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Physico-Chemical Factors Of Chandraprabha Wetland with Special Reference to Aquatic Biota

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A B S T R A C T

River Chandraprabha is located, southwest of Varanasi in Uttar Pradesh. The present investigation was carried out to analyse the physico-chemical and biotic characteristic of reservoir (wetland) and river within Chandraprabha sanctuary. The samples were collected seasonally from April 2011 to March 2012 at Site S1 (Chandraprabha Reservoir) and Site S2 (Rajdari i.e., downstream of Chandraprabha Reservoir). The phytoplankton and zooplanktons densities varied from 584-1259 u/l and 245-829 u/l, 243-889 u/l and 112-432 u/l respectively at S1 and S2. The phytoplankton was represented by 74 and zooplankton by 13 genera in the reservoir S1 in contrast to 66 genera of phytoplankton and 13 genera of zooplankton in fluvial site S2. Phytoplankton comprised of Bacillariophyta, Chlorophyta, Cyanophyta and Euglenophyta while zooplankton comprised Cladocera, Copepoda, Rotifera and Protozoa. The densities of macroinvertebrates ranged from 231-319 individuals/m2 at the S1 while 220-352 individuals/m2 at S2. Major groups were Diptera, Coleoptera, Gastropoda, Odonata, Hemiptera, Trichoptera and Ephemeroptera. However, the Hemiptera was not found at S2.

K E Y W O R D S

Biota | Wetland | Phytoplankton | Zooplankton | Macroinvertebrate | Reservoir

C I T A T I O N

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Introduction

Rivers, watersheds, and aquatic ecosystems are the biological engines of the planet. They are the basis for life and the livelihoods of local communities. Understanding, protecting, and restoring ecosystems at river basin level is essential to foster equitable human development and the welfare of all species. Dams transform landscapes and create risks of irreversible impacts. Clashes between dam proponents and critics have brought the large dams issue into focus as one of the most intensely debated issues in sustainable development [Manatunge and Priyadarshana 2006]. Wetlands are one of the richest ecosystems of earth, offering ‘‘sanctuary’’ to a wide diversity of plants and animals. In addition, they play other important key roles, for example provisioning and maintaining water quality for numerous living organisms. Wetlands are defined as “lands of transitional zone between terrestrial and aquatic ecosystems where the water table is usually at or near the surface or where the land is covered by shallow water” [Smith 1980; Cowardin *et al.,* 1979]. Wetlands are often referred to as “biological supermarkets” for the extensive food chain and rich biodiversity they support [Mitsch and Gosselink 2000] and are one of the most important ecosystems, which have multiple utilities these areas, covers 58.2 million hectares in India, out of which 40.9 million hectares are under rice cultivation [Anonymous 2007]. River impoundment has led to creation of many wetlands. However, such wetlands are rarely a part of protected area (PA). It is created for the conservation of natural resources. Purpose of the study was to investigate the temporal variations in physicochemical and selected biological characteristics in the wetland and fluvial sections.

Materials and Methods

Chandraprabha was declared a wildlife sanctuary in 1957 by the Uttar Pradesh Government on account of its rich biodiversity. The Chandraprabha sanctuary, which spreads across 78 sq. kms lies on Naugarh and Vijaigarh hillocks in the Vindhya Range of dense forests in Varanasi district. It lies between north latitude 240 55, 38”- 240 56, 48”and East longitude 830 10, 08”- 830 10, 33” (Fig 1).

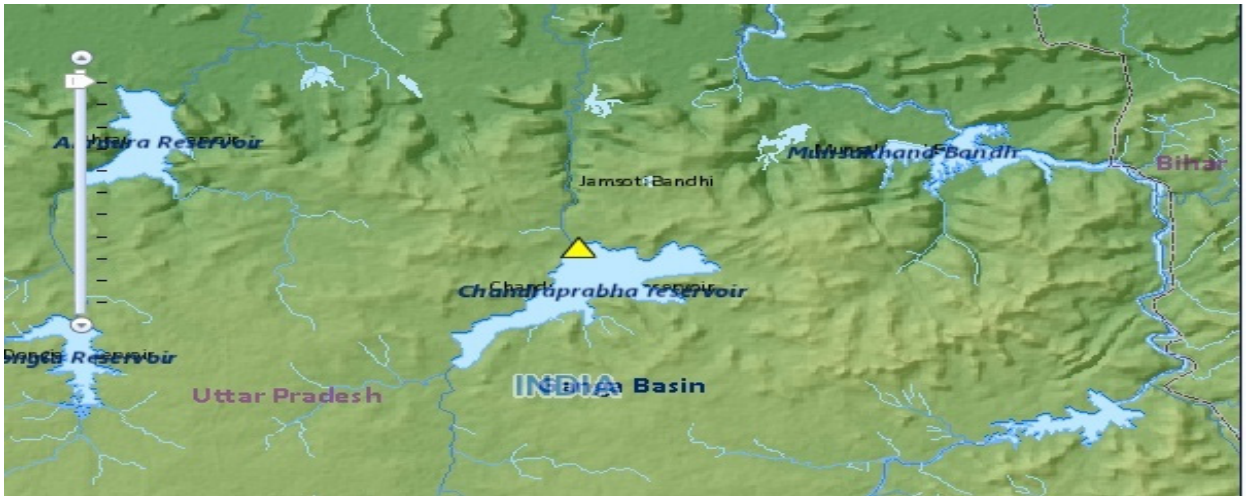

Fig. 1: Satellite image of the study area showing the Chandraprabha reservoir.

The climate is usually hot around the year with an average rainfall of 800-1000 mm. Maximum temperatures during the long dry season in summer soars to 44° Celsius while winters are usually mild. Almost 13% of the land is covered by forests, dominated by thorny species such as Zyzyphus glabarrima, Dicrostachys cinerea, Randia dumetorum and Carissa spinarum while other plant species include Bamboo, Pterocarpus, Anogeissus and Buchanania. The studies were

carried out seasonally from April 2011 to March 2012 at two Sites S1 (Chandraprabha Reservoir) and S2 (Rajdari) within the Chandraprabha Sanctuary. Water samples for physico-chemical analysis were collected from both the sites. Temperature, conductivity, pH, salinity and total dissolved solids were determined at the sites itself using portable Hanna meter. The chemical parameters were measured in the laboratory following the standard methods [APHA, AWWA, WPCF, WEF 1998].

The phytoplankton and zooplankton were collected by plankton net [Welch 1948] and preserved at the site. The bolting silk No. 25 (65n) was used in the net, which is attached with an iron ring of about 20 cm diameter in conical shape. In each collection 100 liters of surface water was collected, which was filtered through the plankton net. The filtrate thus contains plankton 10 ml of the filtrate was preserved in 4% formalin at the spot. The quantitative and qualitative examination was done in the laboratory by the standard methods [APHA, AWWA, WPCF, WEF 1998; Needham and Needham 1975]. Before analysis each plankton sample was diluted and mixed with water to make it to 50 ml, 1 ml of this sub sample was drawn quickly with a wide mouthed pipette and poured into a sedge wick-Rafter plankton counting cell for density (indiv. m-2) and all the plankton were identified to generic levels and enumerated using standard keys [Needham and Needham PR 1975; Nwankwo 2004]. The macro-invertebrate samples were collected from 1 sq ft area by lifting of stones. The material was sieved and preserved in 4% formalin solution. For identification, the organisms of each taxon encountered were placed into separate Petri dish to identify the specimen by microscopic examination using dissection microscopes (binoculars with a magnification between 5x and 50x) and microscopes (minimum magnification 100x). Standard keys were used for the identification of macroinvertebrate samples the fauna was identified to family level [Corkum 1989; Pennak 1953; Edmondson 1959; Macan 1979] and counts were made to obtain density (indiv. m^{-2}), relative abundance (as %).

Observation

Seasonal variations are recorded in the physico-chemical characteristics of the region on both the sites. However the range value of air, water temperature, pH, salinity, silicate, nitrate and phosphate were similar for both the sites. The Dissolved Oxygen (DO), Sp. Conductivity, Total Dissolve solids (TDS) and Current Velocity (CV) varied on both the sampling sites (Table 1).

Sites	**S1**			**S2**		
Parameters/ Seasons	**S**	**M**	**W**	**S**	**M**	**W**
Air Temperature (0C)	31-32.8	27.2-28.7	21-22.3	33.45-34	27.5-28.9	21.57-22.8
Water Temperature (^{0}C)	28.2-29.5	24-26.2	16-19.6	29.2-29.8	23.97-25	16.9-17.2
Ph	8.32-8.60	7.6-7.8	7.56-7.85	7.6-7.85	7.6-7.8	7.7-7.8
Salinity	0.19-0.2	0.2	0.2-0.23	0.21-0.22	0.22	0.21-0.22
Dissolved Oxygen (mgl^{-1})	3.9-6.9	4.3-6.4	4.8-7.1	6.7-8.2	6.9-7.9	5.8-6.2
Sp. Conductivity (µ mhos cm^{-2})	614-634	523-538	567-578	115-121	89-102	110-123
Total dissolved solids (mg l^{-1})	62.3-67	53.3-55.9	82-85.2	40.3-43.6	32.67-36	42.3-46.3
Current Velocity (cms-1)	15-19	22-27	18-21	42-48	46-51	40-47
Alkalinity (mg l^{-1})	82.5-85	82.6-84.4	80.7-84	53.5-55.5	58-61	51.2-54.2
Hardness (mg l^{-1})	189-195	183-195	190-198	100-109	130-142	125-131
Silicate (mg l^{-1})	3.0-3.2	3.2-3.6	2.6-2.8	3.0-3.2	3.6-3.8	2.6-3.0
Phosphate (mg l^{-1})	0.038-0.041	0.049-0.052	0.029-0.03	0.04-0.041	0.038-0.041	0.029-0.031
Nitrate (mg l^{-1})	0.029-0.03	0.04-0.042	0.038-0.04	0.03-0.029	0.028-0.03	0.048-0.05

Table 1. Range of Physico-chemical parameters in two locations during different seasons of Chandraprabha reservoir (S1) and its downstream (S2).

The phytoplankton were represented by 74 taxa from 4 major groups namely Bacillariophyceae (43 genera), Chlorophyceae (19taxa), Cyanophyceae (9taxa) and Euglenophyceae (3taxa) at S1 and Bacillariophyceae (39genera), Chlorophyceae (18taxa), Cyanophyceae (7taxa) and Euglenophyceae (2taxa) at S2. The Bacillariophyceae members were found to be dominant throughout both the study sites. The densities varied from 584-1259 u/l at S1, while 245-829 u/l at S2. Seasonal comparison shows that the total number of phytoplankton was low in rainy season compared with that of summer and winter (Table 2). The quantitative share exhibited similar trend with diatoms having largest share (least being 55.6% at S1 and 60.9% at S2), followed by green algae and others (Table 2). A total of 13 zooplankton taxa were identified from both the sites and represented by Rotifera, Cladocera, Copepoda and Protozoa. Zooplanktons densities varied from 243-889 u/l at S1 and 112-432 u/l at S2 and maximum in summer (Table 2). Qualitatively, the zooplankton consisted of Rotifers, (39%), Cladocera and Protozoans (23%), and Copepods (15%) at S1 and Rotifers, (41%), Cladocera and Protozoans (25%), and Copepods (8%) at S2, in order of richness. Quantitatively, also the order of abundance was similar. The quantitative share exhibited similar trend with Rotifers having largest share (least being 40% at S1 and 63.6% at S2), followed by Cladocera and others (Table 2).

Sites	**S 1**			**S2**		
Parameters/ Seasons	**S**	**M**	**W**	**S**	**M**	**W**
Density of Zooplankton (u/l)	889	243	568	432	112	253
Species Richness Zooplankton	11	7	13	11	9	9
Density of Phytoplankton (u/l)	1259	584	813	829	245	748
Species Richness of Phytoplankton	63	53	61	52	49	54
Density of Macroinvertebrate (individuals/m^2)	339	231	276	352	289	220
Species Richness of Macroinvertebrate	7	5	7	8	8	4
Plankton composition						
Phytopplankton						
Bacillariophyceae	55.6	58	56.8	61.9	60.9	66.6
Chlorophyceae	27.5	30.8	30.5	31.6	31.7	27.1
Cyanophyceae	14.5	8.79	10.1	6.01	6.86	5.52
Euglenophyceae	2.46	2.47	2.58	0.52	0.57	0.83
Zoopplankton						
Rotifera	45.3	54	40	63.6	54.8	62.2
Cladocera	24.4	20.6	23.8	9.09	21.4	13.3
Protozoa	16.3	9.52	10	6.82	4.76	4.44
Copepoda	14	15.9	26.3	20.5	19	20
Macroinvertebrate composition						
Gastropoda	29.7	37.5	28.6	23.3	34.3	45
Trichoptera	13.5	16.7	14.3	20	14.3	15
Ephemeroptera	10.8	20.8	10.7	13.3	14.3	20
Diptera	32.4	12.5	39.3	26.7	25.67	20
Chironomids	21.6	0	25	16.7	8.57	0
Other Diptera	10.8	12.5	14.3	10	17.1	20
Coleoptera	8.11	12.5	3.57	6.67	5.71	0
Odonata	5.41	0	3.57	6.67	2.86	0
Hemiptera	0	0	0	3.33	2.86	0

Table: 2. Density, species richness and % share of Biota at Chandraprabha reservoir and its downstream.

During the study, macro–invertebrate fauna was represented by Orders Diptera, Coleoptera, Gastropoda, Odonata, Hemiptera, Trichoptera and Ephemeroptera at both the sites (Table 2). Of these Hemiptera was absent at S2. Diptera, mostly represented by larvae of different mosquitoes and Chironomid flies were abundant, followed by Gastropoda at S1 while Diptera and Gastropods were highest in percentage at S2. The densities of macro–invertebrates ranged from 231-319 individuals/m2 at the reservoir (S1) while 220-352 individuals/m2 at downstream S2. The density in general was highest during summer at S1 while during winter at S2 (Table 2).

Discussion

Wetlands are probably the earth's most important fresh water resource of earth and are the most threatened too. The present study examines Chandraprabha sanctuary in light of its PA tag. Sediment quality indicated that both the sites were sandy loam in nature. Water quality parameters such as current velocity, pH, dissolved oxygen, total alkalinity and total hardness differed at S1 and S2. CV and DO was low in the reservoirs compared with fluvial downstream station (S2) while reservoir (S1) was rich in bicarbonate ions. Among phytoplankton, Bacillariophyta was dominant followed by Chlorophyta and Cyanophyta at both the sites. It is a well-established fact that plankton is used to compare the relative productivity and fishery potential of different water bodies [Jhingran 1991]. Among phytoplankton at S1 was slightly richer in diatoms and green algae populations, but qualitatively more diatoms followed by green algae occurred at S2. In general, the requirement of dissolved oxygen for growth of many diatom species is well documented. In the present study, the river water showed higher population of diatoms which coincided with the higher dissolved oxygen throughout the study period. The Diatoms choose well aerated waters that are rich in dissolved oxygen, which support the present observation [Ramesha and Sophia 2013; Venkateshwarlu 1970]. Moreover the water from catchment area surface runoff brings nutrients that enriched the reservoir during monsoon, and result in higher values of plankton during summer. The density of phytoplankton has earlier been recorded to be greater during summer (629-759 u/l) and winter (348-413 u/l) and lowest in monsoon in Gobindsagar Reservoir [Kumar 1990; Singh et. al. 2010; Nautiyal 1996; Patil Alaka 2015]. Findings of present investigation stand clearly in support of these earlier observations.

Among zooplankton rotifers were dominant at S2, while cladocera and copepod dominated the scenario at reservoir. The macroinvertebrate composition varied only mildly. In general, increased nutrient levels and phytoplankton density lead to the increases in zooplankton abundance [Lin et. al. 2003]. 7 species of Rotifers have been identified that comprise 40.33% among the zooplankton groups. In Deccan wetlands the rotifers formed the most dominant zooplankters with higher density. Minimum density of zooplankton was recorded in rainy season, maximum during winter and summer in Vadgaon tank of Kolhapur (Maharastra) also. Species richness was less in case of macroinvertebrates when compared to plankton because of the response of former to poor habitat quality. It has been reported that less habitat-dependency of plankton when compared with macroinvertebrates consents to more occupancy of plankton on several habitats [Manjare et. al. 2010; Chandrasekhar 2007; McCormick and Cairns 1994). However, the share of Chironomidae was high only in the Reservior site (S1) attributed to presence of soft substratum (sand), as also observed at rocky mountain drainage system [Knight and Gaufin 1966; Nautiyal et. al. 2013]. Temporarily there was no difference in most abundant taxa in S1 and S2 except abundance of Chironomidae in S1 during summer and winter. There was a gradual decrease in the total number of plankton as the water progressed downstream. Specific conductivity, TDS, CV, and DO accounted for variations in plankton richness and density in the reservoir and it's downstream.

Diatoms were predominant at all seasons. Their number followed by green algae was more in fluvial stretch (Site S2). Among zooplankton rotifers occurred in great numbers at S2, while number of cladocera and copepods were greater at S1. The benthic macroinvertebrates community differed slightly at S1 and S2.

Conclusion

The present piece of work is a preliminary investigation on protected area of Chandraprabha sanctuary. It can be assumed on the basis of present investigation that Chandraprabha reservior is a rich site for the growth of biota and therefore is a potential site for conservation and development of various aquatic flora and fauna. Reservoirs are also a more reliable source of water supply for irrigation, domestic and industrial use. The reservoirs directly support many activities including fisheries, navigation, and recreation. Higher biotic diversity observed in reservoir site (S1) may be due to the higher nutrient enrichment and the lentic nature of the habitat. The reservoir was observed to be the most suitable habitat for the growth of periphytic microalgae characterized by the abundance and diversity.

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