characterized by grey to black coloured organic-rich argillaceous sediments. The arsenic affected area generally developed over a meander scroll of the Bhagirathi River (Acharyya S.K. & Shah B. A., 2007).

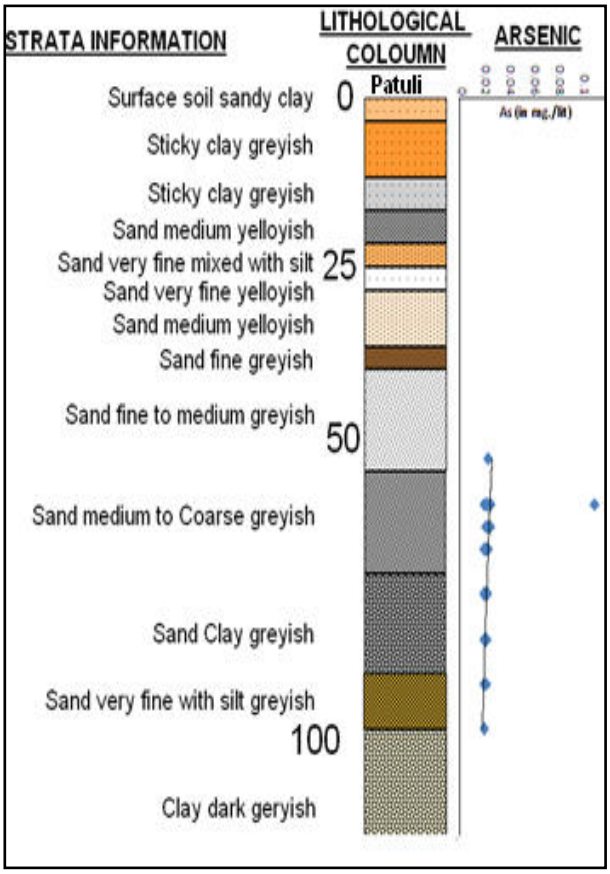

Fig-6: Lithology of Younger Deltaic Plain, Gazipur Village, Katwa, West Bengal

Stratigraphic bore hole information have been collected from PHE office of Burdwan sub- division, the location of the borehole is located in Patlui, which is hardly 0.5 km. to 0.6 km. from Gazipur Village of Gazipur Grampanchyet. So for this reason we had taken for analysis of As concentration in Gazipur Grampanchyet.From this figure two kinds of relation come out clearly, 1) Mainly three kinds of strata that containing As concentration in groundwater in this region of Gazipur Grampanchyet, namely Sand medium to coarse grayish, with 73.17 m. to 86.97 m., here As concentration is very high and the range of As concentration is also very high that is from 0.004 to 0.09(on the basis of collected data) , another strata namely Sand Clay Greyish and Sand very fine with

Silt-Grayish with the depth of 86.97 m. to 91.50 m.; 91.50 m. to 94.00 m. respectively posses very low amount of As concentration. Sand fine to medium grayish with 59.45 m. to 73.17 m. is also contain small amount of As.

Table-3: Geomorphological regions, their characteristics and arsenic contamination in groundwater.

Name of the Geomorphological Region	Area Coverage (in sq. km.)	Geomorphological Character	Geological Time	Distance from baghirati River	Level of As (mg/l)
Younger Deltaic Plain	35.53	This region is associated with various levees, active /abandoned channels,cut-off meander loops, ox-bow lakes, back swamps and inter-levee depressions	Recent Holocene	Nearest to the river 0.6 to 1.5 km.	0.001 to 0.09 (Low to high)
Deltaic Plain	75.73	Ganga Deltaic Plain and Filled-Valley-Cuts, and abandoned channels, swamps and active channels in Ganga Plain are perennially or seasonally water filled where the aquifers	Holocene	3 to 12.5 km.	0.001 to 0.004 (Moderate to Low)
Older Deltaic Plain	67.05	These uplands extend as regionally persistent palaeo-interfluve areas dissected by Holocene sediment filled palaeochannels (Acharyya S.K. & Shah B. A., 2007).	Pleistocene Holocene	>12.5 km.	< 0.003 (Very Low)

As concentration is associated with the depth of 50 m. to 100 m. in this block, and high As concentration found at the depth of 60 m. to 65 m. and with the increasing depth As concentration decreases from surface to 50 m depth characterized by different layers such as Surface soil sandy clay, Sticky clay grayish, sand medium yellowish, sand very fine mixed with silt, sand very fine yellowish, sand medium yellowish and sand fine grayish are free of arsenic contamination in groundwater. Clay dark garish, lower layer from 110 m. characterized by no arsenic contamination in groundwater

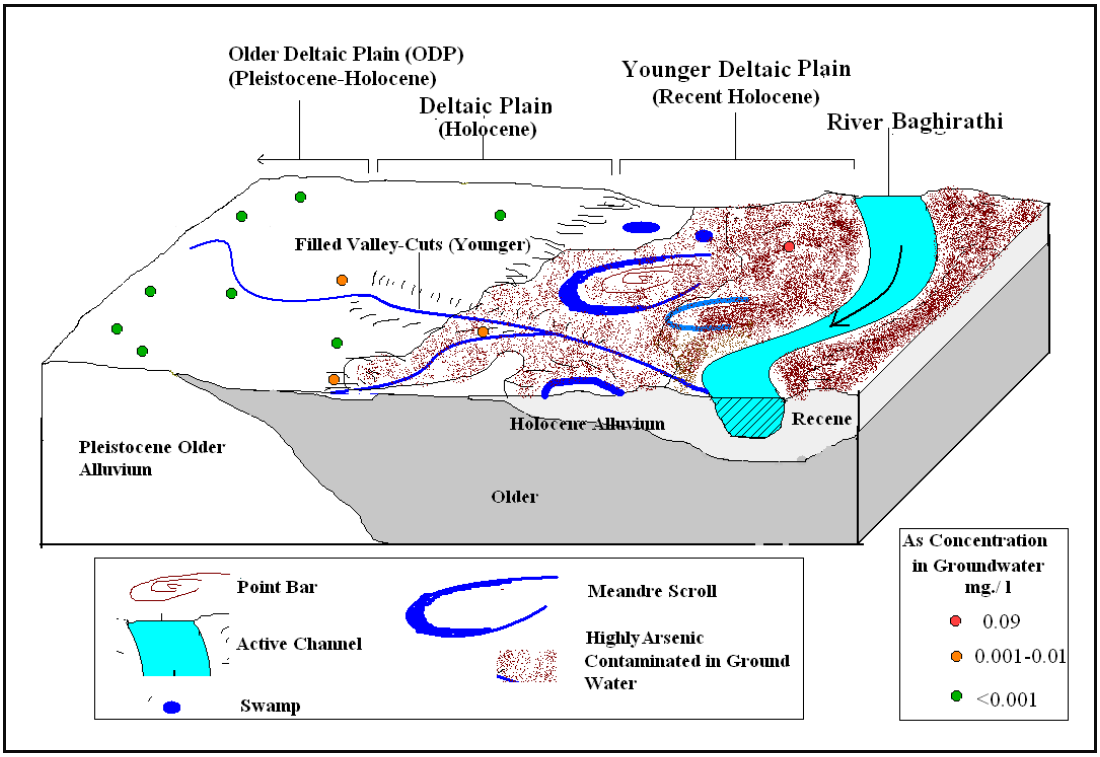

Fig- 7: Schematic Representation of Geomorphological Region and spatial distribution of arsenic concentration in groundwater.

9.0 Conclusion:

Geomorphological regions and Quaternary Morpho-Stratigraphic unites interrelated with each other, that's why they are similar in nature. Being a flood plain this is characterized by very low relative relief and elevation. The mode of occurrence and mobility of arsenic in sedimentary aquifers is mainly influenced by local geology, geomorphology, hydrogeology, and geochemistry of sediments and water, as well as anthropogenic activities, such as, land use and extreme withdrawal of groundwater for irrigational purpose for long time. Geology and quaternary geomorphology seem to be controller of the distribution of arsenic because higher levels of dissolved arsenic occur mainly within the present-day topographically recent alluvium ad filled valley cuts (younger) region. Older Deltaic Plain of Pleistocene-Holocene are free of arsenic contamination in groundwater, but filled-valley-cuts of older posses low to moderate arsenic contamination in groundwater. On the other hand deltaic plain of Holocene experienced low to moderate arsenic concentration due to presence of several filled-valley-cuts and few swampy areas in this region. Holocene sea level rise and development of reducing conditions at organic-rich swampy lands are directly linked to epicenters of arsenic distributions (Shamsudduha M., Uddin A. 2007). High arsenic-contaminated tube wells are located in Holocene Newer Alluvium entrenched channels and floodplains or younger deltaic plain, which are characterized by grey to black coloured organic-rich argillaceous sediments (Shah B. A., 2010).

Katwa-II Block includes 35.53sq. km (approx) of Younger Deltaic Plain out of 173sq. km. of total Block, which is $1/5^{th}$ of the total that's the point that Katwa-II remains low arsenic contamination in groundwater overall compared to the high arsenic contaminated blocks of Burdwan (e.g. Purbasthali-I & II). For that reason due to lack of good environment for arsenic contamination ingroundwater Katwa-II remain relatively low arsenic contamination in groundwater.

Reference:

Acharyya S. K. & Shah B. A. 2010, Groundwater arsenic pollution affecting deltaic West Bengal, india, PEPSPECTIVES IN EARTH SCIENCE- 2010

Acharyya S.K., Lahiri S, Raymahashay B.C., Bhowmik A., 2000, Arsenic toxicity of groundwater in parts of the Bengal basin in India and Bangladesh: the role of quaternary stratigraphy and Holocene sealevel fluctuation. Environ Geol 39:pp 1127–1137.

Akter A.; Ali M. H., Arsenic contamination in groundwater and its proposed remedial Measures, 2011, Int. J. Environ. Sci. Tech., 8 (2), 433-443, Spring 2011

Bhattacharya P., Chatterjee D. and Jacks G., 1997, Occurrence of arsenic contaminated groundwater in alluvial aquifer from delta plains, Eastern India. Option for safe drinking water supply. Int. J. Water Resource Development, 13(1): pp 7992.

Biswas B., 2010, Geomorphic Controls of Arsenic in Ground Water in Purbasthali I & II Blocks of Burdwan District, West Bengal, India, INTERNATIONAL JOURNAL OF ENVIRONMENTAL SCIENCES Volume 1, No 4, 2010

Chakraborti D., Das B., Rahman M,m, Chowdhury U. K., Biswas B, Goswami, Bishwajit Nayak, Arup Pal, Mrinal Kumar Sengupta, Sad Ahamed, Amir Hossain, GoutamBasu, Tarit Roychowdhury and Dipankar Das,2008, Status of groundwater arsenic contamination in the state of West Bengal, India: A 20-year study report, School of Environmental Studies, Jadavpur University, Kolkata, India

Farooqui A. and Bajpai U., 2003, Biogenic arsenopyrite in holocene peat sediment, India, 2003, Ecotoxicology and Environmental Safety 55 (2003) 157–161

http://www-nehc.med.navy.mil/downloads/ep/posters/arsensml.pdf

http://www.cancer.org/Cancer/CancerCauses/OtherCarcinogens/IntheWorkplace/arsenic

M.A. Hoque , W.G. Burgess , M. Shamsudduha , K.M. Ahmed , 2011, Delineating low-arsenic groundwater environments in the Bengal Aquifer System, Bangladesh, 2011, Applied Geochemistry 26 (2011) 614–623, Published by Elsevier Ltd

Mukherjee A. & Fryar A. E. & Howell P. D., 2007, Regional hydrostratigraphy and groundwater flow modeling in the arsenic-affected areas of the western Bengal basin, West Bengal, India, 2007, Springer-Verlag 2007

Nguyen Thanh Lan, Tran Nghi, Dang Mai, Dinh Xuan Thanh, 2007, Characteristics of Quaternary sedimentary facies in relation to water bearing capacity of aquifers and aquicludes in the Red River Delta, Vietnam, 2007, VNU Journal of Science, Earth Sciences 23 (2007) 170-176

Purkait B. and Roy A. (Contributor) Arsenic Pollution in Ground Water of the Deltaic Alluvial Plain of West Bengal – A Case Study of Malda District, 2008, Geological Survey of India

Sengupta S, Mukherjee P. K. , Pal T, Shome S, 2004, Nature and origin of arsenic carriers in shallow aquifer sediments of Bengal Delta, India. Environ Geol 45: pp 1071– 1081.

Shah B. A.,, Arsenic-contaminated groundwater in Holocene sediments from parts of Middle Ganga Plain, Uttar Pradesh, India CURRENT SCIENCE, VOL. 98, NO. 10, 25 MAY 2010

Shamsudduha M., Uddin A., 2007 Quaternary shoreline shifting and hydrogeologic influence on the distribution of groundwater arsenic in aquifers of the Bengal Basin, Journal of Asian Earth Science, Elsevier.

Sinha R., S. Tandon K., Gibiling M. R., Bhattacharjee P. S. & Dasgupta A. S., 2005, Late Quaternary geology and alluvial stratigraphy of the Ganga basin. Himalayan Geology, Vol. 26 (1), 2005, pp. 223-240

Subhrangsu K. Acharyya & Babar A. Shah, 2007, Arsenic-contaminated groundwater from parts of Damodar fan-delta and west of Bhagirathi River, West Bengal, India:influence of fluvial geomorphology and Quaternary morphostratigraphy, 2007, Environ Geol (2007) 52:489–501

Weinman S., Steven L. Goodbred, Jr., Yan Zheng, Zahid Aziz2, Singhvi4, Yogesh C. N., Steckler M., Alexander van Geen2, 2006, Arsenic concentrations in shallow groundwater of Araihazar, Bangladesh: Part I. Geological control through floodplain evolution, Submited to Water Resources Research, January 9, 2006