# **ORIGINAL RESEARCH PAPER**

# Assessment of Water Quality Status and Zooplanktons of River Bhagirathi In Uttarkashi

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### **ABSTRACT**

The present paper was depicted to analyze the water quality status in single terms and zooplanktons of the Bhagirathi river. The water quality parameters were analyzed in lab.such as pH, Total Dissolved Solids (TDS), Total Hardness (TH), Chloride, Dissolved Oxygen, Calcium, Biochemical Oxygen Demand (BOD and Chloride. In the 1 site of the first area, the value of WQI in monsoon 55.79, winter 31.73 and summer 45.66, In the site 2, the value of WQI in monsoon 61.46, winter 38.17and summer 46.42, In the site 3, the value of WQI in monsoon 61.36, winter 32.91 and summer 47.55 were observed. Water quality index in the all study site is good in winter and summer, but poor in monsoon season. These freshwater systems also support various forms of aquatic life. The zooplankton of our study site mainly comprised of Protozoa, Rotifer, Copepoda, and Cladocera. A total of 11 genera of Zooplanktons were observed during the study. The maximum number of Zooplanktons genera was during winter and minimum during the rainy season. The most remarkable aspect of River Bhagirathi at these sites seems to be the tremendous potential to heal the health of the entire river ecology that gets damaged due to insufficient water released from the hydro-electric power project after the dam wall into the main river channel. Immediate steps need to be taken to restore the ecological balance – mainly in main river channels after the dam wall of hydro-electric power projects.

**Keywords:** Water quality Status, Water Quality Index, Physico-Chemical Parameters, Bio-indicators" of aquatic ecosystems

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### INTRODUCTION

Uttarakhand is a Himalayan state of India, It is consisting of thirteen District. Uttarkashi is one of the remote districts of Uttarakhand, that is famous for mainly two main holy rivers..ie. Bhagirathi and Yamuna. Bhagirathi river is originated from Gagotri glacier. A lot of people of Uttarkashi depend upon the Bhagirathi river for their livelihood requirements. Water is the main natural resource and life preservative. It is essential for most human activities like – drinking, cooking, washing, bathing, agriculture, industry, recreation, and fisheries, etc. The natural source of water may be mainly in the

form of rivers, glaciers, rainwater, groundwater lakes, etc. But in the last decades, the natural sources of water are continuously being deteriorated in all around the world. The shortage of potable and clean drinking water has emerged in recent years as one of the most serious important problems in many parts of India [1]. The status of water is measured by its quality. The water quality is described by its Physico-chemical properties, therefore Physico-chemical analysis of Ganga water was done by many workers [2]. The water quality is determined by scientific calculation (WQI) value. This single value provides a wide knowledge of water quality and its

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suitability for various purposes like drinking, fishing, irrigation, etc. [3]. A water quality index (WQI) helps in understanding the water quality status of a river and hence it has been applied for both surfaces and groundwater quality evaluation all around the globe for the last few decades [4]. Maneri Bhali I and II Hydropower construction and operation in the Bhagirathi river are associated with several serious environmental problems such as water diversion, interruptions of continuous channel flow of the river, problems associated with fish migration, hydropeaking, reservoir flushing, inundation of landscapes, and alterations in biochemical cycling. Due to the human interruption, the quality of this river is deteriorating at a greater scale affecting the aquatic flora and fauna and the adjoining entities present therein [5]. The health of a freshwater aquatic ecosystem is well defined by zooplanktons that inhabit it. These unique inhabitants have also been used as "bio-indicators" of aquatic ecosystems. Besides acting as bio-indicators, these microscopic organisms are an important part of the food web and the fishes are also related to them. In the case of Zoolanktons - they are well known as fish food as indicators of water quality is well known.[6,7] The

diversity of zooplankton, the phytoplankton, and the water quality parameters make an aquatic habitat unique. These interactions are directly or indirectly are subjected to the complex influences, some of which results in quantitative changes e.g. increase or decrease of the size of the population Welch P [26] also observed that the fluctuation of biotic factors as dissolved oxygen, temperature, total alkalinity, phosphate, nitrogen, and pH can influence the growth of zooplanktons. Das P showed a relationship between zooplankton and physicochemical parameters such as densities, pH, alkalinity, nitrate, and phosphate[8]. Nutrient availabilities influence the abundance of Rotifer and Copepoda. Kumar A reported that Zooplankton did not always follow the fluctuation of Physico-chemical parameters[9]. The importance of zooplankton as fish food and as an indicator of water quality are well known.[10] Water temperatures between 10-29°c are suitable for zooplankton development [11].

# Study Area

The study area is situated in the middle Himalaya in the Uttarakhand state of India. We have selected three sampling sites. First site  $(S_1)$  was

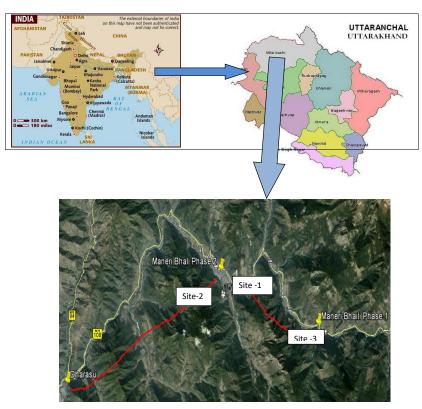


Fig. 1. Uttrakashi District Showing River Bhagirathi Sampling Station - Map not a scale

a point of the river near Uttarkashi city. The second site  $(S_2)$  was near about 3 km downward from the Uttarkashi city. The third site  $(S_3)$  was near about 10 km. upward from Uttarkashi City. Uttarkashi District Showing Bhagirathi river and sampling Sites1,2 and 3 are given in Fig. 1.

### **MATERIALS AND METHODS**

Water samples were collected from three sampling sites viz. Sampling site I, Site 2, Site 3 The samples were collected into the sample bottle and brought to the laboratory. The study was carried from August 2018 to July 2019. Various Physico-Chemical parameters of the water samples were analyzed by following the standard methods [12-14]. Readings of the samples were taken in triplicates. A set of nine most water quality parameters namely pH, electrical conductivity (EC), total dissolved solids (TDS), Calcium,

Alkalinity, Chloride total hardness (TH), dissolved oxygen (DO), biochemical oxygen demand (BOD) were analyzed. The water samples were taken in a beaker from each from the sites and then the pH was determined at the study site using an electronic pH meter (Hanna pocket pH meter - model H-196-107). Modified Winkler's method was used for the estimation of dissolved oxygen concentration in the river water. Alkalinity is the expression of the total quantity of base (usually in equilibrium with carbonates and bicarbonate) that can be determined by titration with strong acid. The conductivity of the water sample was measured with the help of systronics water and soil analysis kit (Model 460E). Total Dissolved Solids of water sample was measured with the help of systronics water and soil analysis kit (Model 460E). Chloride, Hardness, and calcium were measured by titration methods in the sample. BOD in the water sample was determined



Fig. 2. View of sampling site I in Uttarkashi. This site has proximity to populated areas.



Fig. 3. View of sampling site II downward from Uttarkashi



Fig. 4. View of sampling site III upward site from Uttarkashi

as per APHA[13] by the incubation method. Zooplanktons at each site were done by pouring ten liters of water through a plankton bucket with mesh apertures of about 50 ml. The entire sample was immediately fixed with 4% formalin solution. Identification and enumeration were made in a Sedgwick-Rafter counting cell. Identification of Zooplankton species was made according to Needham J.G. and Needham P.R. [23].

# Calculation of Water Quality Index

WQI is a single value of some water quality parameters, which decide the overall quality of a river. This is scientific information about water quality. For the calculation of the water quality index, nine parameters were selected. Three sites were taken for the present investigation. The calculated values of the present study were compared with the standard value that is recommended by the WHO, BIS, and ICMR agency. This method Brown [15] has been used in the following steps:

WQI =  $\sum W_n Q_n / W_n$ Where,  $Q_n$  = Quality rating of the n<sup>th</sup>parameters  $W_n$  = unit weight of the n<sup>th</sup>parameters Qn calculated by the following equation:  $Q_n = (V_n - V_i) / (V_s - V_i) \times 100$ Where,  $Q_n$  = sub-index of the n<sup>th</sup>parameters.  $V_n$  = actual value present of the  $n^{th}$ parameters parameter.

 $V_i$  = ideal value of the n<sup>th</sup>parameters parameter  $V_s$  = standard value for the of the n<sup>th</sup>parameters parameter.

The ideal value of all parameters was zero except (pH= 7 and DO= 14.6).

We calculated the unit weight (Wn) for the nth parameter, which is inversely proportional to the standard value of that particular variable.

 $W_n = k/V_s$  Water Quality Rating as per Weight Arithmetic Water Quality Index Method.

Where K (constant) = 
$$1/[1/(V_{s1} + 1/V_{s2} + 1/V_{s3} + 1/V_{s3} + 1/V_{s4} + 1/V_{s4})]$$
 or  $K = \frac{1}{\sum (1/Si)}$ 

### RESULT AND DISCUSSION

From the results, it was observed that seasonal changes in Characteristics of water quality were observed. During the study average pH in a different season of River water samples was varied from 7.35-7.58 at all sites. pH increased during summer months and decrease during monsoon and winter, maximum values during summer may be due to increase photosynthesis of the algal blooms resulting into precipitation of carbonates of

Table 1. Water Quality Index value, Rating of water quality and grading, Water Quality Index Level (Brown et al., 1972).

S.No	WQI Value	Rating of Water Quality	Grating	Possible usage
1	0-25	Excellent	A	Drinking, irrigation
2	26-50	Good	В	Drinking, irrigation
3	51-75	Poor	C	Irrigation
4	76-100	Very Poor	D	Irrigation
5	Above 100	Unsuitable For drinking purpose	E	Proper treatment required before use

Table 2. Standard values For Drinking water Quality by Recommended Agency

		0 1
Parameters	Standard values	Recommended Agency
TT	0.5	ICMP/DIC

S.No	Parameters	Standard values	Recommended Agency
1	рН	8.5	ICMR/BIS
2	Conductivity MS Cm <sup>-1</sup>	300	ICMR/BIS
3	DO Mg/L	5	ICMR
4	TDS (mg/L)	500	ICMR/BIS
5	Calcium (mg /L)	75	BIS
6	Hardness (mg/L)	300	ICMR/BIS
7	Alkalinity(mg /L)	120	ICMR
8	Chloride(mg/L)	250	BIS
9	BOD(mg/L)	5	ICMR

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 inflow of water. The same result was obtained by Kumar[17]. The average conductivity of the water samples was varied from 96.64 -128 mS cm-1 at all sites. Higher conductivity values were recorded in all sampling sites in winter and lower conductivity in monsoon. The average DO of the study sites was obtained ranges from 8.6 -11.53 mg/L. The Bhagirathi water contains maximum dissolved oxygen in the 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 [18].

The average TDS was observed from 66.9-90.69 mg/L at all sites. Higher Total dissolve solid values were recorded in all sampling sites in summer and monsoon and lower TDS in winter. Sabata and nayar[24] showed a wide variation in TDS in the different months in different sites. The average calcium was observed from 33.7 -58.4 mg/L at all sites. In the present study, the Calcium was found it be Maximum in winter and minimum during Monsoon months in all study sites. Lower calcium in monsoon may be attributed to dilution by rainwater. A similar observation was made by Gurumayum [19]. The average total hardness was obtained from 55.16- 84.4 mg/L at all sites. The hardness of water is the presence of sulfate, bicarbonate, chloride, and Ca and Mg [17]. Total hardness of water was found to be maximum in winter and minimum in monsoon season the same result was found[20]. The alkalinity of a water sample is its quantitative capacity to neutralize a strong acid. The average alkalinity of every sample was obtained ranges from 18.25 -26.9 mg/L at all sites. The average chloride was observed from ranges 12.5-19.0 mg/L at all

sites. In the present study, the Chloride was found it's being Maximum in Monsoon and minimum during winter in all study sites. Nautiyal P[21] has also reported high Chloride during the monsoon period and low during winter. The average BOD has observed ranges from 1.64-4.30 mg/L at all sites. The values of BOD clearly showed higher concentration during Monsoon respectively [17]. BOD showed higher value during monsoon and comparatively low during winter respectively.[22] at the Bhagirathi river.

The water quality index is the mathematical formulation to know the status of Bhagirathi river water. For this study, the water quality index was used. The status of water quality was given by five categories (Table 1). If the water quality index shows the 0.00-25.00 value (Excellent); 25.00-50.00 value (Good quality); 50.00-75.00 value (Poor); 75.00-100.00 value (Very poor) and if the value is more than the 100 than it is not suitable for drinking. Standard values For Drinking water Quality By Recommended Agency is given in Table 2.

During the study period, all sampling stations show good water quality in winter and summer but it was found poor in monsoon season in all sampling sites. In Sampling site 1 (Table 3,4,5), the value of WQI in monsoon (55.79); winter (31.73), and summer (45.66). In the sampling site 2(Table 6,7,8), the value of WQI in monsoon (61.46), winter (38.17) and summer (46.42), In the sampling site 3(Table 9,10,11), the value of WQI in monsoon (61.36); winter (32.91) and summer (47.55) were found respectively. Therefore, the water quality index indicates the water quality of all study site is good in winter and summer, but poor in the monsoon season. The maximum number of Zooplankton was observed in winter and minimum in the rainy season and similar findings were also reported by Gautam. Thus our results suggest that the most critical issue is the variation in water discharge level after the dam wall

into the main river channel of hydro-electric power projects. As the water levels fluctuate, it causes the Physico-chemical parameters to change and so the reduction occurs. The monthly variation in diversity index Shannon Wiener [25] was calculated for zooplankton for all three the sites of Bhagirathi river and the data have been presented in Fig 5. The Shannon wiener diversity index was calculated for Zooplankton in the Bhagirathi river.

The maximum value of the Shannon wiener diversity index at a site I was found 2.30 in January and a minimum value of 0.00 in August. At Site II, The maximum value of the Shannon wiener

diversity index was found 2.245 in January & a minimum of 0.0 in August. At Site III, The maximum value of the Shannon wiener diversity index was found 2.306 in Feb. & minimum of 0.0 in August. The maximum value of Concentration of dominance at the site I was found 0.5 in September and a minimum value of 0.00 in August. At Site II, The maximum of Concentration of dominance was found 0.50 in may & minimum of 0.0 in August. At Site III, The maximum value of Concentration of dominance was found 0.33 in June & a minimum of 0.00 in August as shown in Fig. 6. The diversity of zooplankton, the phytoplankton,

Table 3. Seasonal water quality index at Site 1 (Monsoon Season)

S.No	Parameters	Observed Value	Standard value (Sn)	Quality Rating (Qn)	Unit Weight (Wn)	Wnqn
1	рН	7.35	8.5	23.33	0.213	4.97
2	Conductivity(mS cm-1)	97.6	300	32.53	0.006	0.196
3	DO(mg/L)	9.74	5.00	50.62	0.362	18.325
4	TDS(mg/L)	69.15	500	13.83	0.004	0.056
5	Calcium(mg/L)	36.4	75	48.53	0.024	1.165
6	Hardness (mg CaCO3/L)	58.66	300	19.55	0.006	0.118
7	Alkalinity (mg CaCO3/ L)	19.12	120	15.93	0.015	0.239
8	Chloride(mg/L)	15.74	250	6.296	0.007	0.045
9	BOD (mg/L)	4.23	5.00	84.6	0.362	30.626
	, ,			ΣQn=295.216	$\Sigma$ Wn=0.999	$\Sigma W_n Qn = 55.735$

Table 4. Seasonal water quality index at Site 1 (Winter Season)

S.No	Parameters	Observed Value	Standard value (Sn)	Quality Rating (Qn)	Unit Weight (Wn)	Wnqn
1	рН	7.40	8.5	26.66	0.213	5.678
2	Conductivity(mS cm-1)	122.87	300	40.96	0.006	0.245
3	DO(mg/L)	11.53	5	31.98	0.362	11.576
4	TDS(mg/L)	77.37	500	15.47	0.004	0.061
5	Calcium (mg/L)	54.7	75	72.94	0.024	1.750
6	Hardness (mg CaCO3/L)	82.16	300	27.39	0.006	0.164
7	Alkalinity (mg CaCO3/ L)	24.8	120	20.67	0.015	0.310
8	Chloride(mg/L)	15.16	250	6.065	0.007	0.043
9	BOD (mg/L)	1.64	5	32.8	0.362	11.874
	, 6 ,			$\Sigma Qn = 274.935$	$\Sigma$ Wn=0.999	$\Sigma W_n Qn = 31.704$

Table 5. Seasonal water quality index at Site 1 (Summer Season)

S.No	Donomatons	Observed	Standard	Quality Rating	Unit Weight	Wasa
5.110	Parameters	Value	value (Sn)	(Qn)	(Wn)	Wnqn
1	pН	7.44	8.5	29.34	0.213	6.249
2	Conductivity(mS cm-1)	114.05	300	30.01	0.006	0.180
3	DO(mg/L)	9.22	5	56.04	0.362	20.286
4	TDS(mg/L)	87.95	500	17.59	0.004	0.070
5	Calcium(mg/L)	43.4	75	57.86	0.024	1.388
6	Hardness (mg CaCO3/L)	58.33	300	19.44	0.006	0.116
7	Alkalinity (mg CaCO3/L)	21.6	120	18	0.015	0.27
8	Chloride(mg/L)	17.08	250	6.832	0.007	0.047
9	BOD (mg/L)	2.35	5	47	0.362	17.01
				$\Sigma Qn = 282.112$	$\Sigma$ Wn=0.999	$\Sigma$ Wnqn = 45.62

Table 6. Seasonal water quality index at Site 2 Monsoon Season

S.No	Parameters	Observed Value	Standard value (Sn)	Quality Rating (Qn)	Unit Weight (Wn)	Wnqn
1	рН	7.49	8.5	32.66	0.213	6.956
2	Conductivity(mS cm-1)	107.55	300	35.85	0.006	0.215
3	DO(mg/L)	8.77	5	60.72	0.362	21.980
4	TDS(mg/L)	78.13	500	15.62	0.004	0.062
5	Calcium(mg/L)	42.3	75	56.4	0.024	1.353
6	Hardness (mg CaCO3/ L)	65.16	300	21.72	0.006	0.130
7	Alkalinity (mg CaCO3/ L)	19.4	120	16.166	0.015	0.242
8	Chloride(mg/L)	19	250	7.6	0.007	0.053
9	BOD (mg/L)	4.20	5	84	0.362	30.408
	( )			ΣOn=330.736	$\Sigma$ Wn=0.999	$\Sigma$ Wngn =61.40

Table 7. Seasonal water quality index Site 2 Winter Season

S.No	Parameters	Observed Value	Standard value (Sn)	Quality Rating (Qn)	Unit Weight (Wn)	Wnqn
1	рН	7.50	8.5	33.33	0.213	7.099
2	Conductivity(mS cm-1)	128	300	42.66	0.006	0.25596
3	DO(mg/L)	11.32	5	34.16	0.362	12.36
4	TDS(mg/L)	80.25	500	16.05	0.004	0.064
5	Calcium (mg/L)	58.4	75	77.86	0.024	1.868
6	Hardness (mg CaCO3/L)	84.4	300	28.13	0.006	0.168
7	Alkalinity (mg CaCO3/L)	26.9	120	22.41	0.015	0.336
8	Chloride(mg/L)	16.4	250	6.56	0.007	0.045
9	BOD (mg/L)	2.20	5	44	0.362	15.93
	( 6 )			$\Sigma Qn = 305.16$	$\Sigma$ Wn=0.999	$\Sigma$ Wnqn = 38.132

Table 8. Seasonal water quality index Site 2 Summer Season

S No	S.No Parameters		Standard	Quality Rating	Unit Weight	Quality Rating
5.110	Farameters	Value	value (Sn)	(Qn)	(Wn)	(qn) Wnqn
1	pН	7.58	8.5	38.66	0.213	8.234
2	Conductivity(mS cm-1)	115.05	300	38.35	0.006	0.231
3	DO(mg/L)	9.4	5	54.16	0.362	19.605
4	TDS(mg/L)	87.16	500	17.432	0.004	0.069
5	Calcium (mg/L)	44.5	75	59.333	0.024	1.423
6	Hardness (mg CaCO3/L)	64	300	21.333	0.006	0.127
7	Alkalinity (mg CaCO3/L)	21.8	120	18.166	0.015	0.272
8	Chloride(mg/L)	18.16	250	7.264	0.007	0.050
9	BOD (mg/L)	2.26	5	45.2	0.362	16.36
				$\Sigma Qn = 299.898$	$\Sigma$ Wn=0.999	$\Sigma$ Wnqn = 46.378

Table 9. Seasonal water quality index Site 3 Monsoon Season

S.No	Parameters	Observed	Standard	Quality	Unit Weight	Quality Rating
		Value	value (Sn)	Rating (Qn)	(Wn)	(qn) Wnqn
1	pН	7.41	8.5	27.33	0.213	5.821
2	Conductivity(mS cm-1)	96.64	300	32.21	0.006	0.193
3	DO(mg/L)	8.6	5	62.3	0.362	22.62
4	TDS(mg/L)	79.4	500	15.88	0.004	0.063
5	Calcium (mg/L)	33.7	75	44.93	0.024	1.078
6	Hardness (mg CaCO3/L)	55.16	300	18.38	0.006	0.110
7	Alkalinity (mg CaCO3/ L)	18.25	120	15.20	0.015	0.228
8	Chloride(mg/L)	17.3	250	6.92	0.007	0.048
9	BOD (mg/L)	4.3	5	86	0.362	31.132
				$\Sigma Qn = 309.35$	$\Sigma$ Wn=0.999	$\Sigma$ Wnqn =61.300

Table 10. Seasonal water quality index Site 3 Winter Season

S.No	Parameters	Observed Value	Standard value (Sn)	Quality Rating (Qn)	Unit Weight (Wn)	Quality Rating (qn) Wnqn
1	рН	7.57	8.5	38	0.213	8.094
2	Conductivity(mS cm-1)	126.43	300	42.14	0.006	0.25284
3	DO(mg/L)	11.34	5	33.95	0.362	12.2899
4	TDS(mg/L)	66.9	500	13.38	0.004	0.05352
5	Calcium (mg/L)	50.9	75	67.86	0.024	1.62864
6	Hardness (mg CaCO3/ L)	75.9	300	25.3	0.006	0.1518
7	Alkalinity (mg CaCO3/ L)	24.9	120	20.75	0.015	0.31125
8	Chloride(mg/L)	12.5	250	5	0.007	0.035
9	BOD (mg/L)	1.39	5	27.8	0.362	10.0636
				$\Sigma Qn=274.18$	$\Sigma$ Wn=0.999	$\Sigma$ Wnqn = 32.88

Table 11. Seasonal water quality index Site 3 Summer Season

S.No	Parameters	Observed Value	Standard value (Sn)	Quality Rating (Qn)	Unit Weight (Wn)	Quality Rating (qn) Wnqn
1	рН	7.45	8.5	30	0.213	6.39
2	Conductivity(mS cm-1)	112.17	300	37.39	0.006	0.224
3	DO(mg/L)	8.9	5	59.37	0.362	21.491
4	TDS(mg/L)	90.69	500	18.138	0.004	0.072
5	Calcium(mg/L)	43.5	75	58	0.024	1.392
6	Hardness (mg CaCO3/L)	58.16	300	19.386	0.006	0.116
7	Alkalinity (mg CaCO3/ L)	20.3	120	16.916	0.015	0.253
8	Chloride(mg/L)	17.08	250	6.832	0.007	0.047
9	BOD (mg/L)	2.42	5	48.4	0.362	17.52
	( 8 )			$\Sigma On = 294.432$	$\Sigma$ Wn=0.999	$\Sigma$ Wnqn = 47.51

# **Diversity Index of Zooplanktons of Bhagirathi River**

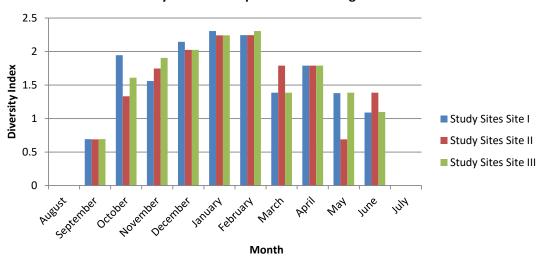


Fig. 5. Diversity index (Shannon Wiener 1964) of Zooplankton of Bhagirathi River for the Period August July

and the water quality parameters make an aquatic habitat unique. These interactions are directly or indirectly are subjected to complex influences, some of which results in quantitative changes e.g. increase or decrease of the size of the population [26]. Concentrations of dominance were observed maximum in monsoon season and the minimum is the winter season. The concentration of dominance is also inversely related to the diversity of an organism. It was estimated to be maximum when the diversity of Zooplankton was recorded to be minimal during the period of study. Concentration of dominance of zooplanktons of Bhagirathi River

# Study Sites Site II August Exertises Octobes Partial Describes Partial March April Mark June 1914 Study Sites Site III

### Fig. 6. Concentration of Dominance of Zooplanktons of Bhagirathi River for the Period August July

Month

### **CONCLUSIONS**

The present study was carried out to know the water quality status of Bhagirathi River, From the above study, it is concluded that the Physico-Chemical parameters of the study area are found near the standard values in winter and summer seasons while it was found different from standard values is monsoon season. The water quality index indicates the good quality of water in Winter and Summer Seasons and poor in monsoon season in all the sampling sites. The rating of water quality shows that the water of the river is suitable for drinking and irrigation in winter and summer seasons. Water is not fit for drinking in monsoon season in all sampling sites. The highest priority should be given to water quality monitoring and their indigenous technologies should be adopted. Zooplanktons is bio-indicator of aquatic ecosystems, the value of Shannon wiener diversity index is good in winter while its value is zero in monsoon, It is concluded from the present study that an integrated effort should be made involving every stakeholder for the conservation and management of aquatic biodiversity of Bhagirathi for maintaining the proper functioning of the fluvial system. We suggest that there should be a critical level of water discharge that should be maintained after the dam wall of hydroelectric power projects into the main river channel so that the quality of water and aquatic biodiversity can be sustained.

### **ACKNOWLEDGMENT**

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# CONFLICT OF INTEREST

There are no conflicts to declare.

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