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Physico-Chemical Studies on Pollution Potential of River Devaha at District Pilibhit (U.P.)

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ABSTRACT

A systematic study has been carried out to assess the water quality of Devaha River (Devhahuti ganga) at district Pilibhit from May 2009 to April 2010. The river is subjected to severe domestic and Sugar Industries pollution at Pilibhit. One water sample from each Six sampling stations (stretch-about 74 Kms) were collected in a month and analyzed for physico-chemical parameters .

The study area experiences a seasonal climate and broadly divided into three seasons as summer (March to June), Rainy (July to October), and winter (November to February).

Study reveals that the river in Pilibhit district upstream was of better quality whereas the downstream stretch was polluted as indicated by very low DO, High T.S., T.D.S., E.C., B.O.D., C.O.D., Hardness and Nutrients.

The river also shows high pollution load in winter season, in downstream (from site III to VI), which is due to the discharge of heavy distillery and sugar Industries effluent into the river.

Key words: Physico-chemical studies, Pollution, Devaha river, U.P.

INTRODUCTION

India is rich in water resources, having a network of as many as 113 rivers (the figure does not include tributaries) and vast alluvial basins to hold plenty of ground waters. India is also blessed with snow-capped peaks in the Himalayan range, which can meet a variety of water requirement of the country. However, with the rapid increase in the population of the country and the need to meet the increasing demands of irrigation, domestic and industrial consumption, the available water resources in many parts of the country are getting depleted and the water quality has deteriorated[6]. Water pollution is an acute problem in all the major rivers of India[3].

River Devaha is an important tributary of the river Ramganga. It is also known as Devahahuti ganga. River Devaha has its source at Nanak Sagar Dam near Nanakmata (Sitarganj, District Udhamsingh Nagar, State Uttarakhand) of Tarai region of Himalaya's. The river is considered as a sacred water body having its mythological link with the Hindu devotees and Sikh's Guru 'Gurunanak Dev Ji'.

The pollution potential of river Devaha is gaining momentum day by day. Survey of water channel of river Devaha at Pilibhit has revealed that, the inhabitants of villages, town, city and distillery, sugar industries on the way of river (One distillery and one sugar industry at Manjhola, one sugar industry at Pilibhit city and two at Barkhera) have familiar practice to disposing of waste-water and dumping their toxic-wastes in it.

Cremation of dead bodies at river bank is a usual practice, which is further deteriorating the quality of river water. The cattle waste of neighbouring villages brought to the river further aggrieve the pollution of its water. This has caused severe water pollution in the river Devaha to the extent that its water is no more potable and is posing severe threat of the survival to the aquatic flora and fauna and also to human beings.

For this study, the water samples were collected from six sites. Sample station I was Doony dam, which is located at about 22 km. from Nanak Sagar dam). Sample station II was near Navkund village, which located at about 49 Kms. from Nanak Sagar Dam. Sample station III was Khakra river or Nala at a premerger site of Devaha river enter up at Pilibhit, located at about 53 Km. distance from Nanak Sagar Dam. Sample station IV was Devaha-river at post merger point of Khakra river, located at about 1 km. away from station III. Sample station V was under Pilibhit Bareilly-Highway bridge. This sample Station is about 57 Km. distance from Nanaksagar Dam. Sample station VI was near Bisalpur, situated at about 96 Km. from Nanaksagar dam.

MATERIAL AND METHODS

A total of 72 subsurface water samples were collected from six different sites during each month over a period of one whole year (May 2009 to April 2010). The samples were taken in in high-grade plastic bottles of 2L capacity. Tap water and 8M HNO_3 were used to wash the plastic bottles, it is than washed with distilled water and finally with double distilled water[9].

Than the bottles were rinsed thrice with sample water, and the water samples were stored in a refrigerator at 4°C, after adding the necessary preservative[2]. All samples were labelled properly.

The pH and temperature of the water samples were determined at collection site, immediately after sampling, water samples were analyzed by standard methods[2,11]. The samples were analyzed for following physico-chemical parameters :-Water temperature (°C), pH, Turbidity (NTU). Total solids (mg/l), Total dissolved solids (mg/l), Electrical conductivity (μmho/cm), Dissolved oxygen (mg/l), B.O.D. (mg/l), C.O.D. (mg/l), Hardness, (mg/l), Chlorides (mg/l), Calcium (mg/l), Magnesium (mg/l), sodium (mg/l), potassium (mg/l).

Temperature

Temperature of water samples was recorded to ±0.1°C accuracy using a mercury thermometer, immediately after collecting the sample. Table 1 show's average summer, rainy and winter season temperatures of the river water, which vary from 31.0 to 31.6°C, 30.2 to 31.0°C and 18.3 to 19.0°C respectively. The variation is mainly related with the temperature of atmosphere and weather conditions[1-2].

pH

The pH of water samples was measured by a digital pH meter, immediately after collecting the sample. The average pH ranges from 7.57 to 8.16 in summer, 7.42 to 7.87 in rainy and 7.58 to 8.09 in winter. The pH values were observed to be little higher at site I and II, than other sites. These were also higher in summer and winter season than rainy season. Usually, the natural waters are alkaline due to the pressure of sufficient quantities of carbonates. These is generated by CO_2 absorbed from atmosphere. Significant changes in the pH occurs due to disposal of Industrial, domestic sewage etc.

Turbidity

According to WHO, the drinking water limit for water is 2.5 NTU. The average turbidity values in samples varied from 3.18 to 21.84 NTU in summer, 17.84 to 27.28 NTU in rainy and 2.78 to 11.87 NTU in winter season. The highest value of turbidity was recorded from site V in September (38.00 NTU) and lowest value of turbidity was observed at site I in January (2.01 NTU). From summer season onwards the water became turbid due to melting of snow and rains[8].

Total-solids

The average T.S. determined were ranged from 151.01 mg/l to 762.52 mg/l in summer, 325.26 mg/l to 685.09 mg/l in rainy season and 116.32 mg/l to 942.20 mg/l in winter season. The highest value of T.S. was observed at site III in February (991.53 mg/l) and lowest value of T.S. was observed at site I in February (109.01 mg/l). The largest amount of total-solids adds to the highest turbidity and electrical conductivity[10].

Total-dissolved solids

The average T.D.S. determined were ranged from 114.10 mg/l to 633.96 mg/l in summer, 169.04 mg/l to 515.75 mg/l, in rainy season and 94.50 mg/l to 826.98 mg/l in winter season. The highest value of T.D.S. was observed at site III in February (871.42 mg/l) and lowest value of T.D.S. was observed at site I in Feb. (91.00 mg/l).

RESULTS AND DISCUSSION

Results of physico-chemical analysis are given in Table 1.

The higher value of T.D.S. indicates pollution in water. Various types of minerals present in a dissolved state i.e., true solution, constitute the total dissolved solids in water, various salts like sulphates, nitrates, chlorides and phosphates of sodium, calcium, magnesium and other cations are included in T.D.S.

Electrical conductivity

Electrical conductivity is the ability of an aqueous solution to carry an electric current. This is depends on the presence, mobility, valency and concentration of Ions.

In present observations, the electrical conductivity varies from station I to VI. It was 200.58 to 1023.04 µmho/cm in summer, 296.48 to 830.45 µmho/cm in rainy season and 166.72 µmho/cm to 1333.86 µmho/cm in winter season. The highest value of E.C. was observed at site III in February (1383.62 µmho/cm) and lowest value of electrical conductivity was observed at site I in February (160.67 µmho/cm). These values indicate high pollution load in downstream of the river.

Dissolved-oxygen

Dissolved oxygen is one of the important parameter in water quality assessment. Oxygen generally reduced in the water due to respiration of biota, decomposition of organic matter, rise in temperature, oxygen demanding wastes and inorganic reductants such as hydrogen sulphide, ammonia, nitrates, ferrous iron etc[13].

In present observations, the average D.O. values were ranged from 1.29 mg/l to 7.38 mg/l in summer, 3.02 mg/l to 6.56 mg/l in rainy season and 0.25 mg/l to 7.86 mg/l in winter season.

The highest value of D.O. was observed at site I in February (8.20 mg/l) and lowest value of D.O. was observed at site III in December to February (0.0 mg/l).

These value indicates high organic pollution load at site III, which is due to the discharge of distillery and sugar industries waste along with domestic sewage water into the river. According to R. Radha Krishnan, the level of the oxygen (3 to 5 mg/l) is an indicator of healthy state of water and values below 3 mg/l are hazxardous to human[12].

Biological oxygen demand

B.O.D.is the most commonly used parameter to define the strength of a municipal or organic industrial waste water.

The average B.O.D. determined were ranged from 1.27 mg/l to 25.41 mg/l in summer, 2.03 mg/l to 13.54 mg/l in rainy season and 1.20 mg/l to 34.08 mg/l in winter. The highest value of B.O.D. was observed at site III in February (36.10 mg/l) and lowest value of B.O.D. was observed at site I in January & February (1.11 mg/l).

Chemical-oxygen-demand

Chemical-oxygen-demand (COD) serves as a reliable parameter for judging the extent of pollution in water.

The average C.O.D. determined were ranged from 6.37 mg/l to 117.63 mg/l in summer, 12.01 mg/l to 60.07 mg/l in rainy season and 6.10 mg/l to 142.71 mg/l in winter. The highest value of C.O.D. was observed at site III in February (172.11

Table 1 : Average values of Physico-chemical parameters of River Devaha at Pilibhit, showing seasonal variations. (S=Summer; R=Rainy; W=Winter)

	Temperature (°C)			pH			Turbidity (NTU)			Total Solids (mg/l)		
	S	R	W	S	R	W	S	R	W	S	R	W
Site I	31.0	30.2	18.3	8.16	7.87	8.09	3.18	17.84	2.78	151.01	325.26	116.32
Site II	31.1	30.5	18.6	8.15	7.82	8.09	4.90	23.66	3.82	170.99	338.45	132.41
Site III	31.6	31.0	19.0	7.63	7.51	7.76	21.84	25.32	11.87	762.52	685.09	942.20
Site IV	31.4	30.5	18.8	7.84	7.70	7.78	14.64	25.57	8.09	392.30	403.73	484.09
Site V	31.2	30.6	18.8	7.78	7.70	7.75	17.27	27.28	9.12	389.89	409.16	488.43
Site VI	31.3	30.8	18.9	7.57	7.42	7.58	16.11	24.47	11.49	528.55	434.63	733.30

	Total Dissolved Solids (mg/l)			Electrical Conductivity (µmho/cm)			Dissolved Oxygen (mg/l)			B.O.D. (mg/l)		
	S	R	W	S	R	W	S	R	W	S	R	W
Site I	114.10	169.04	94.50	200.58	296.48	166.72	7.38	6.56	7.86	1.27	2.03	1.20
Site II	124.58	175.41	101.25	218.76	306.84	176.42	7.20	6.35	7.41	1.35	2.04	1.35
Site III	633.96	515.75	826.98	1023.04	830.95	1333.86	1.29	3.02	0.25	25.41	13.54	34.08
Site IV	306.55	249.04	399.51	511.38	415.36	667.24	3.95	4.85	2.45	14.80	9.03	18.45
Site V	312.27	257.08	407.22	522.86	429.11	678.47	4.32	4.96	2.96	12.05	6.65	16.80
Site VI	437.86	272.05	641.28	732.22	453.26	1088.56	4.07	5.16	2.74	13.54	6.66	25.63

	C.O.D. (mg/l)			Hardness (mg/l)			Chlorides (mg/l)			Calcium (mg/l)		
	S	R	W	S	R	W	S	R	W	S	R	W
Site I	6.37	12.01	6.10	80.79	107.69	74.94	7.85	10.01	7.57	25.11	32.68	23.62
Site II	10.49	13.59	10.78	88.44	114.76	78.89	12.17	13.45	11.30	27.75	35.15	24.75
Site III	117.63	60.07	142.71	196.36	140.20	265.03	132.27	100.84	142.89	56.31	43.01	74.48
Site IV	73.41	42.82	88.70	113.88	121.30	121.47	52.76	40.08	63.75	36.76	36.75	39.40
Site V	67.54	35.48	81.05	122.82	128.59	131.44	58.50	42.73	68.59	40.07	39.75	42.63
Site VI	75.86	38.72	94.73	155.72	134.65	212.33	75.55	47.09	93.45	49.83	41.85	66.45

	Magnesium (mg/l)			Sodium (mg/l)			Potassium (mg/l)		
	S	R	W	S	R	W	S	R	W
Site I	4.47	6.37	3.85	4.63	9.55	5.78	1.33	2.15	1.55
Site II	4.77	6.55	4.15	7.20	11.26	8.80	1.68	2.63	1.77
Site III	12.52	7.97	19.42	40.49	27.50	52.01	18.55	12.44	25.65
Site IV	5.36	6.91	5.86	20.57	16.89	26.02	7.33	4.97	10.23
Site V	5.52	7.13	6.06	21.78	18.24	27.46	9.26	7.42	12.53
Site VI	7.59	7.32	11.27	28.65	22.40	37.23	14.93	10.78	19.01

mg/l) and lowest value of C.O.D. was observed at site I in December (4.94 mg/l)

Total hardness

Barrett has reported that the hard water is more productive than the soft water from fisheries point of view[4], but this is unsuitable for domestic uses.

The average hardness in (mg/l) were ranged from 80.79 to 196.36 mg/l in summer, 107.69 to 140.20 mg/l in Rainy and 74.94 to 265.03 mg/l in winter. The highest value of hardness was observed at site III in February (334.98 mg/l) and the lowest value of hardness was observed at site I in January (66.12 mg/l).

The value of hardness given in Table I for site I to VI are within the maximum permissible limit given by WHO.

Chlorides

Chlorides are a widely distributed in all types of rocks in one or the other form[7]. The most important source of chlorides in the waters is the discharge of domestic sewage. Industries are also important sources of chlorides.

The average value of chloride (mg/l) were ranged from 7.85 to 132.27 mg/l in summer, 10.01 to 100.84 mg/l in rainy and 7.57 to 142.89 mg/l in winter. The highest value of chlorides was observed at site III in February (162.10 mg/l) and the lowest value of chlorides was observed at site I in January (6.95 mg/l). High concentration of chloride can make water unpalatable and, therefore, unfit for drinking or livestock watering[7].

The value of chlorides given in Table I for site I to VI are within the maximum permissible limit given by WHO.

Calcium

Calcium is largely responsible for the hardness of water, which is turn reduces the utility of water for domestic and industrial purposes.

The average value of calcium in mg/l determined were ranged from 25.11 to 56.31 mg/l in summer, 32.68 to 43.01 mg/l in rainy and 23.62 to 74.48 mg/l in winter season. The highest value of Calcium in mg/l was observed at site III in February (90.21) and the lowest value of calcium in mg/l was observed at site III in January (22.00).

The value of calcium given in Table I for site I to VI are within the maximum permissible limit given by WHO.

Magnesium

The average value of magnesium in mg/l determined were ranged from 4.47 to 12.52 mg/l in summer, 6.37 to 7.97 mg/l in rainy and 3.85 to 19.42 mg/l in winter season. The highest value of magnesium in mg/l was observed at site III in February (26.71) and the lowest value of magnesium in mg/l was observed at site I in January (2.52).The concentration of calcium was always greater than that of magnesium.

The values of magnesium, given in Table I for site I to VI are within the maximum permissible limit given by WHO.

Sodium

The average value of sodium in mg/l determined were ranged from 4.63 to 40.49 mg/l in summer, 9.55 to 27.50 mg/l in rainy season and 5.78 to 52.01 mg/l in winter season. The highest value of sodium in mg/l was observed at site III in February (60.10) and the lowest value of sodium in mg/l was observed at site I in May (4.23).

The values of sodium in Table I for site I to VI are within the maximum prescribed limit given by WHO. Sodium was found to have greater values than potassium throughout the study. The results agree with those obtained by Joshi et al.[8] for River ganga at Haridwar.

Potassium

The quantities of potassium in river water increased due to the disposal of waste waters. As such, it is not very much significant from the health point of view but large quantities may be laxative.

The average value of potassium in mg/l determined were ranged from 1.33 to 18.55 mg/l in summer, 2.15 to 12.44 mg/l in Rainy season and 1.55 to 25.65 mg/l in winter season. The highest value of potassium in mg/l was observed at site III in February (29.07) and the lowest value of potassium in mg/l was observed at site I in June (1.23).

The values of potassium in Table I for site I to VI are within the maximum prescribed limit given by WHO.

CONCLUSION

The present study revealed that the water of Devaha river upstream (site I and site II) is of good quality than downstream river (site III to VI).

The highest and maximum values of physico-chemical parameter's (High BOD, COD, Turbidity, T.S., T.D.S., E.C., Hardness, Nutrients and low D.O.) were shown at site III in winter, indicating high pollution load, which is due to the discharge of effluent of distillery and sugar industries of Manjhola (in winter) along with domestic sewage water of Pilibhit, into Khakra, which ultimately merge into River Devaha (before site IV). The values of physico-chemical parameter's at site VI were again increased, due to addition of discharge of effluent of sugar industries situated at Pilibhit (after site V) city and Barkhera.

Non-point sources like cattle dropping and agricultural run-off are also responsible for the deterioration of water quality of Devaha river. Results of this study recommends the treatments of domestic sewage and industrial effluent before letting into the river.

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