Hydro-Biological Characterization Of Haripura Reservoir (Gularboj) In Uttarakhand With Special Reference To Pollution Status

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Abstract: This study is focused on physico-chemical parameters and Phytoplanktonic diversity of Haripura reservoir water from September 2012 to August, 2013. The qualitative evaluation of plankton with seasonal variation and water quality of Haripura reservoir were analyzed. Three groups of phyto-plankton viz. Bacillariophyceae, Chlorophyceae, Cyanophyceae and Dinophyceae were identified during the study period, Bacillariophyceae were most dominant among the all groups at Haripura reservoir. During present study it was also revealed that the water of Haripura reservoir is polluted by direct contamination of local people, mismanagement of reservoir and other anthropogenic activities. Some selected Physico-chemical parameters viz. temperature, transparency, electric conductivity; dissolved oxygen, pH, alkalinity, phosphates, nitrates and total hardness were monitored.
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Key words: Water Quality, Planktonic diversity, Haripura reservoir

Introduction:

The management of land and water resources is so inextricably linked that for any sound eco-development programme, an integrated approach is extremely necessary while formulating policies for a rational use of the major natural resources. Consequently, a good deal of attention has been oriented towards harnessing these resources in India and elsewhere, through various irrigation projects involving construction of clusters of dams and reservoirs. These reservoirs were primarily meant for fulfilling the needs of irrigation, power generation, flood control and water supply for domestic and industrial consumption, while the utility of these man-made water bodies for augmenting fish -production was conceived at a later stage.

According to a report by **UNESCO (1978),** the water surface area of world reservoirs presently totals up to 600, 000 kms. In India,however, reservoirs cover an area of approximately 20,000 km2 **(Bhukaswan, 1978),** spread over different types of soils and exposed to different agro climatic conditions**.** In developing countries such as India, there is scarcity of food and a major part of population is still underfed. In such conditions, fish serves as a very important source of food for the people living in the coastal areas as well as other parts of the countries.

The reservoir is a single ecosystem by itself, linked to other catchment ecosystems through terrestrial corridors, distinctive corridors and subterranean corridors. The fresh water has been of vital important to man and animals for sustenance of life and maintaining the balance of nature. The fresh water is a finite and limited resource **(Bouwer, 2000).** Fresh water constitutes only about three percent of the total water present on the earth. The fresh water, due to its low concentration of salts and abundance of aquatic vegetation provides an ideal medium for micro-organisms **(Tonapi, 1980)** and being used for various purposes like drinking, cooking, rearing of cultivable fishes, irrigation and for several domestic uses. Therefore, the role of water in nature is unique not only from the point of human consideration but also many of those organisms which make water medium their abode **(Reddy, 1994).** But in last few decades these reservoirs are degrading day by day due to ignorance of government, anthropogenic pressures, different types of agricultural practices in surround area, use of pesticides, insecticides and other harmful chemicals. These activities certainly influence the abiotic and biotic community of the reservoirs. The abiotic and biotic features are interwoven structurally and functionally which influence the aquatic organisms. Therefore it is important to know the physico-chemical parameters of soil, water and their effect on aquatic ecosystem in term of limnology of the Haripura reservoir the properties of water make it unique in comparison to other and some of its properties have been discussed by **Das (1998).** The unique physical and chemical properties of water have allowed life to evolve in it. With symptoms of stress already visible, future of man on the planet is closely linked with the way water will be managed in time to come. Fortunately, water is a renewable resource, however, its seasonal availability and wide spatial and temporal variability calls for implementation of conservation and management strategies to meet challenges emerging out of rising water demands in developed, developing and under-developed countries. In the recent past, the problem of sustained water supply was globally addressed through construction of small, medium and major reservoirs (also referred to as man-made lakes) across rivers, their tributaries and streams. Such storage reservoirs impound large volumes water for meeting year-round demand of the same for competing uses. Although often criticized for their adverse environmental impacts, the lakes and reservoirs have transformed societies all over the world. For the development of fisheries in the Uttarakhand region it is necessary to know the present health status of the reservoirs, lakes, river and other aquatic bodies which are being used for fish culture, irrigation and other important purposes. It is experienced that Haripura reservoir losing its productivity day to day due to its improper management. Therefore it is necessary to know the present status of the reservoir in terms of physico-chemical and Planktonic diversity.

2. Material and Methods

Study Area: Haripura reservoir (Gulerbhoj) in Uttarakhand is situated in the sub-mountain tract of Udham Singh Nagar district of Uttarakhand. It is a south - sloping out wash plain. This region is located near the foot of outer Shivalik and is comprises of two parallel strips of land locally known as ' Bhabar' and ' Tarai '. The Bhabar is situated immediately below the foot hills while Tarai belt lies South of Bhabar and parallel to it and extends right from Sharda river in the East to Kashipur town in the West. The Tarai region merges into the Gangtic Plains all along it's Southern edges falling into the Districts of Pillibhit, Bareilly, Rampur and Moradabad in Uttar Pradesh. A large number of rivers which originates from the Shivalik hills, enter into and flow through the Tarai region of Uttarakhand. These types of reservoirs are importance these provides opportunity to strengthen the economic growth of the concern areas by the fisheries, irrigation, water supply to local communities.

Physicochemical Parameters:

Selected Physico-Chemical parameters were analyzed of the **Haripura reservoir** during the year of 2012-13

1. **Temperature**
2. **Transparency**
3. **Electric conductivity**
4. **DO**
5. **pH**
6. **Alkalinity**
7. **Phosphate**
8. **Nitrate**
9. **Total Hardness**

For Plankton study samples were collected from Haripura reservoir. The samples were taken in a borosil glass bottle of 300 ml capacity and in plastic container. Plankton identified **(APHA, 1995; Edmondson, 1992).**

3. Results and Discussion

The results obtained for the studies made during the year 2012-13 at Haripura Reservoir, Uttarakhand are presented here (Table-1) A total of 9 physico-chemical parameters were studied parameters changes as observed in each parameters are here below described.

Physico-chemical Parameters

Temperature is one of the important parameters which influence the metabolic activities of aquatic milieu. During study period i.e 2012-13 the overall mean values of temperature at Haripura reservoir, highest value was (23.50^{0C}) and lowest (11.0^{0C}) was recorded during the months of June and December, respectively. The highest range value of temperature was (24.25^{0C}) during the month of June and lowest range value (10.70^{0C}) of temperature was noted during the month of December at Haripura reservoir. Similarly **Bhadula and Joshi** (2014) have studied on aquatic ecosystem and showed highest value of temperature during the month of June and lowest in January and December months. Our study revealed that temperature showed negative correlation with dissolved oxygen. Transparency was measured with the help of secchi disc. During the study period i.e 2012-13 the overall mean values of transparency at Haripura reservoir, highest value was (22.40cm) and lowest (7.00cm) was recorded during the months of December and July, respectively. The highest range value of transparency was (25.80cm) during the month of December and lowest range value (5.40cm) of transparency was noted during the month of July at Haripura reservoir. Transparency of water is important for the light penetration in aquatic ecosystem and in our study period it was found that transparency was higher during the winter months and gradually decreases during the summer and monsoon period. Similarly, **Bhadula *et. al*. (2013)** showed the transparency was lower the same period of time.

During the study period i.e 2012-13 the overall mean values of electric conductivity at Haripura reservoir, highest value was (0.698) and lowest (0.275) was recorded during the months of March and December, respectively. The highest range value of electric conductivity was (0.727) during the month of March and lowest range value (0.260) of electric conductivity was noted during the month of December at Haripura reservoir. In this study period i.e 2012-13 the overall mean values of dissolved oxygen at Haripura reservoir, highest value was (6.5 mg/l) and lowest (4.1 mg/l) was recorded during the months of January and June, respectively.

Table-1: Physico-chemical Parameters of Haripura reservoir water during 2012-13

Months Parameters	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.
Temperature	19.60 (19.40-19.80)	15.90 (15.70-16.20)	13.40 (13.20-13.60)	**11.00 (10.70-11.50)**	13.80 (13.40-14.10)	16.70 (16.20-16.90)	20.20 (20.00-21.50)	21.10 (20.70-21.50)	22.60 (21.40-23.80)	**23.50 (22.70-24.25)**	23.00 (22.10.23.70)	21.50 (21.00-22.00)
Transparency (cm)	16.70 (14.50-18.40)	12.76 (10.40-14.80)	17.00 (15.40-19.80)	**22.40 (20.50-25.80)**	19.50 (17.10-20.90)	16.35 (14.50-19.32)	18.20 (16.70-21.30)	15.80 (13.60-16.70)	16.70 (14.50-18.40)	12.76 (10.40-14.80)	**7.00 (5.40-9.80)**	7.50 (5.70-10.00)
Electric Conductivity (μScm^{-1})	0.470 (0.450-0.508)	0.358 (0.340-0.365)	0.280 (0.270-0.292)	**0.275 (0.260-0.285)**	0.382 (0.362-0.396)	0.496 (0.477-0.537)	**0.698 (0.678-0.727)**	0.570 (0.560-0.580)	0.479 (0.455-0.510)	0.357 (0.350-0.365)	0.289 (0.275-0.296)	0.367 (0.345-0.378)
DO (mg/l)	5.6 (5.4-5.7)	5.9 (5.7-6.1)	6.0 (5.9-6.2)	6.3 (5.9-6.5)	**6.5 (6.3-6.7)**	6.2 (6.0-6.4)	5.0 (4.5-5.6)	4.7 (4.5-5.0)	4.5 (4.3-4.7)	**4.1 (3.5-4.6)**	4.3 (4.0-4.5)	4.5 (4.3-4.8)
pH	7.8 (7.4-7.9)	8.0 (7.8-8.2)	8.2 (8.0-8.4)	8.4 (8.2-8.7)	**8.5 (8.4-8.8)**	8.1 (7.8-8.3)	7.9 (7.7-8.2)	**7.4 (7.3-7.6)**	7.6 (7.4-7.7)	7.5 (7.4-7.6)	7.3 (7.2-7.6)	7.5 (7.4-7.7)
Alkalinity (mg/l)	140 (130-145)	150 (140-160)	155 (150-160)	155 (150-160)	160 (150-175)	180 (170-190)	**185 (180-195)**	160 (150-170)	155 (150-160)	150 (145-155)	**130 (120-140)**	140 (130-150)
Phosphates (mg/l)	**0.118 (0.116-0.119)**	0.137 (0.132-0.142)	0.216 (0.211-0.220)	0.360 (0.355-0.368)	**0.421 (0.418-0.426)**	0.365 (0.358-0.369)	0.286 (0.279-0.288	0.136 (0.131-0.140)	0.128 (0.120-0.136)	0.134 (0.132-0.137)	0.146 (0.135-0.150)	0.160 (0.150-0.168)
Nitrates-nitrogen (mg/l)	0.125 (0.120-0.132)	0.142 (0.138-0.149)	0.278 (0.271-0.290)	0.471 (0.464-0.475)	**0.472 (0.468-0.485)**	0.422 (0.418-0.427)	0.321 (0.315-0.328)	0.147 (0.140-0.157)	**0.120 (0.110-0.130)**	0.132 (0.130-0.140)	0.145 (0.131-0.153)	0.138 (0.125-0.130)
Total Hardness (mg/l)	98.7 (96.6-102.3)	102.5 (97.5-104.3)	**107.4 (105.3-111.3)**	85.6 (82.3-87.2)	80.3 (78.4-82.3)	78.6 (76.7-82.2)	83.3 (80.2-86.1)	86.8 (84.5-90.1)	83.9 (82.10-85.30)	83.0 (82.00-84.10)	80.0 (75.10-85.10)	**75.9 (72.40-78.9)**

The highest range value of dissolved oxygen was (6.7 mg/l) during the month of January and lowest range value (3.5 mg/l) of dissolved oxygen was noted during the month of June at Haripura reservoir. During the study period i.e 2012-13 the overall mean values of pH at Haripura reservoir, highest value was (8.5) and lowest (7.3) was recorded during the months of January and July, respectively. The highest range value of pH was (8.8) during the month of January and lowest range value (7.2) of pH was noted during the month of July at Haripura reservoir. In this study period i.e 2012-13 the overall mean values of alkalinity at Haripura reservoir, highest value was (185 mg/l) and lowest (130 mg/l) was recorded during the months of March and July, respectively. The highest range value of alkalinity was (195 mg/l) during the month of March and lowest range value (120 mg/l) of alkalinity was noted during the month of July at Haripura reservoir. During the study period i.e 2012-13 the overall mean values of phosphates at Haripura reservoir, highest value was (0.421 mg/l) and lowest (0.118) was recorded during the months of January and September, respectively.

Thus, bio-available phosphorus occurs in extremely low concentrations in freshwater and is taken up quickly by phytoplankton The highest range value of phosphates was (0.426 mg/l) during the month of January and lowest range value (0.116) of phosphates was noted during the month of September at Haripura reservoir. During the of study period i.e 2012-13 the overall mean values of nitrates at Haripura reservoir, highest value was (0.472 mg/l) and lowest (0.120 mg/l) was recorded during the months of January and May, respectively. Algal cells require nitrogen to synthesize proteins.

Typically nitrogen is available in lakes in higher concentrations than phosphorus. Most algae take up $NH4^{+}$ions (from decomposition) or $NO3^{-}$ ions (from bacterial nitrification of $NH4^{+}$. The highest range value of nitrates was (0.485 mg/l) during the month of January and lowest range value (0.110 mg/l) of nitrates was noted during the month of May at Haripura reservoir. During the first year of study period i.e 2012-13 the overall mean values of total hardness at Haripura reservoir, highest value was (107.4 mg/l) and lowest (75.9 mg/l) was recorded during the months of November and August, respectively. The highest range value of total hardness was (111.3 mg/l) during the month of November and lowest range value (72.40 mg/l) of total hardness was noted during the month of August at Haripura reservoir.

Phytoplanktonic Diversity

To assess phytoplankton diversity samples were collected seasonally during the study period, from September 2012 to August 2013 at Haripura reservoir. During the study period, the qualitative estimation of phytoplankton revealed the following observations and results (Table-2).

Table-2:- Phytoplankton diversity and seasonal variation at Haripura reservoir during 2012-13

S.N.	Genera	Monsoon	Winter	Summer
Bacillariophyceae				
1.	*Achnanthes sp.*	+	+	+
2.	*Amphipleura sp.*	+	+	+
3.	*Amphora ovalis*	+	+	+
4.	*Bacillaria sp.*	+	+	+
5.	*Biddulphia sp.*	+	+	+
6.	*Brebissonia sp.*	+	+	+
7.	*Caloneis sp.*	+	+	+
8.	*Cocconeis sp.*	+	+	+
9.	*Cymatopleura sp.*	+	+	+
10.	*Cymbella sp.*	+	+	+
11.	*Denticula sp.*	+	+	+
12.	*Diatoma sp.*	+	+	+
13.	*Diatomella sp.*	+	+	-
14.	*Epithelmia sp.*	-	+	+
15.	*Eunotia sp*	+	+	-
16.	*Fragillaria sp.*	+	+	-
17.	*Frustulia sp.*	+	+	+
18.	*Gomphoneis sp.*	+	+	+
19.	*Melosira sp.*	+	+	-
20.	*Meridion sp.*	+	-	-
21.	*Navicula sp.*	+	+	+
22.	*Neidium sp.*	+	+	-
23.	*Nitzschia sp.*	+	+	+
24.	*Pinnularia sp.*	+	+	+
25.	*Rhicosphenia sp.*	+	+	+
26.	*Synedra sp.*	+	+	+
27.	*Tabellaria sp.*	+	+	+
Chlorophyceae				
28.	*Ankistrodesmus sp.*	+	+	+
29.	*Chlorella vulgaris*	-	+	+
30.	*Cladophora sp.*	+	+	+
31.	*Closterium sp.*	+	+	+
32.	*Cosmarium sp.*	+	+	+
33.	*Debarya sp.*	+	+	+
34.	*Eudorina sp.*	+	+	+
35.	*Hormidium sp.*	+	+	+
36.	*Mesotaenium sp.*	-	+	+
37.	*Microspora sp.*	-	+	+
38.	*Pediastrum simples*	+	+	+
39.	*P. duplex sp.*	+	+	+
40.	*P. ovale*	+	+	+
41.	*Rhizoclonium sp.*	-	+	+
42.	*Scenedesmus sp.*	+	+	+
43.	*Spirogyra sp.*	+	+	+
44.	*Stigeclonium sp.*	+	+	+
45.	*Tetradesmus sp.*	+	+	+
46.	*Ulothrix sp.*	+	+	+
47.	*Uronema sp.*	+	+	+
48.	*Volvox sp.*	+	+	+
49.	*Zygnema sp.*	+	+	+
Cyanophyceae				

50.	*Anabaena sp.*	-	+	+
51.	*Ocillotoria sp.*	+	+	+
52.	*Microcystis aerugninosa,*	-	+	+
53.	*Spirulina sp.*	-	+	+
Dinophyceae				
54.	*Ceratium sp.*	-	+	+

Qualitative Estimation Of Phytoplankton:

A total number of 54 genera of phytoplankton were encountered during the course of study. The occurrence of various phytoplankton species at Haripura sampling stations has been given in the Table-6. Diatoms (Bacillariophyceae) accounted for the major share of phytoplankton diversity, represented by 27 genera (*Achnanthes sp, Amphipleura sp, Amphora ovalis, Bacillaria sp, Biddulphia sp, Brebissonia sp, Calonies sp, Cocconeis sp, Cymatopleura sp, Cymbella sp, Denticula sp, Diatoma sp, Diatomella sp, Epithelmia sp, Eunotia sp, Fragilaria sp, Frustulia sp, Gomphoneis sp, Melosira sp, Meridion sp, Navicula sp, Neidium sp, Nitzschia sp, Pinnularia sp, Rhicosphenia sp, Synedra sp and Tabellaria sp*), green algae (Chlorophyceae) were appeared to be the second dominating group in terms of phytoplankton diversity, represented by 22 genera (Ankistrodesmus *sp*, *Chlorella vulgaris, Cladophora sp, Closterium sp, Cosmarium sp, Debarya sp, Hormidium sp, Mesotaenium sp, Microspora sp, Pediastrumm simples, P. duplex, P. ovale, Pleodorina sp, Rhizoclonium sp, Spirogyra sp, Scenedesmus sp, Stegioclonium sp, Tetradesmus sp, Ulothrix sp, Uronema sp, Volvox sp, Zygnema sp*), the qualitative analysis of blue green algae (Cyanophyceae) constituted only 04 genera (*Anabaena sp, Ocillatoria sp., Microcystis aerugninosa, Spirulina sp.,*), Dinophyceae constituted 1 genera (Ceratium). In both the years phytoplankton distribution followed the pattern, **Bacillariophyceae> Chlorophyceae> Cyanophyceae>Dinophyceae.** During the study period there were 54 genera at Haripura reservoir, Uttarakhand. Among 54 genera recorded at maximum 27 genera (50%) belong to class Bacillariophyceae, 22 genera (41.00%) to Chlorophyceae, 4 genera (7.00%) to Cyanophyceae and 1 genera to Dinophyceae (2.00%) (Table-2). Phytoplankton are primary producers of any aquatic ecosystem and it was found that phytoplankton are found in adequate amount in the reservoir. Diatoms are generally found throughout the year. Various workers have studied the diversity of phytoplankton in aquatic ecosystems and showed similar type of pattern in their study **(Bhadula and Joshi, 2012, Khanna *et.al.*, 2012, Negi and Rajput, 2013).**

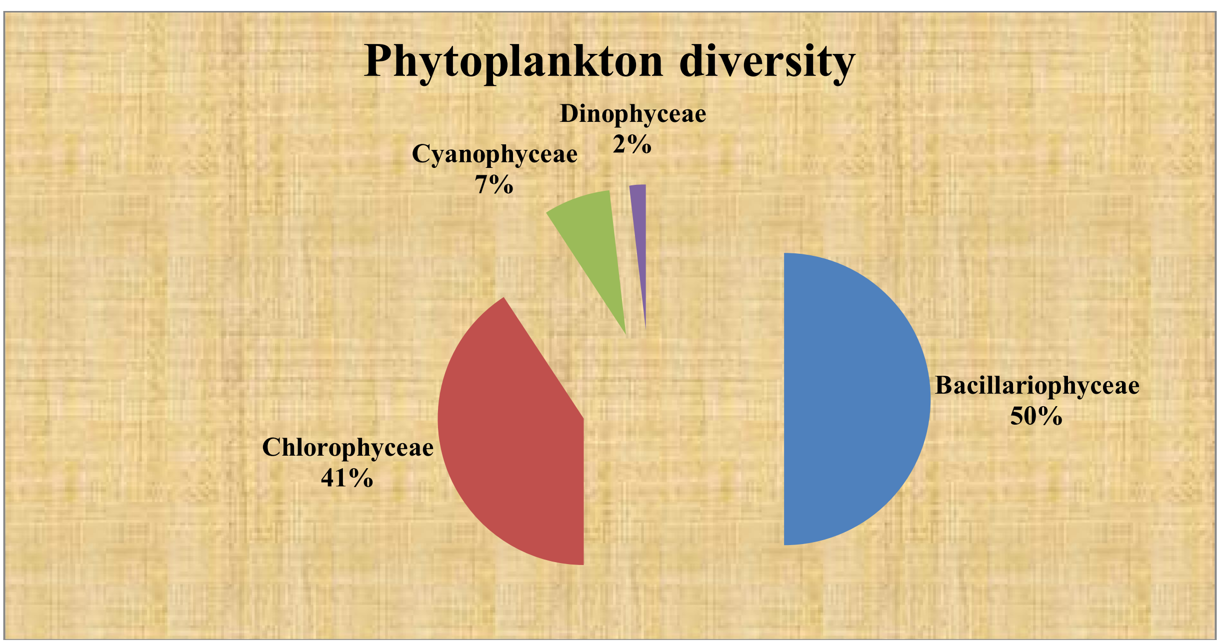

Fig-1. Showing Phytoplankton diversity and variation at Haripura reservoir during 2012-13.

This study has shown that water samples of Haripura reservoir are polluted, especially due to agricultural land, anthropogenic activities of peripheral people. Interventions should be made to reduce anthropogenic discharges in the reservoir area otherwise; high levels of pollution will seriously influence the population. Our study should be considered for future strategy in using the Haripura reservoir for fisheries and irrigation purpose.

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