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Research Article

SEASONAL VARIATION IN PHYSICO-CHEMICAL CHARACTERISTICS OF RIVER BHAGIRATHI IN UTTARKASHI, UTTARAKHAND

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ABSTRACT

During the last few decades there has been an increasing demand for monitoring water quality of many rivers by regular measurements of various water quality variables. River Bhagirathi in Uttarakhand requires the same qualitative and quantitative aspects of monitoring for predicting the steady state water quality conditions. In the present work various physico-chemical parameters in surface water of river Bhagirathi i.e., Temperature, Velocity, Turbidity, Conductivity, TS, TDS, TSS, pH, Total Alkalinity, Total Hardness, Chloride, Free CO_2, DO, BOD, COD, Phosphate, Nitrate, Sodium and Potassium were analyzed for various seasons i.e Summer, Monsoon and Winter for a period of two years (October 2010 to September 2012).. Our results showed that TS, TDS and TSS were maximum in Monsoon, Temperature was maximum in monsoon and Dissolved Oxygen was found to be maximum in winter. Velocity was found to be maximum in monsoon followed by summer and winter. The observations implied that the physico-chemical conditions of River Bhagirathi was good in all the three seasons however change in seasonal conditions had a great effect on hydrological parameters.

Keywords: Physico-chemical, Seasonal, River Bhagirathi.

INTRODUCTION

Rivers are the most important freshwater resource for man. Social, economic and political development has been largely related to the availability and distribution of freshwaters contained in riverine systems. Water quality problems have intensified through the ages in response to the increased growth and concentration of populations and industrial centers (Arora and Mehra 2003). Water quality parameters provides current information about the concentration of various solutes at a given place and time (Khanna and Singh, 2000). These parameters provide the basis for judging the suitability of water for its designated uses and to improve existing conditions. The Bhagirathi sometimes called Jahnvi or Devnadi is the largest tributary river of the Ganges (Ganga) in northern India. It is perennial in nature as it receives all the three types of water inputs *i.e*., snowmelt runoff, rainfall runoff and groundwater (Mane *et al.,* 2005). However, the three components vary in space and time. The extent of human activities that influence the environment particularly the freshwater has increased dramatically during the past few decades (Kulshrestha and Sharma, 2006; Khanna *et al.,* (2006). The scale of socio-economic activities, urbanizations, industrial operations and agricultural production has a widespread impact on water resources (Kurbatova, 2005). As a result, very complex inter-relationships between socio-economic factors and natural hydrological and ecological conditions have developed. A considerable work on Physico-chemical parameters has been done by many eminent limnologists in India and abroad (Bhutiani and Khanna, 2007; Bhutiani *et al*. , 2014; Khanna *et al.* 2013;Mathivanan *et al.,* 2007; Kannan and Job 1980; Ismael and Dorgham 2003; Khanna *et al*., 2007, 2010; Valecha and Bhatnagar, 1988; Epstein 1972). The present study was designed to monitor seasonal variation in water quality parameter to investigate limiting factors, which could adversely affect the plants and animals, including fish production in this important river.

Study area

The study area is located in the Garhwal Himalayas which is an important zone of Middle Himalaya and a part of state Uttarakhand in India. It encompasses the Uttarkashi district, latitude 30°22' - 31°25'N and longitude $77^0$51' - 99°27'E. This area is very rich in biodiversity and the entire region of Himalayas is rich in terms of major fluvial systems of the Ganges, Yamuna and their tributaries. In the Garhwal Himalayas the Ganga river system is formed by two main streams, the Bhagirathi and the Alaknanda. The Bhagirathi is an important river originating from Gaumukh in Gangotri glacier (within the physical boundary of Uttarkashi district) and passes via thickly populated towns like Uttarkashi, Tehri and Devprayag. At Devprayag it meets the Alaknanda and from the confluence downstream it is called the Ganga, which flows down and emerges as the river of plains at Rishikesh-Haridwar. The river channel of the Bhagirathi at Uttarkashi exhibits a gradual increase in its width; the river bed possesses large boulders and pebbles etc.

METHODOLOGY

The present study was conducted on River Bhagirathi covering a stretch of approximately 35 km from upstream at Harsil (S1) to downstream at Bhattwari (S2). The study was carried out for a time period of two years from October 2010 to September 2012 on a monthly basis. Seasonal relation was later found to know the effect of different environmental conditions on river water. Water samples were collected every month early in the morning in sterilized sampling bottles and were analyzed for 19 important physical and chemical parameters. Few physico-chemical parameters like Temperature (^{0}C), Velocity (m/s), pH, free CO_2 (mg/l), and Dissolved Oxygen (mg/l) were performed on the spot and other parameters like Turbidity (JTU), Conductivity (µmho/cm),Total Solids (mg/l), TDS (mg/l), TSS (mg/l), Total Alkalinity (mg/l), Total Hardness (mg/l), Chloride (mg/l), BOD (mg/l), COD (mg/l), Phosphate (mg/l) and Nitrate (mg/l) were analyzed in laboratory by following the methodology of (APHA, 1998; Khanna and Bhutiani, 2004; Trivedi and Goel, 1986; Wetzel and Likens, 1991). Temperature and Velocity was measured by using Celsius thermometer (0–110 ^{0}C) and flow meter respectively. Turbidity, Conductivity and pH were measured by using Jackson Turbidity unit, Conductivity meter and digital pH meter. Total Solids, TDS, TSS were measured by volumetric analysis. Total Alkalinity, Total Hardness, Chloride, free CO_2, DO, BOD and COD were analyzed by titration method. Phosphate and Nitrate were analyzed by using UV-VIS Spectrophotometer and Sodium and Potassium by flame photometer.

RESULTS AND DISCUSSION

The physico-Chemical parameter (Avg.± SD) values obtained in different seasons of River Bhagirathi are given in table 1. From the results the temperature showed a great variation in all the three seasons and was recorded maximum in monsoon (18.66 ^{0}C ±1.70) and followed by summer (17.9 ^{0}C ±1.70) minimum in winter (11.11 ^{0}C ±1.25). The variation in the water temperature may be due to different timing of collection and influence of season (Parashar *et al*., 2006). Same study was made by (Khanna *et al.,* 2011; Khanna *et al.* 2012) in river Ganga at Haridwar. Velocity was recorded highest in monsoon followed by summer and minimum in winter. This may be due to maximum contribution of snowmelt during the month of May and June. But the main source to this river is precipitation that it receives and has a great velocity in its flow during monsoon. The pH of water is important because many biological activities can occur only within a narrow range. Thus, any variation beyond an acceptable range could be fatal to a particular organism. (Zafer and Sultana, 2007) reported pH of 7.6 and 7.55 respectively for monsoon season. In present study the pH recorded in monsoon was (7.53±0.08 at S2 and 7.57±0.05 at S1) and (7.71 ± 0.12 at S1 and 7.60±0.08 at S2) in summer. Turbidity is a major problem in the river water of all states. The turbidity values 381.2 JTU± 41.9 at S1 and 474.8 JTU±49.1 at S2 was found higher during monsoon season. TDS and TSS were found maximum in monsoon and minimum in winter and

showed a wide variation in all the three seasons. (Khanna and Bhutani, 2003a) in Ganga water showed wide variation in TDS in different months on different sites. Total solids cause ecological imbalance in the aquatic ecosystem by mechanical abrasive action. Higher values of total solids may cause deterioration of the surviving conditions of aquatic organisms. Same conditions were shown by (Khanna *et al.,* 2007). Alkalinity of water is a measure of weak acid present in it and of the cation balanced against them. Alkalinity plays an important role in controlling enzyme activities. Maximum and minimum values of alkalinity in different seasons were found in the present study. (Venkateswarlu, 1969) attributed that there is an indication to suggest that alkalinity concentration is affected directly by rainfall. Similar effect has been noticed in the present investigation immediately often the onset of rains. The total alkalinity was found highest in summer (78.47mg/l±5.88 at S1 and 81.83mg/l±16.60 at S2) and minimum in monsoon. (Bhatt *et al.,* 1999) observed that the hardness of river increases in the polluted waters by the deposition of salts. Since the study area is free from industrial pollution, the hardness was observed fairly within the limits, which might be due to salts coming from the mountain area. Total hardness was maximum in monsoon followed by winter summer. Chloride concentration in water indicates presence of organic waste particularly of animal origin **.** In the present study the concentration of chloride varied greatly in all the seasons. It was found highest in monsoon (10.84mg/l±0.17) and lowest in winter (1.81mg/l ±0.48).

Dissolved oxygen data are valuable in determining the water quality criteria of an aquatic system. In the system where the rates of respiration and organic decomposition are high, the DO values usually remain lower than those of the systems where the rate of photosynthesis is high. Temperature also plays an important role in determining DO in an aquatic body. The DO recorded in present study was maximum in winter (9.51mg/l±0.32) and minimum in summer (7.71mg/l±0.67) indicating to water quality and effect of seasonal change. This trend was also observed by (Khanna and Bhutiani, 2003b) in river Ganga at Haridwar. BOD has been used as a measure of the amount of organic materials in an aquatic solution which support the growth of microorganisms (Ciaccio, 1971). BOD determines the strength or polluting power of sewage, effluents and other polluted waters and provides data on the pollution load in natural waters. Higher values of BOD indicate a higher consumption of oxygen and a higher pollution load. In present study BOD (2.57mg/l±0.12) was found highest in monsoon and lowest (1.75mg/l±0.30) in winter. COD determines the amount of oxygen required for chemical oxidation of organic matter using a strong chemical oxidant, such as potassium dichromate under reflux conditions. The maximum COD values were found in winter (6.52mg/l±0.29 at S1 and 6.30mg/l±0.17 at S2) whereas minimum COD values were found in summer (5.48mg/l±0.78 at S1 and 5.67mg/l±0.80 at S2). Similar pattern was reported by (Khanna and Bhutiani, 2005). Phosphate determination is useful in

measuring the water quality since it is an important plant nutrient and may play a role of a limiting factor among all other essential plant nutrients (Dugan, 1972) whereas Nitrate represents the end product of oxidation of nitrogenous matters and its concentration may depend on the nitrification and denitrification activities of micro-organisms (Sinha *et al*., 2000). Phosphate, Nitrate, sodium and potassium showed a slight variation in all the seasons and were found within permissible limits. In the present study all the three seasons had a great effect on the concentration of various physical and chemical factors and showed a positive relation with the change in seasons.

Table 1: Showing average seasonal variation in physico-chemical parameters in river Bhagirathi for the year October 2010 to September 2012.

	Summer		Monsoon		Winter	
	S1	S2	S1	S2	S1	S2
Temperature ^{o}C	17.9 ± 1.70	16.93±1.82	18.66± 0.95	18.34±1.29	11.11±1.25	11.12±0.81
Velocity m/s	1.23 ± 0.16	1.41±0.17	1.13± 0.64	1.65±0.14	1.02±0.07	0.97±0.11
Turbidity JTU	29.9 ± 55.03	32.26±36.0	381.2 ± 41.9	474.8±49.1	24.11±5.00	25.54±6.45
Conductivity µmho/cm	137.15± 1.03	137.9±1.13	317.4±1.18	342.4±1.12	109.4±1.16	109.3±1.11
T.S mg/l	607.2 ± 141.4	563.2±170.7	1637±170.7	1752±251.6	260.1±81.64	252.5±129.0
TDS mg/l	217.08±125.8	194.4±81.64	474.0±141.42	488.0±100.0	178.6±95.74	169.7±81.64
TSS mg/l	390.17± 50.0	368.9±150.0	1163±95.74	1264±200.0	81.44±50.0	82.83±57.73
pH	7.71 ± 0.12	7.60±0.08	7.57±0.05	7.53±0.08	7.88±0.09	7.95±0.09
T alkalinity mg/l	78.47± 5.88	81.83±16.60	53.45±8.13	56.65±6.48	68.10±6.85	68.13±4.65
T Hardness mg/l	86.12 ± 2.88	83.81±3.94	108.9±8.34	108.3±2.64	96.08±21.10	96.4±7.93
Chloride mg/l	2.63 ± 0.58	2.60±0.65	10.46±0.80	10.84±0.17	1.81±0.48	1.83±0.97
Free CO_2 mg/l	2.72 ± 0.09	2.65±0.06	3.03±0.04	3.10±0.21	1.45±0.11	1.52±0.08
D.O mg/l	7.71 ± 0.67	7.87±0.18	7.79±0.66	7.88±0.32	9.51±0.32	9.27±0.50
B.O.D mg/l	2.30 ± 0.28	2.37±0.14	2.57±0.12	2.43±0.10	1.77±0.30	1.75±0.19
C.O.D mg/l	5.48 ± 0.78	5.67±0.80	5.73±0.37	5.60±0.48	6.52±0.29	6.30±0.17
Phosphates mg/l	0.025 ± 0.05	0.028±0.03	0.11±0.06	0.11±0.07	0.08±0.05	0.07±0.04
Nitrates mg/l	0.01± 0.09	0.01±0.04	0.06±0.05	0.18±0.01	0.03±0.07	0.03±0.02
Sodium mg/l	0.39± 0.06	0.44±0.02	0.45±0.06	0.34±0.03	0.39±0.07	0.37±0.04
Potassium mg/l	0.01± 0.06	0.02±0.04	0.04±0.05	0.04±0.02	0.09±0.03	0.09±0.04

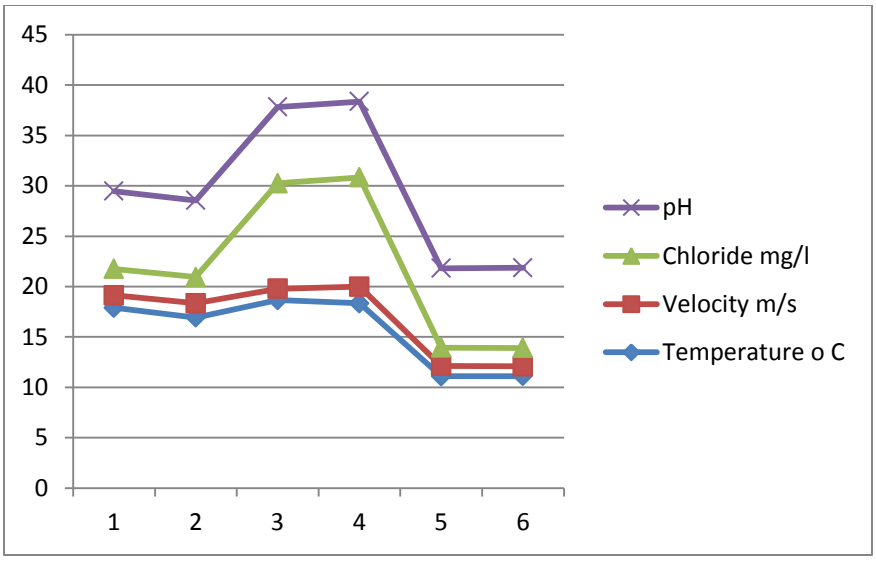

Fig.1: Showing average seasonal variation in Temp., pH, Chloride and Velocity in river Bhagirathi.

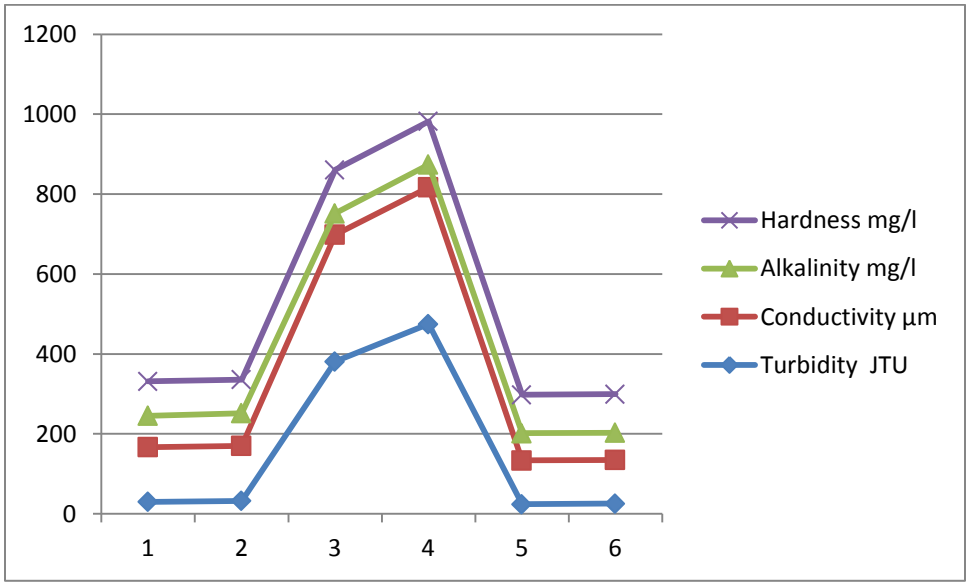

Fig. 2: Showing average seasonal variation in Temp., Transparency and velocity in river Bhagirathi.

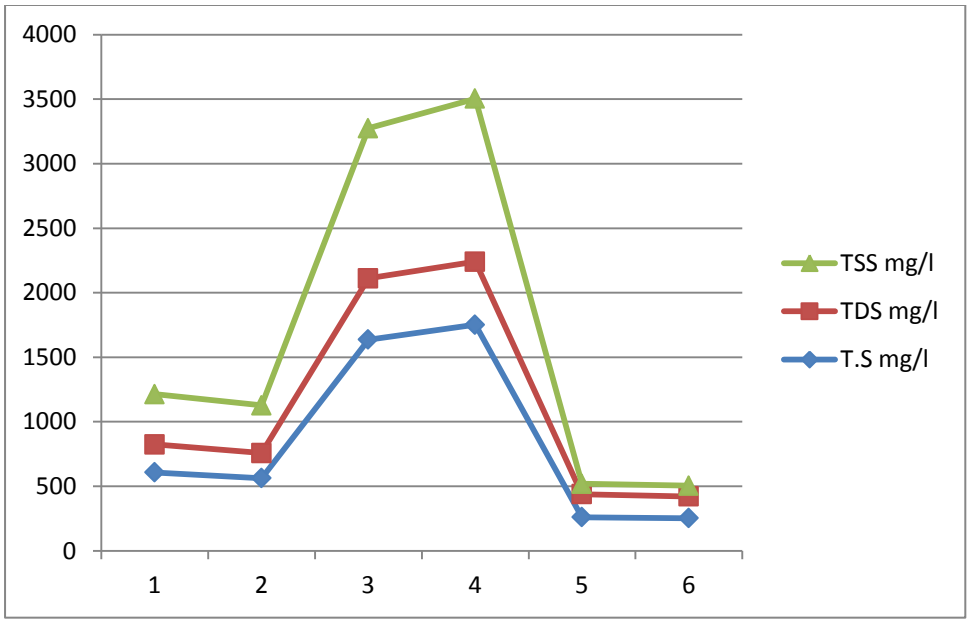

Fig. 3: Showing average seasonal variation in TSS, TDS and T.S. in river Bhagirathi.

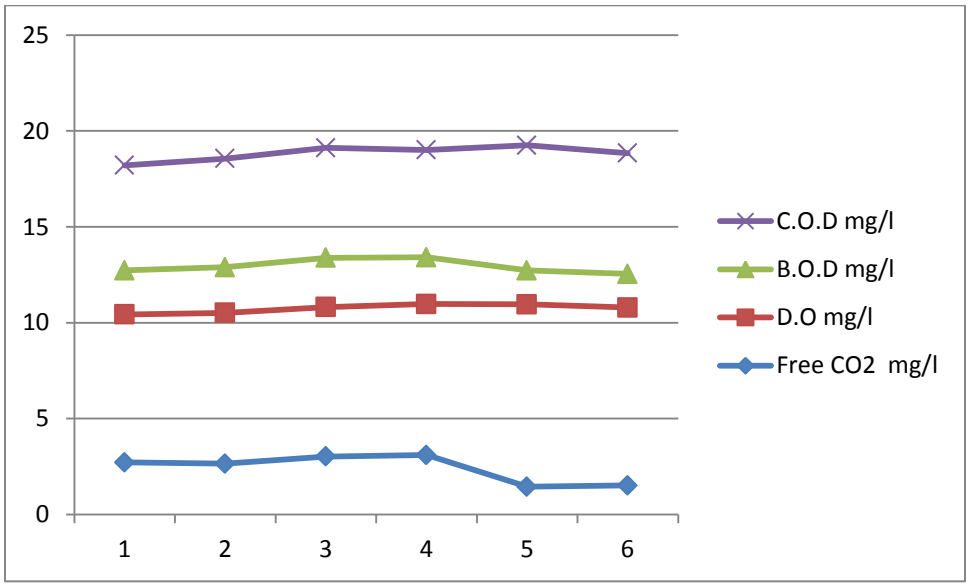

Fig. 4: Showing average seasonal variation in COD, BOD, D.O and Free CO_2 in river Bhagirathi.

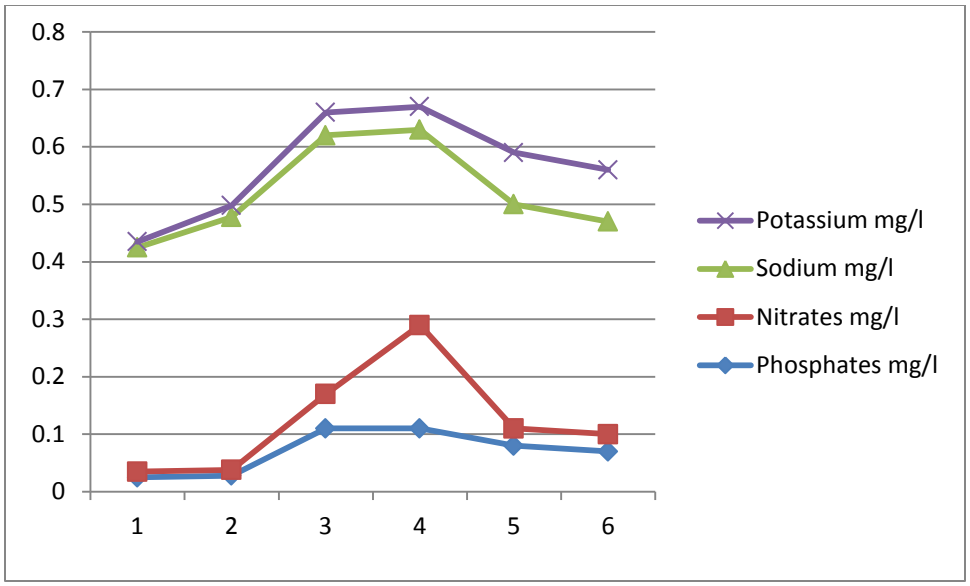

Fig. 5: Showing average seasonal variation in Potassium, Sodium, Nitrates and Phosphate in river Bhagirathi.

CONCLUSION

The present study revealed that the physico-chemical conditions of river Bhagirathi were fairly good in all the seasons, however the slight variations were observed in river water in the monsoon season due to run-off of organic matter into river from foothills and river basin. The concentrations of various nutrients and other water quality parameters undergo seasonal changes and the values showed a slight variation in all the seasons. The problem of pollution was not serious in the water but the management efforts should be made for the conservation of River Bhagirathi in Uttarkahi otherwise it will turn into the state that would affect its physico-chemical status that may not be fit for human consumption as well as the growth and survival of aquatic life present in it.

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