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Groundwater: Physicochemical assessment along the Koshi River in kharik block of Naugachia subdivision, Bhagalpur

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Abstract
Owing to highest rate of siltation in the Koshi river, runoff and formation of wetlands, ground water samples of the Koshi region of Naugachia subdivision become contaminated with heavy metals and As. Arsenic occurs in water due to carrying off arsenic bearing mineral along with sediments and over exploitation of ground water for irrigation of crops. Some samples of Kharik Block have been tested for hardness, P^H, conductivity and Arsenic. Almost all samples show hardness of water and contain arsenic below permissible limit. Some of the samples have P^H more than permissible limit by W.H.O. The problem of iron is common in this region.

Keywords: Wetlands, conductivity, hardness

Introduction
The Koshi river from the very beginning has been a source of trouble to the people of North Bihar due to perennial flood and Naugachia in particular (Kumari *et al*., 2019; Jha *et al*., 2017) [1, 2] With a catchment area of 10839 Km^2 of North Bihar, the Koshi river is the third largest in India. The area of the Naugachia Subdivision is 1,63,98748 hectare having 39,8581 male and 3,49,256 female population distributed in seven blocks comprising 71 panchayats. The devastating flood water of the Koshi river causes enormous damage to this area which is famous for cultivation of banana, maize and wheat crops Besides this the slopes and nature of the river cause land degradation causing huge loss of life and property (Jha *et al*., 2015) [3]. The rural population is facing the risk of contaminated ground water due to channelization of flood water with ground water (Datta *et al*, 1991;. WHO, 2004; Jha *et al*., 2017) [6, 5].
Rapid population growth, failures in rainfall and over exploitation of ground water resources for agriculture purposes have caused the degradation of water quality and so needs to be monitored regularly. Ground water composition in the region depends on several important factors, one of which is the branches off the main Koshi river. These can alter the safe aquifer composition and hydrological cycle.
The Koshi river leaves its former channel and branches off into many channels for its passage. There is every possibility of salinity increased conductivity and hardness of ground water. P^H is the parameter to ascertain H+ ion concentration in moles litre-^{1} and is an important index of the quality of water (Jha *et al*. 2012; De, 2017) [2, 8]. The ISI standard of P^H ranges from 6.0-8.5 or 6.0-9.00. Conductivity (K) expressed in micro Siemens per cm^2, an important physical parameter of water, is determined by conductivity mater with dip-type cell (Kumari *et al*., 2017; Jha *et al*. 2014) [10, 6] Electrical conductivity and P^H are one of important physical characteristics to know the ionic composition and thermodynamic state too. Though hardness of water is not a pollution parameter, it shows water quality. It is in terms of Ca^{2+} and Mg^{2+} expressed as $CaCO_3$.
Studies have revealed that arsenic is present more than permissible limit in the Gangetic plain at many places in Bhagalpur district from Gosaindaspur to Diara of Pirpainti Block. But the presence of arsenic more than permissible limit has not been recorded in the dhars and chaurs of the Koshi region (Jha *et al*., 2016; Kumar *et al*., 2018; Wang *et al*., 2001) [12, 13, 14]. The problem of iron contamination in ground water in this region is common and widespread. The settling of iron compounds in water container may be seen in ground water of this area. Arsenic below permissible limit in ground water may be due to high efficiency adsorption of arsenic (+3) and arsenic (+5) by ferric compound. Arsenate forms a strong complex with iron in the aqueous system.
Arsenic occurs in water due to carrying of arsenic bearing mineral, from Rajahal Hills, industrial discharge, use of insecticides and nature of sediment load from the parent place (Jha *et al*., 2014) [15].

Arsenite (+3) is most toxic from of inorganic arsenic found in ground water samples and arsenate (+5) in comparatively lesser active due to its lesser solubility. As (+3) in organic form is a toxic pollutant due to its mobility and solubility (Jha *et al*., 2019) [16]. Arsenic dissolves in aquifers at different p^H condition. Arsenic also exists in other environment at media example soil, lakes, seawater and water bodies. A large chunk of the population of the country faces the problem of arsenicosis due to the use of arsenic contaminated ground water. At higher concentration it may cause skin lesion, liver and cancer too (Vandorn *et al*., 2011; Kumar *et al*., 2012) [19, 20].

Experimental: The samples have been collected from different village of the Koshi region of Kharik Block in water sample bottles. A minimum distance of 0.5 km has been kept for sampling sites. The samples have been analyzed for P^H by a P^H meter using a glass electrode. P^H and temperature of the samples have been noted in the field and for other details the samples in water bottles have been labeled as S_1,S_2 …….S_{20}. The hardness of water is known by titrating 25 ml of ground water sample with N/50_HCl using methyl orange as an indicator. The conductivity of the samples is known by conductivity meter model no. 304. The arsenic content is determined by merckoquant kit available in the laboratory. The results of this kit are in agreement with the results obtained by Atomic Absorption Spectrophotometer.

Results and discussion: - P^H and temperature of ground water samples range from 7.5 -9.1 at 29º respectively. The higher values of P^H clearly indicate the alkaline nature of ground water logging due to perennial flood during July-August and exploitation of ground water resources for agriculture. The hardness of water in terms of Ca^{2+} shows the presence of high bicarbonates and carbonates in water. The hardness in terms of Ca^{2+} ranges from 20.4 to 60.00, Table 1, Figure 4. The analytical results of p^H, conductivity and hardness have been shown in Table 1 and Arsenic in Table 2. The graphical representations have been shown in figure 2 to 4. Figure 1a and 1b represents the google map of Kharik Block along the Koshi river and figure 1c shows the flood control map of Kharik Block in Naugachia subdivision. Table 2 clearly shows that the aquifer at a depth of 70 to 110 feet is free from arsenic contamination.

Table 1: P^H, Conductivity and Hardness in ground water of Kharik Block along the Koshi river.

Sample No.	Name of the village	Depth of tube well in feet	P^H	Conductivity	Hardness in terms of Ca^{2+}	Temp.
S1	Maircha	90	9.0	0.75 ms	44.8	36.9
S2	Maircha	70	9.0	1.04 ms	40.0	36.9
S3	Maircha	80	8.6	1.15 ms	51.6	36.9
S4	Maircha	85	9.0	1.15 ms	47.2	36.9
S5	Ratanpura	100	8.2	0.87 ms	55.2	36.9
S6	Ratanpura	100	9.1	1.16 ms	59.2	36.9
S7	Ratanpura	110	8.5	0.79 ms	50.0	36.9
S8	Ratanpura	85	8.4	0.69 ms	20.4	36.9
S9	Bhavanpura	75	8.5	1.14 ms	47.6	36.9
S10	Bhavanpura	90	8.5	0.89 ms	45.6	36.9
S11	Bhavanpura	100	8.6	1.32 ms	28.4	36.9
S12	Bhavanpura	100	9.0	1.76 ms	24.4	36.9
S13	Chorhar	75	9.2	1.12 ms	39.2	36.9
S14	Chorhar	95	9.2	0.89 ms	60.0	36.9
S15	Chorhar	90	9.0	0.76 ms	26.8	36.9
S16	Chorhar	60	8.5	1.04 ms	51.6	36.9
S17	Bagadi	105	8.5	0.79 ms	28.0	36.9
S18	Bagadi	70	8.6	1.39 ms	59.2	36.9
S19	Bagadi	70	8.7	1.48 ms	24.8	36.9
S20	Bagadi	100	8.7	0.77 ms	53.2	36.9

Table 2: Arsenic Contamination in ground water of Kharik Block along the Koshi river.

Sample No.	Presence of Arsenic in ppm
S1	N.D
S2	N.D
S3	N.D
S4	0.01
S5	N.D
S6	N.D
S7	N.D
S8	0.01
S9	N.D
S10	0.02
S11	N.D
S12	N.D
S13	N.D
S14	0.01
S15	N.D
S16	0.01
S17	N.D
S18	N.D
S19	N.D
S20	N.D

Fig 1a: Google map of Kharik Block along the Koshi river.

Fig 1b: Google map of Kharik Block along the Koshi river.

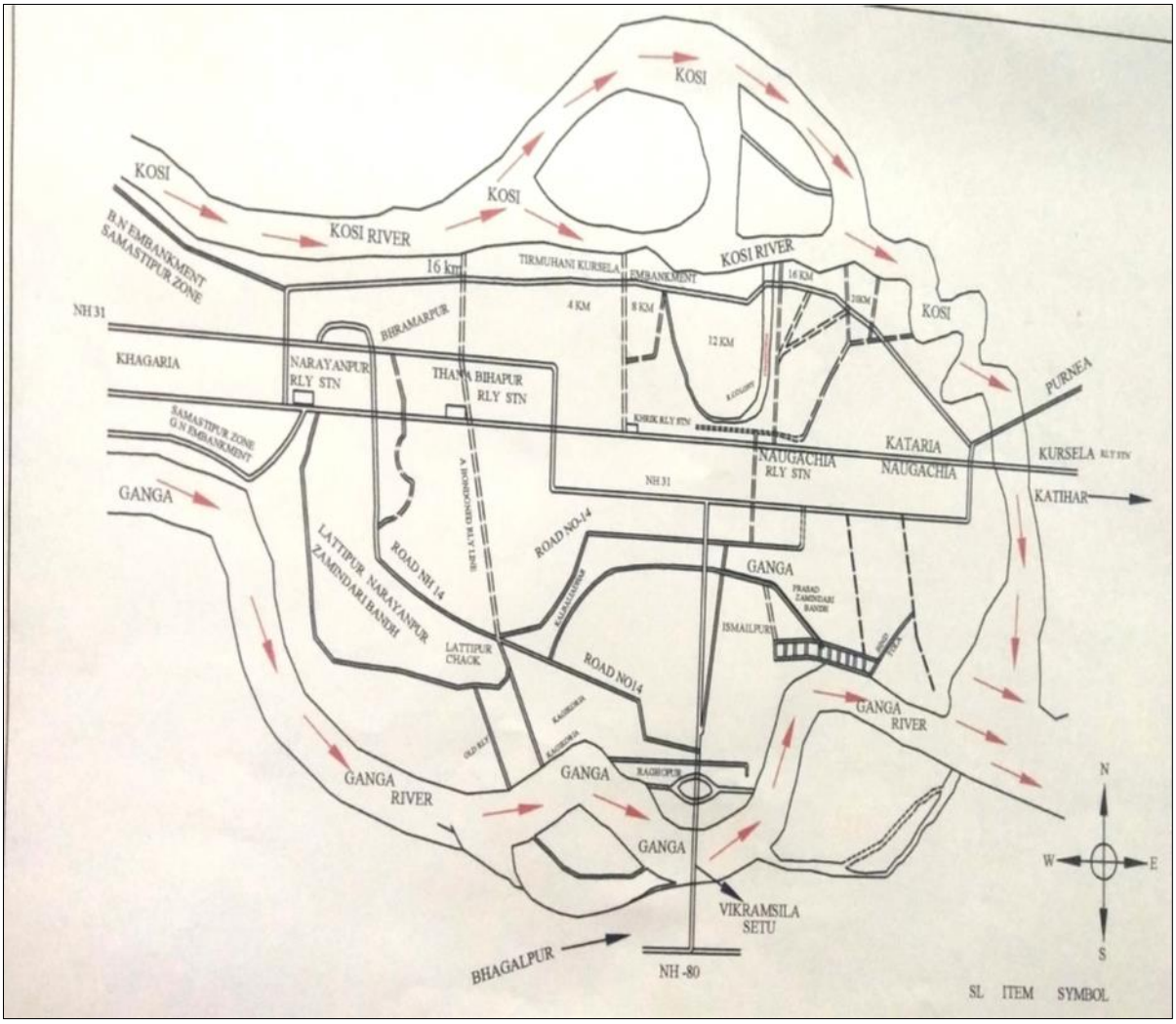

Fig 1c: Flood control map of Kharik Block in Naugachia Subdivision.

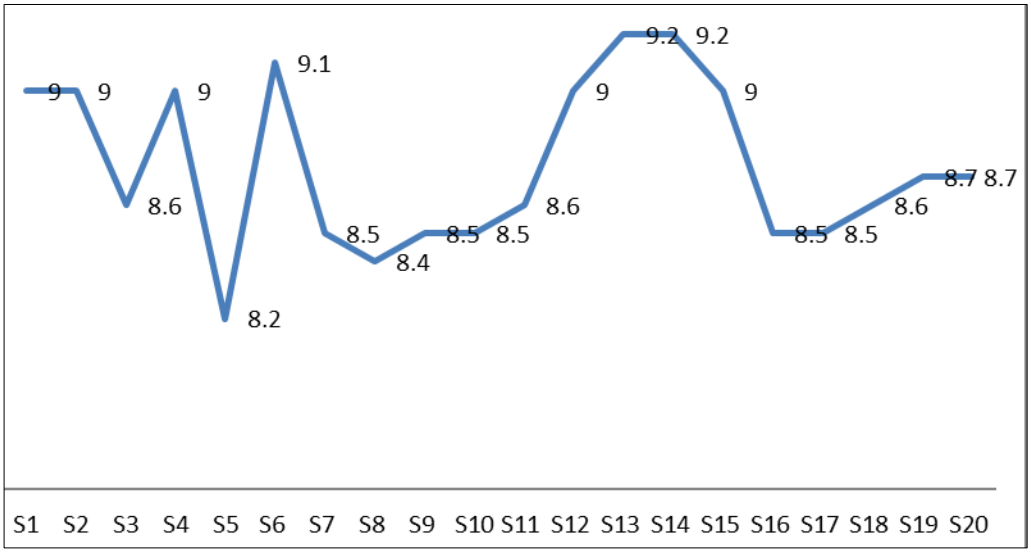

Fig 2: Variation of P^H in ground water of Kharik Block along the Koshi river.

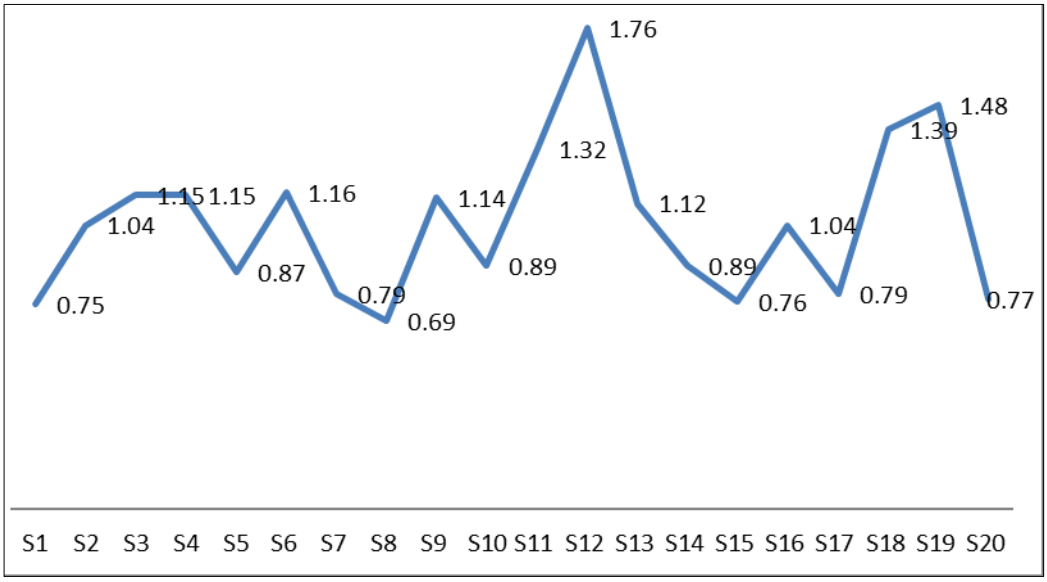

Fig 3: Variation of conductivity in ground water of Kharik Block along the Koshi river.

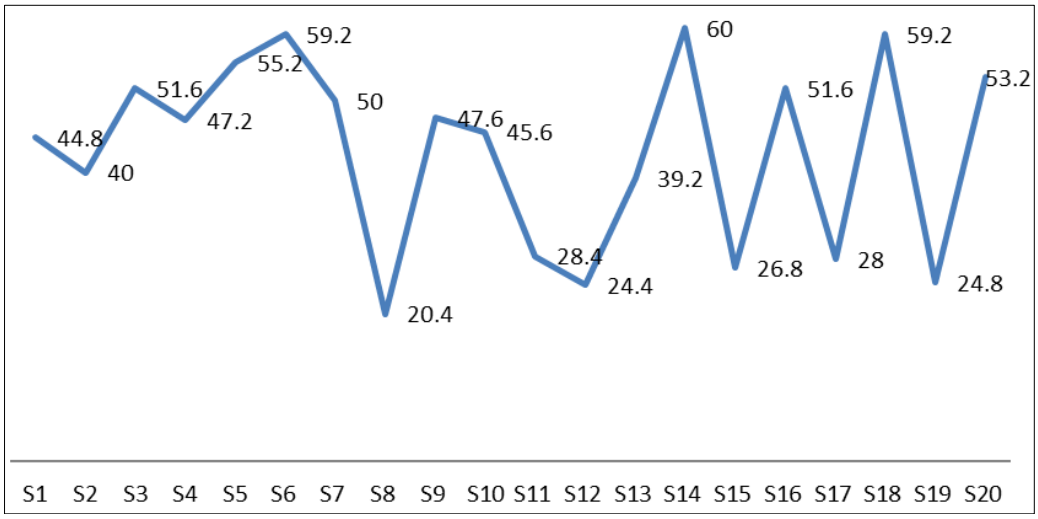

Fig 4: Variation of hardness in ground water of Kharik Block along the Koshi river.

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