First Report on Assessment of Hydrological Parameters and Plankton Composition in Dandiganahalli Dam, Karnataka

Kavitha K [1], Nagabhushan C M [1]* and Uday J[2]

[1*]Department of Studies in Zoology, Vijayanagara Sri Krishnadevaraya University, Ballari, Karnataka, India

[2] Shri Vagdevi Educational Trust, Nelamangala, Bangalore, Karnataka India

**Corresponding author*:
Dr. Nagabhushan C M,
Assistant Professor,
Department of Studies in Zoology, VSK University,
Ballari. nagabhushancm@vskub.ac.in

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ABSTRACT

The present investigation is a pioneer study intended to assess hydrological parameters to evaluate the feasibility of the remote reservoir set amid forested hills, the Dandiganahalli dam for potential Agriculture, Fisheries and Domestic purpose. The Spatio-temporal hydrological parameters were studied for a period of 12 months from February 2022 to January 2023 and were compared with the standard values prescribed by World Health Organization (WHO). Over the years, the lake has not been subjected to human interference leading to deterioration of water quality. Correlation analysis was done between physico-chemical parameters. The pH, Conductance, Alkalinity and Hardness levels indicated moderate quality of water. The values of DO, BOD and COD levels indicated the absence of major organic pollutants. Incidence of alkaline pH and low electrical conductivity may provide suitable climate for the existence of specific indicators. The reservoir appears to have the capacity to accumulate heavy metals, particularly iron, which is found in the range from 0.22 mg/l to 0.30 mg/l while the other heavy metals viz., Cd, Se, Mn, Cu, As, Pb, Cr and Zn were in negligible amounts, whereas Hg and CN were not detected. During the study period out of 43 plankton species encountered, 31 belonged to phytoplankton representing Euglenophyceae-06, Bacillariophyceae-05, Cyanophyceae-10, Chlorophyceae-10 and 12 belonged to zooplankton community representing Protozoa-03, Copepoda-02 and Rotifera-07. Based on the investigation, optimum values of the hydrological parameters and owing to the least affect caused by anthropocentric activities, the reservoir water could be utilized for domestic, agricultural, sport fish and aquaculture purposes. The present information and yearly documentation could form baseline information for policy decision makers. Since it is the virgin reservoir not being polluted by any industrial effluent discharges into the water bodies, monitoring and safeguarding the reservoir from illegal and unscientific activities could protect its carrying capacity and long term enhanced productivity.

Keywords: Dandiganhalli dam, Physico-chemical parameters, Spatio-temporal studies, Plankton diversity.

Introduction

Water quality is one of the important factors in maintenance of a healthy functional ecosystem. The global ecosystem and economy depend chiefly on water resources. About 70% of fresh water resource is used for agriculture purposes. Water sources can be classified broadly into surface waters and ground waters (Pimentel et al., 2004). The freshwater hydrological sources include rivers, lakes, streams, dams, pools, ponds, reservoirs, springs and even aquifers feed domestic supplies and private wells. Spatio-temporal studies on hydrological parameters determine the probable change in quality of water bodies. Lakes form another important ecological source for economic growth in rural areas in terms of agriculture, pisciculture, horticulture, fodder cultivation etc. Hydrological parameters with typical flora and fauna indicate the condition of health of the aquatic ecosystem. In an aquatic ecosystem, plankton occurrence, distribution, abundance, species composition and vertical migration are based on the physico-chemical parameters (Sangmek & Meksumpun, 2014; Veeresha Kumar & Hosmani, 2006; Tiwari & Shukla, 2006; Senthil Kumar and Das, 2008). Phytoplankton plays an important role in the biosynthesis of organic matter (Primary production) in aquatic ecosystems, which directly or indirectly serve all the living organisms of a water body as food (Anjana *et al*., 1998). It would be a useful tool for the assessment of water quality that contributes to understanding the basic nature and general economy of the dam (Pawar *et al*., 2006).

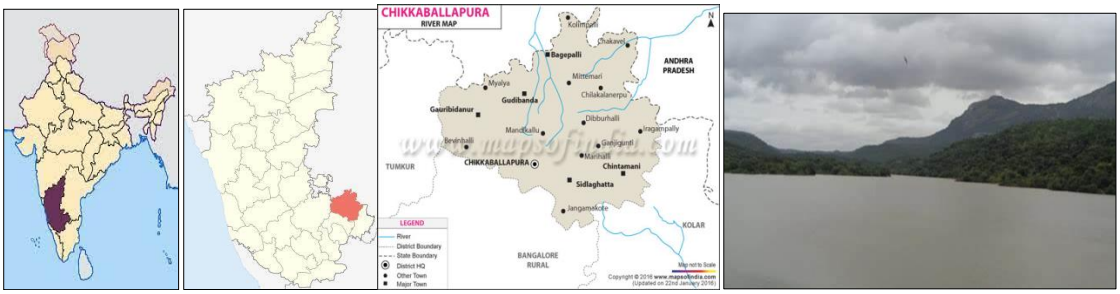


Fig-1: Dandiganahallli lake view from the impoundment.

Materials and methods

Dandiganahalli Dam is located at 13°30'34" N and 77°39'29" E co-ordinates in the draught affected taluk of Gauribidanur taluk in Chikkaballapura District of South-East Karnataka (Fig-1 and Fig-2). It is a perennial dam feeding the neighboring agricultural farms, a site of sport fish and a picnic spot.

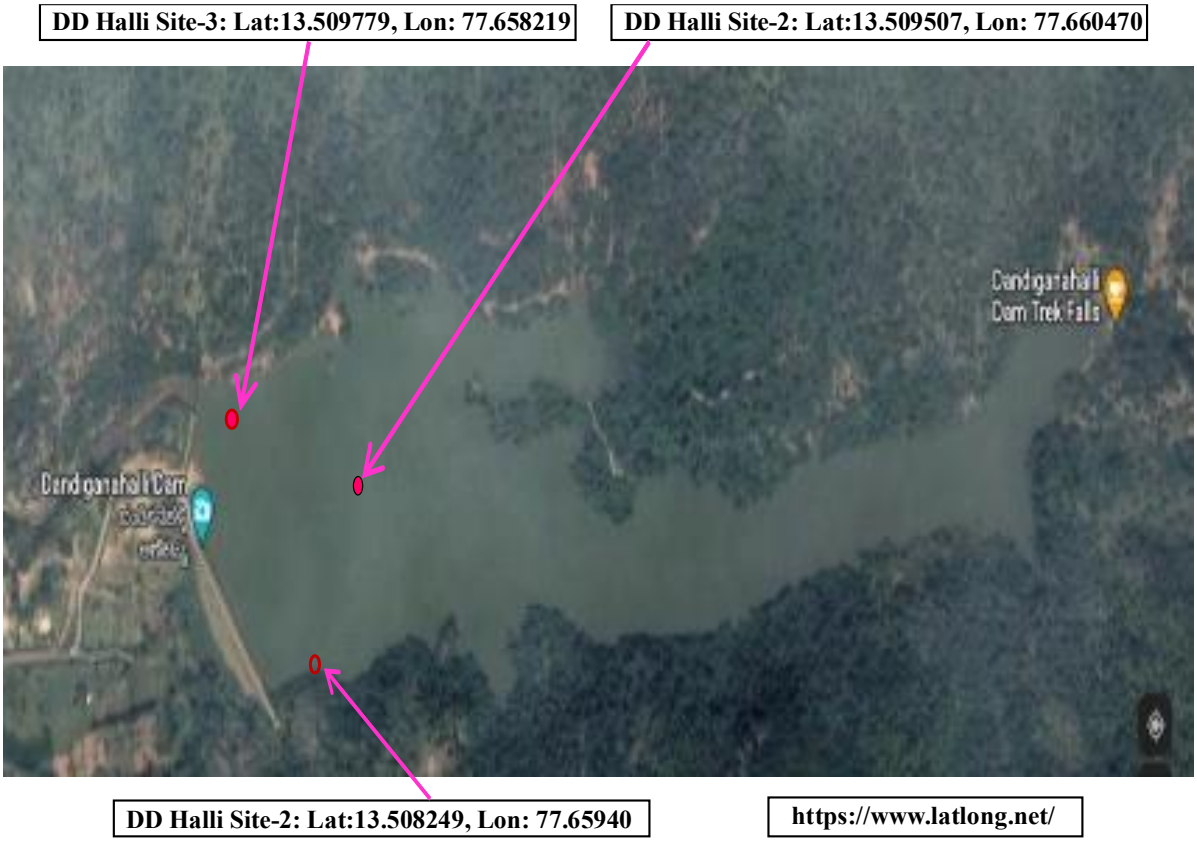


Fig-2: Satellite view of sampling sites.

The present investigation is a pioneer study intended to assess hydrobiological parameters. The study was carried out from February 2022 to January 2023 covering all the seasons. The catchment area is always filled with water making the dam perennial. The water holding capacity of the Dam is approximately 3.12 MCM at its full height of 20.92 m. meteorologically the dam received 736 to 1269 mm rainfall in the past three calendar years (2018-21) (Central Water Commission, 2021). The literature revealed that there is no scientific study carried out with respect to ecological characteristics of this dam.

The basis of selection of dam was that its water is used by a large population which receives periodic flooding from mountains.

During the study period, the surface water samples were collected on monthly basis using pre-washed polypropylene (PP) containers during early morning hours. Water temperature, air temperature and humidity were recorded at the sampling site. The samples for dissolved oxygen were fixed immediately on the field. 33 hydrological parameters were analyzed as per the standard methods prescribed by APHA (2005) and the values are depicted in Table-1. Plankton samples were collected using plankton net (30 µm) by filtering approximately 100 liters of water and concentrated to 30 ml by preserving it in 4% formaldehyde. Qualitative estimation was done as described by Needham and Needham (1962); Desikachary (1959); Gandhi, (1961), Welch, (1952), Bellinger *et al*., (2010). Images were captured using Labomed Lx300 Trinocular Microscope with Sony 5.00 MP camera.

Correlation coefficient statistical analysis measures the closeness of the relationship between chosen independent and dependent variables using SPAA 26.0 version-2. If the correlation coefficient is close to +1 or –1, it shows the probability of linear relationship between the variables *x* and *y*. The correlation coefficient matrix between each pair of parameters was estimated to identify the correlation among hydrological parameters.

Results and Discussion

Physico-chemical analysis of water was undertaken during the study period to investigate various changes in its hydro-physiological features during summer, monsoon and winter. The Air temperature values were relatively consistent along the water body and occurrence of organisms in water is temperature dependent. Water temperature enhances solubility of gases and it ranged from 26.1ºC to 26.4ºC with a SD of 0.15. Lower values in rainy and higher during summer coincided with the observations of Basualto *et al*., (2006) and Medudhala *et al*., (2012).

Humidity is the ratio of the water vapour pressure in the air to that of surface waters at a given temperature. Humidity in the dam was relatively moderate (53.55%) in all seasons which may be attributed to improper rainfall (Veljic *et al*., 2017).

Colour of the dam water was shown to be 5 Hazen units in all seasons. The collected water samples were found to be odorless and clear but showed slight bluish green colour. Similar observations were made by Patil *et al.,* 2020.

The minimum pH value recorded was 7.63 during rainy and maximum was 7.76 during summer seasons shows that the water is slightly alkaline in the narrow range. High levels of dissolved substances cause turbidity. Low levels of turbidity of 0.5 NTU was recorded in all seasons. Presumably, alkaline pH allowed bloom of microbes which in turn might have improved the turbidity levels in the Dam (National Research Council, 1992).

Minimum seasonal average of BOD of 6.02 mg/l was recorded during winter and shot to 17.43 mg/l during summer months indicating eutrophication (Roques *et al*., 1985). Similarly, Chemical oxygen Demand (COD) values ranged from 43.75 in rainy to 100.50 mg/l in summer. COD values were negatively correlated with Chloride with minimum 30.63mg/l in summer and maximum 33.79mg/l during winter whereas total hardness was recorded minimum of 59.56mg/l in rainy season and maximum of 82.79 mg/l in winter. This indicated that there were no industrial effluents discharged into lake and the major source of organic pollutants would be from the domestic source (Venkatesharaju *et al*., 2010).

Winkler's iodometric method of Dissolved Oxygen (DO) estimation showed 5.14 mg/l in rainy and maximum of 6.60 mg/l during winter season. The low levels of DO could be due to dominance of aquatic organisms (Said *et al*., 2004). Free carbon dioxide ranged from 5.08mg/l during summer months to 5.40mg/l during rainy due to bio-decomposition processes (Kelly *et al*., 2011).

Minimum seasonal average of electric conductivity was recorded as 301.5 µs/cm during summer and maximum of 326.5 µs/cm during winter. It is attributed to increased draining and high evaporation at different seasons. The observed mean values were within the standard limits prescribed by Bureau of Indian Standards.

TSS values ranged from 11.5 mg/l to 21.5 mg/l during winter. Run-off water and dissolved solids with organic matter caused increased values of TSS (Rachana and Disha 2016) attributed to fish farm food and the waste products of aquaculture (Suratman *et al*., 2016). Phosphate levels govern the eutrophic status of any water bodies. There were negligible phosphate values (minimum 1.44 mg/l during rainy and maximum during1.68 mg/l during winter). Similar results were observed by Nemery and Garnier, 2016. The oxidized nitrogen as Nitrate ranged from 0.26 mg/l in summer to 0.30mg/l in rainy season. It was probably due to maximum ammonia oxidation. It may be due to fish farming activities (Sharma *et al*., 2017). The amount of sulphate ranged from 10.53 mg/l in rainy to a maximum of 27.33 mg/l in summer (Nagabhushan *et al*., 2012; Abboud *et al*., 2014) due to bathing and washing activities. Calcium sulphates on partial oxidation may also yield Sulphur bearing minerals. Fluoride levels were surprisingly low between 0.13 mg/l in winter and 0.16 mg/l in summer. Alkaline water can give false levels of fluoride in water samples. This could explain the reporting of low fluoride in some of the water from alkaline lakes and may be caused due to bioaccumulation of fluoride in fish that are being reared in the dam. It will be interesting to substantiate the data with further studies on bioaccumulation of metals in fishes of the dam (Gikunju et al., 1990). Calcium levels varied from 38.79 mg/l during rainy to 56.40 mg/l during winter. High levels in the winter months (Table-1, Fig-3) indicate calcite formation leading to algal productivity (Hauro Fukuhara *et al*., 1992).

Correlation coefficients (R) were determined using correlation matrix to assess correlation and interrelation among water quality parameters. The correlations among 33 water quality parameters for each site were determined. In the present study, a significant positive correlation was found for BOD with COD and significant negative correlation was found for electrical conductivity with alkalinity and further total hardness and total suspended solids were negatively correlated at the p-value of 0.01 and 0.05. Based on the correlation coefficient values among parameters, it appears that the Dandiganahalli dam has potential for significant improvement in water quality if discharges are monitored (Table 2) (Ahipathy *et al*., 2006).

The heavy metals (Fe > Cr > Cu > As > Mn > Zn> Cd > Se > Pb > CN=Hg) concentration was negligible except for Iron. Iron concentration varied from 0.22 mg/l to 0.30 mg/l in rainy winter seasons respectively. Enriched iron coupled with phytoplankton productivity enhances the carrying capacity of the reservoir in terms of balanced ecosystem (Yuan *et al*., 2021). Mercury and Cyanide concentration was totally zero.

The biotic communities comprising of phytoplankton showed blooming domination during summer months and declined during monsoon season whereas there was gradual increase in the plankton composition during later winter months. Among the planktonic groups, the Cyanophyceae (32.25%) and Chlorophyceae (32.25%) formed the total bulk of phytoplankton standing crop followed by Bacillariophyceae (16.13%), Euglenophyceae (19.35%) followed by Zooplankton dominated by Rotifers.

Conclusion

Dandiganahalli dam serves as an irrigation source and is surrounded by agricultural and natural forest land. 33 hydrological parameters were evaluated and analyzed in accordance with the standard methods prescribed by the APHA 23rd edition. Temperature, pH, transparency, electrical conductivity, dissolved oxygen, alkalinity, total hardness, calcium hardness, magnesium hardness, nitrate, phosphate, fluoride, calcium, COD, and BOD were recorded within the permissible limits as per the Bureau of Indian Standards, indicating that the dam is relatively unpolluted. The degree of relationship between seasonal hydrological parameters as measured by the correlation coefficient at the 99% and 95% confidence levels do substantiate. There was significant positive correlation (99% level) between different parameters (Table-2). Nevertheless (at 99%) significant negative correlation between air temperature and turbidity; turbidity and pH; turbidity and DO; and turbidity and TDS were observed. This clearly demonstrated that all the physio-chemical parameters were at their optimum levels, with no negative impact on the composition, survival, reproduction, growth and development of planktonic flora and fauna in different seasons.

Phytoplankton composed of Chlorophyceae-10, Cyanophyceae-10, Euglenophyceae-06 and Bacillariophyceae-05 whereas zooplankton was dominated by Rotifers-07, Copepods-02 and protozoans-03 (Table-2).

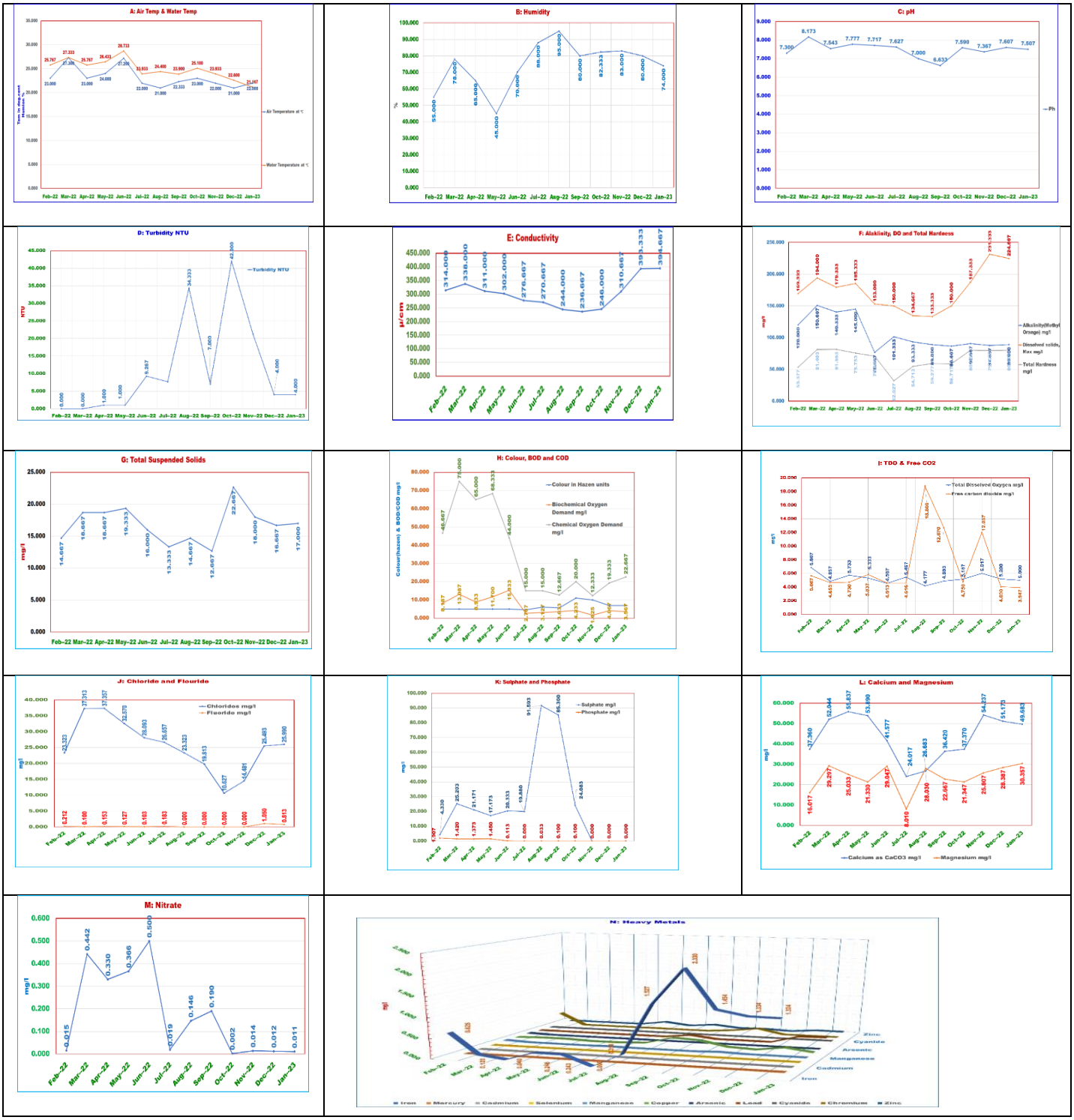
Based on the annual recorded observations, it may be inferred that the Dandiganahalli dam proves to be utilized for domestic purposes, for agricultural plains and fisheries sector judiciously. This documentation may be used by policy makers in making right decisions and thereby increasing the economic and social benefits to the local community. Further continuous monitoring and documentation is required to keep track of the changes or alterations in the hydro-biological parameters for efficient utilization of water resources.

Table-1: Seasonal Physico-chemical Parameters of Dandiganahalli Dam during the study period (Feb-2022 to Jan-2023)

S.No.	Physical Parameters								
	PARAMETERS	**SUMMER**	**RAINY**	**WINTER**	**MIN**	**MAX**	**MEAN**	**SD**	**VARIANCE**
1	Air Temperature (in degrees Celsius)	24.325	24.325	24.325	24.325	24.325	24.325	0.000	0.000
2	Water Temperature at (in degrees C)	26.450	26.150	26.375	26.150	26.450	26.325	0.156	0.024
3	Humidity (%)	53.500	53.500	53.500	53.500	53.500	53.500	0.000	0.000
4	pH	7.760	7.638	7.698	7.638	7.760	7.698	0.061	0.004
5	Turbidity (NTU)	0.500	0.500	0.500	0.500	0.500	0.500	0.000	0.000
6	Conductivity (µs/cm)	301.500	320.750	326.500	301.500	326.500	316.250	13.093	171.438
7	Alkalinity (Methyl Orange) (in mg/l)	135.250	140.000	141.750	135.250	141.750	139.000	3.363	11.313
8	Dissolved solids, Max (in mg/l)	180.250	184.250	181.500	180.250	184.250	182.000	2.046	4.188
9	Total Hardness (in mg/l)	76.718	59.563	82.785	59.563	82.785	73.022	12.044	145.066
10	Total Suspended Solids (in mg/l)	20.500	11.500	21.500	11.500	21.500	17.833	5.508	30.333
11	Colour (in Hazen units)	5.000	5.000	5.000	5.000	5.000	5.000	0.000	0.000
12	Biochemical Oxygen Demand (mg/l)	17.435	7.970	6.025	6.025	17.435	10.477	6.104	37.260
13	Chemical Oxygen Demand (mg/l)	100.500	43.750	47.000	43.750	100.500	63.750	31.868	1015.563
14	Total Dissolved Oxygen (mg/l)	5.350	5.143	6.600	5.143	6.600	5.698	0.788	0.622
15	Free carbon dioxide (mg/l)	5.080	5.405	5.180	5.080	5.405	5.222	0.166	0.028
	Non-Metals								
16	Chlorides (mg/l)	30.630	33.500	33.793	30.630	33.793	32.641	1.748	3.054
17	Sulphate (mg/l)	27.332	10.531	13.046	10.531	27.332	16.969	9.062	82.114
18	Phosphate (mg/l)	1.485	1.445	1.682	1.445	1.682	1.537	0.127	0.016

19	Fluoride (mg/l)	0.168	0.141	0.135	0.135	0.168	0.148	0.017	0.000
	Alkali earth metals								
20	Calcium as $CaCO_3$ (mg/l)	54.148	38.795	56.405	38.795	56.405	49.783	9.582	91.815
21	Magnesium (mg/l)	22.425	20.375	25.958	20.375	25.958	22.919	2.824	7.974
	Compound								
22	Nitrate mg/l	0.264	0.308	0.293	0.264	0.308	0.288	0.022	0.000
	Heavy-metals								
23	Iron (mg/l)	0.240	0.223	0.309	0.223	0.309	0.258	0.046	0.002
24	Mercury (mg/l)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
25	Cadmium (mg/l)	0.000	0.001	0.000	0.000	0.001	0.000	0.000	0.000
26	Selenium (mg/l)	0.000	0.001	0.000	0.000	0.001	0.000	0.001	0.000
27	Manganese (mg/l)	0.007	0.011	0.005	0.005	0.011	0.008	0.003	0.000
28	Copper (mg/l)	0.017	0.018	0.018	0.017	0.018	0.018	0.001	0.000
29	Arsenic (mg/l)	0.001	0.016	0.002	0.001	0.016	0.006	0.008	0.000
30	Lead (mg/l)	0.001	0.001	0.001	0.001	0.001	0.001	0.000	0.000
31	Cyanide (mg/l)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
32	Chromium (mg/l)	0.005	0.225	0.005	0.005	0.225	0.079	0.127	0.016
33	Zinc (mg/l)	0.001	0.000	0.003	0.000	0.003	0.002	0.001	0.000

Fig-3: Monthly variations in the hydrological parameters of Dandiganahalli Dam during the study period (Feb-2022 to Jan-2023)



Phytoplankton composition	
Euglenophyceae	*Euglena sp*
	Phacus longicauda
	Trachelomonas robusta
	Testate amoeba
	Phacus pleuronectes
	Phacus menson
Chlorophyceae	*Coelastrum microporum*
	C reticulatum
	Oocystis nageli
	Paediastrum simplex
	Pediastrum tetras
	Tetraedon longispinum
	Tetraedon caudatum
	Rhizoclonium
	Chlorella vulgaris
	Hormidium sp
Cyanophyceae	*Anabaena aphnizimenoides*
	Microcystis aeruginosa
	Nostoc microscopium
	Oscillatoria Formosa
	Planktothrix
	Echinidinium kareuse
Cyanophyceae	*Cylindrospermopsis*
	Pseudostaurastrum
	Spirulina
	Ceratium hirudinella
Bacillariophyceae	*Nitzschia amphibian*
	Melosera granulata
	Nitzschia longissima
	Navicula pupula
	Synedra ulna
Zooplankton composition	
Rotifera	*Brachionus caudatus*
	Brachionus falcatus
	Brachionus forficula
	Keratella tropica
	Keratella valga
	Keratella tecta
	Keratella cochlearis
Copepoda	*Cyclops varicans*
	Calanus sp
Protozoa	*Amoeba*
	Vorticella patellina
	Paramoecium caudatum

Table-2: A list of phytoplankton and zooplankton recorded in the Dandiganahalli dam during the study period.

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