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Research Article

WATER QUALITY STATUS AND FISH POPULATIONS OF BHAGIRATHI RIVER IN UTTARKASHI, UTTARAKHAND

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ABSTRACT

The present research paper was projected study water quality status and fish population of Bhagirathi river of Uttarkashi, Uttarakhand. Bhagirathi is the important tributary of holy river Ganga of India, originated from Gomukh Glacier. People of Uttarkashi are facing many problems the scarcity of drinking water, irrigation, generation of electricity in rainy season. In order to make a decision the water quality parameters measurement, use of its for public, recreation, river ecology, fish diversity etc. The parameters like pH, conductivity, and turbidity TDS, DO, BOD, total alkalinity, total hardness, were determined. Higher TDS values were recorded in all sampling site in winter and lower in summer. DO was observed maximum in winter and minimum in June to September. BOD was observed high in monsoon and low in winter. It was concluded that good water quality condition in winter, while at summer and rainy season showed poor water quality. The results give good advice that urgent need to for proper water management in rainy season and the suitable tools to restore the water quality of this river for a healthy and promising human society and river ecology for conservation of fish habitat, fishery development etc.

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INTRODUCTION

Uttarakhand state is hilly state in the north part of India. It has a diverse geographical condition on the basis of social, economical and environmental conditions. The state is divided into thirteen districts. One of district is Uttarkashi. It is remote area district of Uttarakhand state of India. Two important holy rivers are originated in Uttarkashi District. i.e. Bhagirathi and Yamuna. Bhagirathi river is originated from Gangotri glaciers and flow through the Uttarkashi district headquarter. In the rainy seasons drinking water and its quality are deteriorated due to heavy rain fall and cloud bursting. In 2013 cloud bursting and land slide occurred along the main and tributaries of Bhagirathi river, which causes the erosion, occurred in the agricultural field and some part of road system. Moreover, Water is not only necessary for survival of human beings, but also for animals, plants and all other living beings (Razo et al., 2004). Nowadays a big problems are facing due to remarkable growth of populations and change of land uses urban region developments. It is due to migration of people from remote or hilly area to plane. Water is used for animals and crops production can also be mutual with the public and

the aquatic and terrestrial ecosystems (Cooper et al., 1998). Water resources are of big environmental issue. It was studied by a wide range of specialists including hydrologists, ecologists, geologists and geomorphologists engineers, (Kumar and Dua,2009). Changes in the water condition are due to the combination of natural and human action factors like inputs from agriculture and release of sediments from erosion and urban and industrial runoff (Huang et al., 2014). Major risk to the domestic use of water is through microbial contamination (Joshua et al., 2015; Matta, 2014).

Bhagirathi River has rich aquatic diversity. One of the most common endemic fish species that inhabit this fresh water is the *Schizothorax* species. Many local people of Uttarkashi depend upon the fish occupation. They catch the fishes by different techniques and sell the fishes to the market for their live hood. But in the rainy season, their occupation is being stop . The study aims to provide detailed information on seasonal variation of Physico-Chemical parameters and native fish population. These species prefer fast running torrential cold water rivers and are found at the bottom under stones and rocks and are usually found above an altitude of 670 meters in

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the river and streams along the Himalaya (Tilak R. *et.al.*, 1975, Talwar P. 1978). This endemic species has slow growth. Their inherent biological features such as short growth period and slow growth to maturity are the main constraints hindering their growth and population increase (Khan M.A. *et.al.*, 2013). Large amounts of money and efforts have been made by government during 5 decades to enhance the quality of water for domestic and industrial consumption and reduce its pollution load. One of the most effective ways to communicate information on water quality trends to policy makers and the general public is the indices

Study Area and Methodology

The present study area is situated in middle Himalaya of Uttarakhand state of India. Uttarkashi is the district main headquarter. For the present study, two sampling stations were selected. Samples were collected between 8 a.m.-11 a.m. and were transported to the laboratory immediately. The temperature was recorded at the time of sampling using centigrade thermometer. The extension (stretch), of one station is approximately 15 km. above from Uttarkashi i.e. Maneri and other station 2 km down from Uttarkashi i.e. Joshiyara. Water samples were collected once in a month from the study area for a period of one year from January 2017-December 2017 at selecting two stations described above and pH, alkalinity, dissolved oxygen were analyzed immediately at the sampling sites using equipments. The other parameters like Total dissolved solids, Total suspended solids, biological oxygen demand, Total hardness, were analyzed in the laboratory. The estimation of physico-chemical parameters were done at all the two study sites. Standard methods as outlined by Trivedi S.K. and Goel P. (1986), APHA (1995), Dutta & Munshi (1995) and Welch P.S. (1952) were followed. Readings were usually taken in triplicates.

Sampling of fishes were done in the Ganges (Bhagirathi) River each month for one year (2017). Same above sites were selected for fish sampling. Hired fisherman used nets for capturing the fish and the sampling was validated using the 3 pass technique where the population of the enclosed area should decrease after each sampling. Scoop net was also used for the fish collection. Sampling was modified during monsoon and peak summer months due to the tremendous increase in water volume. When the river was high, fishermen used cast net and approximately 30 "throws" were performed for each sampling.



Figure 1 View of First sampling site Maneri, Uttarkashi



Figure 2 View of Second Sampling site Joshiyara, Uttarkashi

RESULT AND DISCUSSION

This investigation was carried out on various parameters of water quality (physico-chemical parameter) of river Bhagirathi. The fresh water systems of earth are imperiled and it has been projected that among one of the next major crisis coming would be related to fresh water. This aims to document the changes in physico-chemical properties of water due to fluctuations of water level by average seasonal variations and anthropogenic activities.

In the first sampling site, the average air temperature recorded maximum in monsoon season of 27.6 ± 0.0 °C while minimum in winter season of 21.6 ± 0.0 °C. Average depth temperature recorded maximum in monsoon season of 15.6 ± 0.00 °C and minimum in winter season of 9.33 ± 0.0 °C. In the site II, average air temperature recorded maximum in monsoon season of 30.6 ± 0.0 °C, while minimum in winter season of 20.5 ± 0.0 °C. Average depth temperature recorded maximum in monsoon season of 17.3 ± 0.0 °C. and minimum in winter season of 9.8 ± 0.0 °C. In this study area higher value of water and air temperature were observed in monsoon and lower in winter. Same result was also found by Welch P.S (1952). The lower water temperature recorded during winter months was due to rarely rainfall and cold weather conditions. The higher temperature during in April and May was associated with longer photoperiod bright sunshine dry wind conditions.

Turbidity was found maximum in monsoon of 107.56 ± 0.46 NTU and minimum in winter of 3.74 ± 0.11 NTU in site I. Turbidity was found maximum in monsoon of 99.5 ± 0.14 NTU and minimum in winter of 4.3 ± 0.08 NTU in site II. The Turbidity of the river Bhagirathi water was lowest during November to March and increases from May to Sept due to the increase in atmospheric temperature the glaciers from where the river originates start melting resulting in more quantity of water in the river. Uttarkashi is sensitive zone of Uttarakhand state. In a monsoon, clouds bursting occur as a result water level increases in Bhagirathi river. Higher turbidity was due to high may be due to the construction activities and mixing of muck into the water. Same result were recorded by the report NTPC (2011) and NEERI July 2011 in the same river. The Electrical conductivity value was recorded higher in summer of 125.48 ± 0.18 μ S cm^{-1} and lower in monsoon of 101.9 ± 0.2 μ S cm^{-1} in site I. The Electrical conductivity value was recorded higher in summer of 121.1 ± 0.36 μ S cm^{-1} and lower in monsoon of 109.5 ± 0.26 μ S cm^{-1} in site II. Results

indicate that higher electrical conductivity were observed in summer season lower in monsoon whereas intermediate in winter season. The average value of DO was found maximum in winter of $11.33 \pm 0.09 \text{ mg l}^{-1}$, while minimum in summer of $9.71 \pm 0.05 \text{ mg l}^{-1}$ in the site I. The average value of DO was found maximum in winter of $10.8 \pm 0.18 \text{ mg l}^{-1}$, while minimum in summer of $8.6 \pm 0.05 \text{ mg l}^{-1}$ in the site II. The Bhagirathi water contains maximum dissolved oxygen in colder month followed by a gradual decrease to its lowest value during June to September the higher concentration during the colder month is due to the low water temperature low turbidity and the photosynthetic activities of the green algae which start their growth on the submerged stones and rock (Badola S.P 2009).

Free CO₂ was found maximum in summer of $2.98 \pm 0.01 \text{ mg l}^{-1}$ and minimum during the colder months of $1.82 \pm 0.012 \text{ mg l}^{-1}$ in the site I. In the site II, CO₂ was found maximum in summer of $3.0 \pm 0.013 \text{ mg l}^{-1}$ and minimum in winter of $2.03 \pm 0.02 \text{ mg l}^{-1}$. The increase carbon-dioxide concentration at the onset of rains may be due to anaerobic decomposition of organic materials the higher mean observed in all the station could be attributed to lesser population density of photosynthesis plankton a process which tends to remove CO₂ from the surrounding system this agree with the finding of others workers (Boyd C.E. 1979). Similar result was observed by Ayoada A.A. et.al. in 2009.

Higher total dissolve solid values were recorded in all sampling site in winter and lower TDS Monsoon Same result was found NEERI report 2011 on same river.

The average value of BOD was found maximum in monsoon of $3.75 \pm 0.04 \text{ mg l}^{-1}$, while minimum in winter of $1.5 \pm 0.07 \text{ mg l}^{-1}$ in site I. The average value of BOD was found maximum in monsoon of $4.3 \pm 0.08 \text{ mg l}^{-1}$, while minimum in winter of 2.01 ± 0.05 in site II. BOD is the amount of O₂ required by the living organism engaged in the utilization and ultimate destruction or stabilization of organic water (Hawkes 1993). It is very important indicator of the pollution status of a water body. The values of BOD clearly showed higher concentration during Monsoon respectively Kumar A et.al 2010. BOD showed higher value during monsoon and comparatively low during winter respectively Sati A. et.al (2011) at Bhagirathi river.

In the present study of pH on the study sites was between 7.0 to 7.9. The pH was increased during summer months and decreases during monsoon, maximum values during summer may be due to increase photosynthesis of the algal blooms resulting into precipitation of carbonates of calcium and magnesium from bicarbonate causing in pH during winter may be due to decrease in photosynthesis while during monsoon it may be due to greater in flow of water. Same result was obtained by (Kumar A. et.al., 2010).

Hardness of water is mainly due to calcium and magnesium ions present in it, hardness is generally measured as concentration of only calcium and magnesium as carbonate. Total hardness of water is due to the presence of bicarbonate, sulphate, chloride and nitrates of Ca and Mg (Kumar A et.al., 2010). Total hardness of water was found to be maximum in winter and minimum in monsoon season. Same result was found (Ayoade A.A. et.al., 2009, NEERI 2011). Alkalinity is the measure of of the capacity of the water to neutralize a

strong acid the alkalinity in the water is generally imparted by the salts of carbonate silicates together with the hydroxyl ions in Free State (Trivedi S and Goyal P.K 1986). In the present study the Alkalinity was found its be maximum in summer and minimum during Monsoon months in all study site. NTPC (2011) have also reported high Alkalinity during summer period and low during Monsoon.

The maximum fish population of *Schizothorax spp* were observed 90 number in the month of march of site I in Bhagirathi river. While the minimum fish population 4 number were observed in the month of July. We were observed good number of fish in spring season (Feb to April). The maximum fish population in site II in river Bhagirathi river were observed of 55 number in the month of march. While the minimum fish population were observed of nil number in the month of august. Other workers have also reported similar kind of results (Jha Bhibuti Ranjan 2006; Zhong Y. et.al., 1996). Our data on the measure of fish population – the number of fishes- report lesser number of fishes when the water levels are higher. This variation in data is due to fact that during summers and monsoon, the river is very fast flowing and the volume of water is enormous and there is no method by which the sampling area can be cordoned off. Sampling is relatively easier in winter months where the water level is low and the data set is more reliable and accurate.

Table 1 Average Seasonal Variation of Physico-chemical parameters in Bhagirathi River site I in the year 2017

Parameters	Winter	Summer	Monsoon
Air tem.0C	21.6±0.0	27±0.0	27.6±0.0
Water Temp.0C	9.33±0.0	13.6±0.0	15.6±0.00
Turbidity (NTU)	3.74±0.11	30.68±0.43	107.56±0.46
Conduct. $\mu \text{ S cm}^{-1}$	125.48±0.18	128.05±0.16	101.9±0.2
TDS (mg l ⁻¹)	78.07±0.15	70.51±0.1	62.4±0.16
DO (mg l ⁻¹)	11.33±0.09	9.71±0.05	9.96±0.1
Free CO ₂ (mg l ⁻¹)	1.82±0.012	2.98±0.01	2.33±0.01
pH	7.49±0.07	7.52±0.1	7.31±0.08
Hardness (mg l ⁻¹)	78.44±0.4	56.44±0.10	49.33±0.08
Alkalinity (mg l ⁻¹)	24.056±0.15	23.7±0.01	18.5±0.01
BOD (mg l ⁻¹)	1.5±0.07	2.71±0.05	3.75±0.04

Table 2 Average Seasonal Variation of Physico-chemical parameters in Bhagirathi River site II in the year 2017

Parameters	Winter	Summer	Monsoon
Air tem.0C	20.5±0.0	30.3±0.0	30.6±0.0
Water Temp.0C	9.8±0.0	15±0.0	17.3±0.0
Turbidity (NTU)	4.3±0.08	31.9±0.24	99.5±0.14
Conduct. $\mu \text{ S cm}^{-1}$	120.7±0.25	121.1±0.36	109.5±0.26
TDS (mg l ⁻¹)	81.2±0.37	73.4±0.1	62.7±0.41
DO (mg l ⁻¹)	10.8±0.18	8.6±0.05	9.8±0.07
Free CO ₂ (mg l ⁻¹)	2.03±0.02	3.0±0.013	2.4±0.01
pH	7.41±0.05	7.5±0.07	7.1±0.05
Hardness (mg l ⁻¹)	79.6±0.10	57.7±0.07	64.3±0.06
Ca ⁺⁺ (mg l ⁻¹)	45.9±0.07	35.2±0.15	32.2±0.10
Mg ⁺⁺ (mg l ⁻¹)	33.6±0.16	22.5±0.10	32.1±0.02
Alkalinity (mg l ⁻¹)	23.8±0.01	23.7±0.01	20.9±0.01
BOD (mg l ⁻¹)	2.01±0.05	3.2±0.04	4.3±0.08

Table 3 Monthly variation in the no of fish at site I & II of Bhagirathi river for the period of Jan 2017 to Dec 2017

Month	fish (site I)	fish (site II)
JAN	52	40
FEB	70	45
MAR	90	55
APRI	35	13
MAY	20	15
JUN	12	5
JULY	4	5
AUG	8	0
SEP	16	5
OCT	30	16
NOV	33	18
DEC	28	24

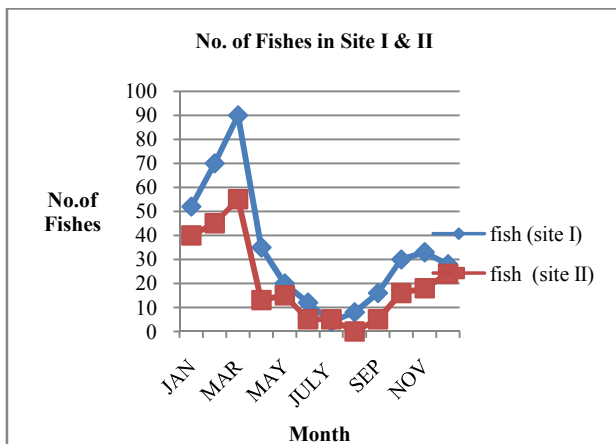


Figure 3 Monthly Variation in Fish Population at site I & II for the period of Jan 2017 to Dec 2017

CONCLUSION

From the above data, it is suggested that water quality of this river is not fit for drinking in rainy and summer seasons. This is due to pollution status is higher in rainy and summer seasons. Therefore main concern should be given to water quality monitoring and adopting local new technologies to make fit for drinking. It is also advised to local people of this region, not to consume water without proper treatment. It is also suggested that an incorporated effort should be planned involving every stakeholders for the protection and managing of aquatic biodiversity of Bhagirathi River. Although all the parameters of the study area were found positive for fish continued existence, but certain parameters such as turbidity which increases in monsoon season as a result in increased number of fish mortality due to choking of gills. Hence there is an urgent need of action plan for conservation of fish habitat, fishery development etc.

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