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Assessment of limnological characteristics of a tropical reservoir

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Abstract

Present study was carried out on Kanigiri reservoir, Nellore Dist., Andhra Pradesh for a period of eight months analyzing selected parameters at fortnightly intervals using standard methods. It is alkaliphilous (pH: 7.70 to 8.45), medium to high productive reservoir (TDS: 131.5 to 227.5 mg/L), experiencing moderate domestic pollution with chlorides (70-129 mg/L) and can promote the growth and survival of fish (D.O of 4.6 to 8.35 mg/L, CO₂ of 0 to 6 mg/L & total ammonia of 0.02 to 0.21mg/L). Hence, it can be said that, water from this reservoir is fit for irrigation, agriculture, pisciculture, industrial, domestic purposes and with little treatment with respect to BOD and total hardness can even fit for drinking also.

Keywords: Limno chemistry, Tropical reservoir, Kanigiri reservoir, Water quality

Introduction

The increasing industrialization, urbanization and developmental activities, to cope-up the population explosion have brought inevitable water crisis and the demand for fresh water has already exceeded its supply in different parts of the world. It has become a major problem all over the world, be it a developed, developing or underdeveloped country, though there exists a disparity in the water use pattern of these countries as it is strongly governed by the economic condition of the population. The uneven distribution of water resources on the Earth makes some regions water scarce while others water rich and this is these spatial and temporal variations in water quantity necessitated the storage of water to meet the water demands, and reservoirs are the resultant storage structures of surface waters. The construction of surface reservoirs can lead to major transformations in the spatio-temporal distribution of river runoff and an increase in water resources during the low flow limiting periods and dry seasons.

The Ministry of Agriculture, Government of India has classified reservoirs as small (<1000 ha), medium (1,000 to 5,000 ha) and large (>5000 ha) for the purpose of fisheries management^[1]. Indian reservoirs are recognized as sleeping giants for fisheries development, and it is clearly evident from the reports of Sugunan that, the present fish production from Indian reservoirs (from 31,53,366 ha) is frustratingly low, i.e., there is only a negligible increase in the actual production from 93,650 tons^[2] to 93,700 tons^[3] over a period of 16 years, compared to its potential production from 2,45,134 tons^[2] to 9,86,000 tons^[3] i.e., the difference between actual and potential production has increased by 5.89 fold from 1995 (1,51,484 tons) to 2011 (8,92,300 tons) there by signaling a tremendous scope for enhancing fish production through development and adoption of economically viable and environmentally sustainable management practices.

Andhra Pradesh with a total reservoir area of 4, 58, 507 ha stands at second place only after Madhya Pradesh (4, 60, 384 ha) and is contributing to 14.54% of total surface area (31, 53, 366 ha) of Indian reservoirs^[4].

Water quality has become a major concern due to ever increasing human developmental activities that over exploit and pollute the water resources. Though water is a renewable resource, reckless usage and improper management of water systems may cause serious problems in availability and quality of water and these water quality interests are closely related to water use pattern. There is an increasing interest in reservoir water quality, in view of multitude of benefits (water supply, flood control, hydropower generation, navigation, fish and wild life conservation, recreation etc.) they offer to the mankind, so, only the present study.

Study area & sampling details

Location: Latitude & Longitude (14°35' 21" N & 79°51' 28" E), Buchireddypalem. It is the main terminal storage reservoir on the left (northern) side of Sangam anicut having a Full Reservoir Level (FRL) of 6230 ha and total water spread area of 6144 ha. It gets its supplies from not only Sangam anicut but also from its own catchment area. Sampling (surface water) was carried out at fortnightly intervals from the two randomly selected sampling points (here after represented as K1 & K2) in the early hours of the day for a period of eight (08) months covering, south-west monsoon (June to September) north-east monsoon (October to December), winter period/post-monsoon (January to February) and hot weather period/pre-monsoon/summer (March to May) on the basis of the local rainfall conditions.

Materials and methods

The amount of rainfall received in the study area during the study period was obtained from the Agricultural Research Station (ARS), Nellore. Air and water temperatures were recorded using a standard mercury centigrade thermometer to the nearest 0.1° and expressed in degree Celsius. Transparency of water was estimated by using standard secchi disc of 20 cm diameter. pH of water samples was measured potentiometrically using digital pH meter (Digital pH Meter-111, EI). The samples fixed for dissolved oxygen were analyzed following modified Winkler-azide method. Free CO₂ content was estimated by the titrimetric method using phenolphthalein indicator and sodium hydroxide. Chloride content was estimated by titrating the water sample with silver nitrate using potassium chromate as indicator and expressed in terms of mg/L. The salinity of water samples was analyzed by following Mohr's method [5] and expressed as ppt. Total suspended solid content of water samples was analyzed by using Millipore filtration assemblage by employing standard method [6] expressed as mg/L. TDS, TS were estimated Gravimetrically [6] and the results were expressed in mg/L. Total alkalinity was estimated by titrating the water with sulphuric acid using phenolphthalein and methyl orange as indicators and the results are expressed in

mg/L. Total hardness of water was estimated by titrating the water samples with standard EDTA, using ammonia buffer and Erichrome Black-T indicator and the results are expressed in mg/L. Water samples for BOD measurement were incubated at 27°C for 3 days, and then samples were analyzed for the dissolved oxygen content following the Winkler's method. The difference in dissolved oxygen content between initial and after incubation period i.e. the amount of oxygen reduced represents BOD and is expressed as mg/L. Standard spectrophotometric procedure was followed to estimate the concentration of ammonia [5]. UV-Visible Spectrophotometer (T 60 LABINDIA) was used to measure the absorbance and the concentration is expressed in mg/L.

The coefficient of correlation amongst the physico-chemical parameters was calculated by the Pearson correlations test using SPSS.

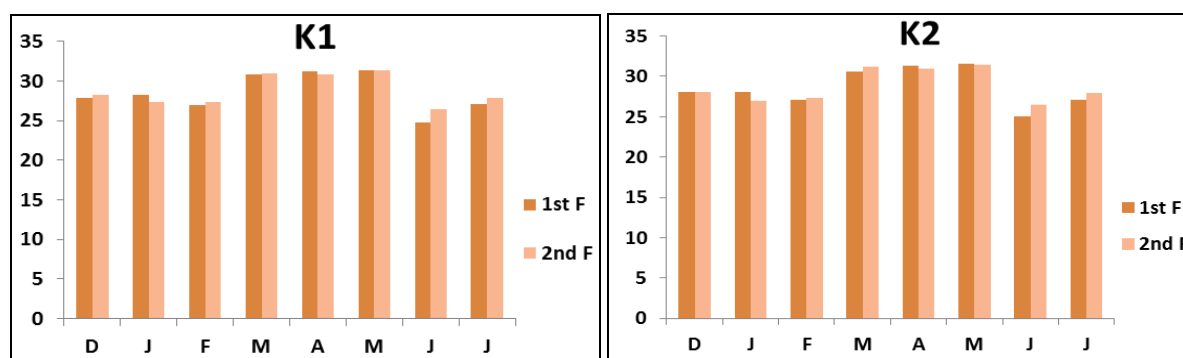
Results and Discussion

Rain fall

During the present study, November witnessed highest rainfall whereas, practically no rainfall was observed for four months i.e., from February to May against eight (08) months of the present study. During the present investigation, the area experienced higher rainfall during N-E monsoon compared to S-W monsoon, which is in accordance with the observation made by Perumal [7].

Air temperature

Climatological parameters influence was seen clearly through a significant variation in the value of air temperature during the study period. In general, the lower values of air temperature were observed in monsoon and post-monsoon, in comparison to pre-monsoon season. During the study period air temperatures recorded at Kanigiri reservoir ranged from 24.90°C to 31.45°C with a Mean \pm SD of 28.70 \pm 2.04°C (Fig.1). Similar trend in air temperature was observed by Basavaraja *et al.* [8] while working on Anjanapura reservoir (28.16°C to 33.5°C) and Mohammad *et al.* [9] while investigating on Wyra reservoir (22.8°C to 33.7°C).



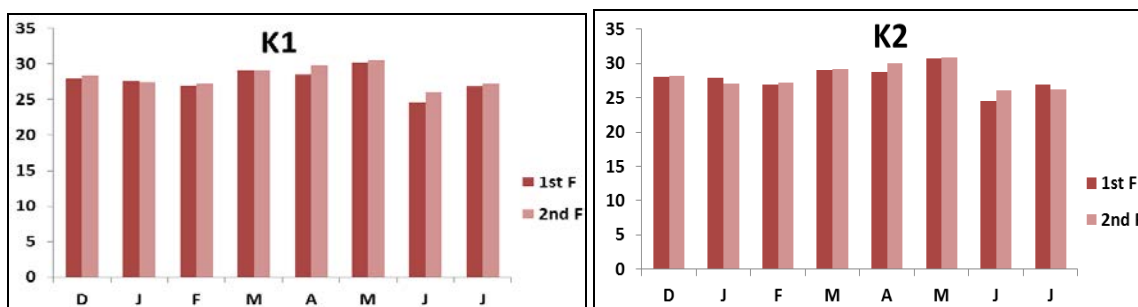
(X- axis: Months Y-axis: Air temperature (°C); 1st F: First fortnight & 2nd F: Second fortnight)

Fig 1: Fortnightly variations of air temperature at selected stations

Water temperature

Water temperature followed similar trend as exhibited by air temperature. It is of immense value as it regulates the biological activities and governs the solubility of gases in water. Temperature of water is subjected to variations in time of collection, water depth besides solar radiation, climate and topography. During the study period, it varied between

24.60°C and 30.75°C (Mean \pm SD of 28.00 \pm 1.59°C) (Fig.2). Similar type of observations were made by Bharamal and Korgaonkar [10] while studying on Tillari dam (22°C to 33°C), Sreenivasulu *et al.* [11] in case of Ramanna tank (25.82°C to 31.38°C), Tembhare [12] while investigating on Kalisarar dam (25°C to 32.5°C).



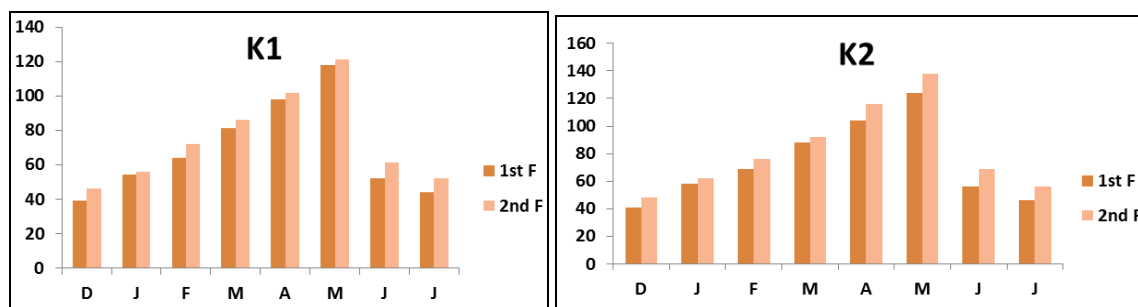
(X- axis: Months, Y-axis: Water temperature (°C); 1st F: First fortnight & 2nd F: Second fortnight)

Fig 2: Fortnightly variations of water temperature at selected stations

Transparency

Transparency of water is of enormous significance, which has far reaching effects on all aquatic organisms, including their development, distribution, behavior etc. through its influence on light penetration in to the water column. During the present study, it varied between 40cm and 129.5cm (Mean ± SD of 74.66 ± 27.14cm) (Fig.3). The observed high values of transparency during pre-monsoon (summer) season compared to monsoon and post-monsoon seasons might be due to higher light intensity and more or less complete settlement of

allochthonous substances entered in to the reservoir through runoff during monsoon and started settling to the bottom during the subsequent post-monsoon season after the cessation of rainfall. Similar type of observations were made by Pawaiya *et al.* [13] who observed transparency values in the range of 106.25 cm to 153.5 cm in case of Harsi reservoir. The transparency in Ramsagar reservoir ranged from 66.59 to 116 cm with low value during monsoon season as reported by Garg *et al.* [14].



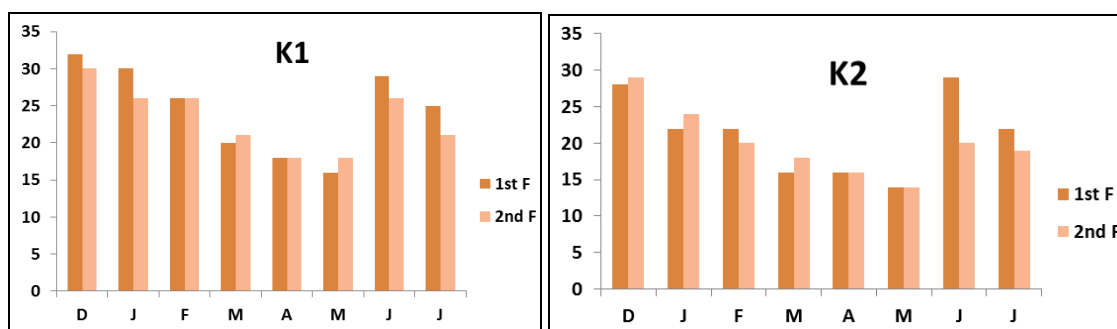
(X- axis: Months, Y-axis: Transparency (cm); 1st F: First fortnight & 2nd F: Second fortnight)

Fig 3: Fortnightly variations of transparency of water at selected stations

Total Suspended Solids (TSS)

TSS content heightens the severity of light limitation. High concentration of these very substances increases turbidity, there by restricts light penetration and hinders photosynthetic activity. During the study period, TSS ranged from 15 mg/L to 30 mg/L (Mean ± SD of 22.22 ± 4.76 mg/L) (Fig.4). Lower TSS values noticed in the pre-monsoon might be due to facilitation of the settlement of suspended particles due to stagnant conditions existing in the reservoirs during that period whereas, higher values observed during December (N-

E monsoon), January (post-monsoon) and July (S-W monsoon) months could be due to the rainfall and associated turbulent conditions, and to certain extent entry of dislocated fine earth materials from the catchment area through runoff in to the reservoir. Similar type of observation was made by Bhadja and Vaghela [15] who documented total suspended solids in the range of 29 to 37 mg/L, 25 to 32 mg/L and 59 to 91 mg/L in case of Aji, Nyari and Lalpari reservoirs of Sourashtra respectively.



X- axis: Months, Y-axis: TSS (mg/L); 1st F: First fortnight & 2nd F: Second fortnight)

Fig 4: Fortnightly variations of Total Suspended Solids (TSS) of water at selected stations

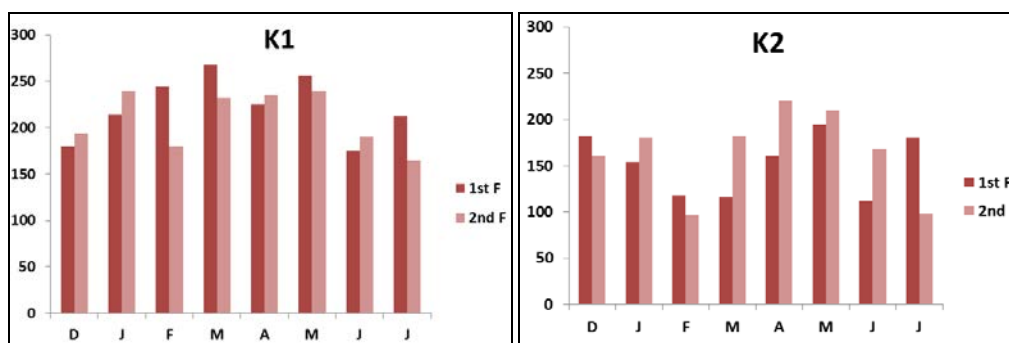
Dissolved Solids (TDS)

During the present study, total dissolved solids fluctuated

between 131.5 mg/L and 227.5 mg/L (Mean ± SD of 186.91 ± 28.78 mg/L) (Fig.5) and based on these values it can be

considered as medium to high productive reservoir. The observations on TDS clearly indicate that, TDS values were high in summer (pre-monsoon) months followed by winter (post-monsoon) and monsoon months. The highest values observed during summer season might be due to intense solar radiation and associated high rate of evaporation in comparison to cooler periods during monsoon, which might

have diluted the water to certain extent. Similar type of observations were made by Hussain *et al.* [16] who observed total dissolved solids ranging from 149 to 211.2 mg/L in case of a flood plain reservoir on river Ravi. Pawaiya *et al.* [13] also noticed TDS in the range of 131.25 to 201 mg/L in case of Harsi reservoir.



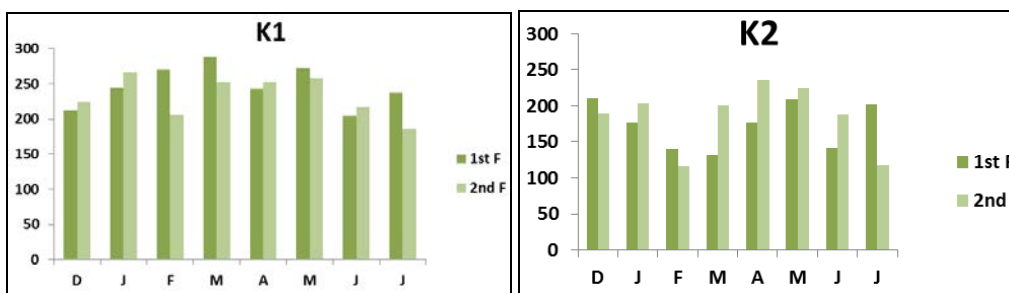
(X- axis: Months, Y-axis: TDS (mg/L); 1st F: First fortnight & 2nd F: Second fortnight)

Fig 5: Fortnightly variations of Total Dissolved Solids (TDS) of water at selected stations

Total Solids (TS)

Total solids of a water sample represent both dissolved and suspended solids. During the present study TS content fluctuated between 151.5mg/L and 244.5 mg/L (Mean ± SD

of 209.13 ± 26.68 mg/L) (Fig.6). Total solids exhibited higher concentrations in pre-monsoon, compared to monsoon and post-monsoon seasons. This can be attributed to the higher concentrations of TDS during this season.



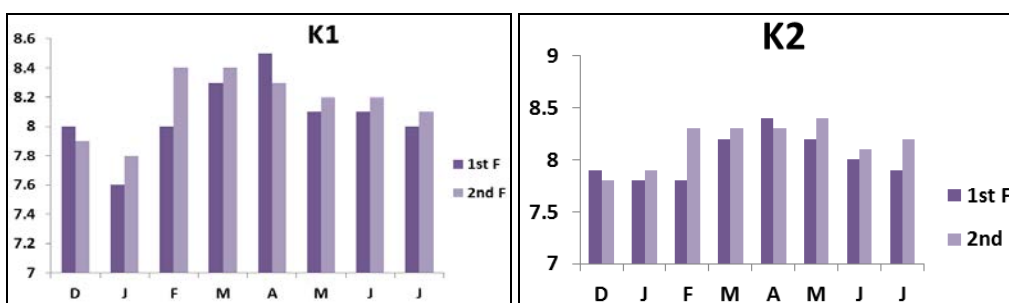
(X- axis: Months, Y-axis: TS (mg/L); 1st F: First fortnight & 2nd F: Second fortnight)

Fig 6: Fortnightly variations of Total Solids (TS) of water at selected stations

pH

pH of an aquatic system is an important indicator of water quality and the extent of pollution in the watershed area. During the present study it ranged between 7.70 and 8.45 (Mean ± SD of 8.11 ± 0.21) (Fig.7). Though water was alkaline throughout the study period, slightly higher values were noticed during pre-monsoon season compared to monsoon and post-monsoon seasons. Highest values observed during pre-monsoon (summer) might be due to increased photosynthetic activity. The decrease in pH during monsoon may be due to greater inflow of water, while during post-

monsoon (winter) could be due to decreased photosynthetic activity. Besides these, monsoonal and post-monsoonal lower values can be attributable to decomposition of organic matter, which on biological oxidation gives up 'carbon dioxide'. Similar type of observations were made by Lubal *et al.* [17] observed pH in the range of 7.2 to 8.6 in case of Mhaswad reservoir. Mathavan and Nambirajan [18] documented pH values ranging from 6.9 to 8.9 in case of Grand anicut. Pawaiya *et al.* [13] observed a pH range of 8.18 to 9.09 in the waters of Harsi reservoir.



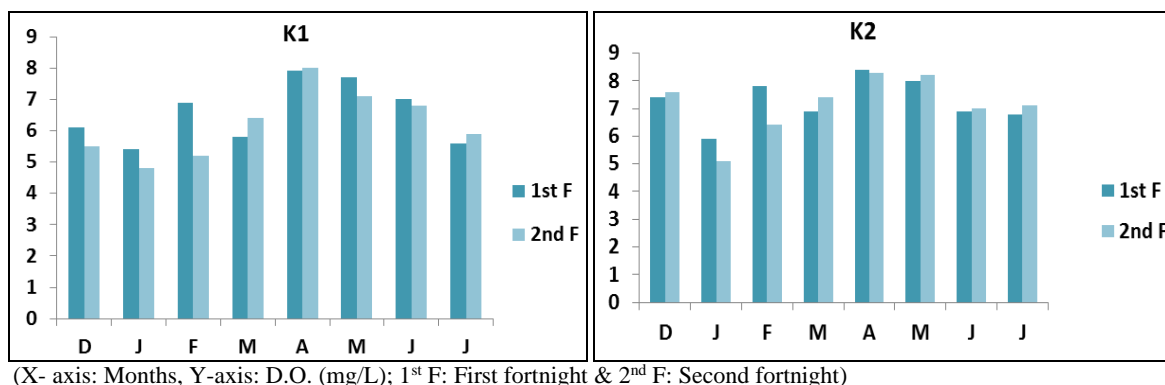
(X- axis: Months, Y-axis: pH; 1st F: First fortnight & 2nd F: Second fortnight)

Fig 7: Fortnightly variations in pH of water at selected stations

Dissolved Oxygen (D.O)

Dissolved oxygen (D.O) is vital in maintaining the oxygen balance in aquatic ecosystems, it is the prime important critical factor in natural waters both as regulator of metabolic processes of plant and animal community and as a vital indicator of water quality, ecological & trophic status and productivity of a reservoir. During the present study, it varied between 4.6 and 8.35 mg/L (Mean \pm SD of 6.79 ± 0.88 mg/L) (Fig.8). Highest dissolved oxygen concentrations were observed during pre-monsoon, whereas the lowest concentrations were noticed during post-monsoon season. These highest values can be attributed to high rate of photosynthetic activity that might have resulted in the

liberation of oxygen as a by-product. Comparatively more or less higher values observed during monsoon season might be due to cumulative effect of wind generated turbulence, resultant mixing coupled with rainfall during this period. Post-monsoon lower values can be attributed to the aerobic decomposition of organic matter that might have entered in to the reservoir through runoff during precipitation. Basavaraja *et al.* [19] also documented DO values in the range of 5.72 to 8.28 mg/L in Anjanapura reservoir. Sreenivasulu *et al.* [11] also observed D.O values ranging from 4.55 to 7.06 mg/L in the waters of Ramanna tank. Mohammad *et al.* [9] also observed D.O in the range of 4.1 to 6.5 mg/L in case of Wyrta reservoir.



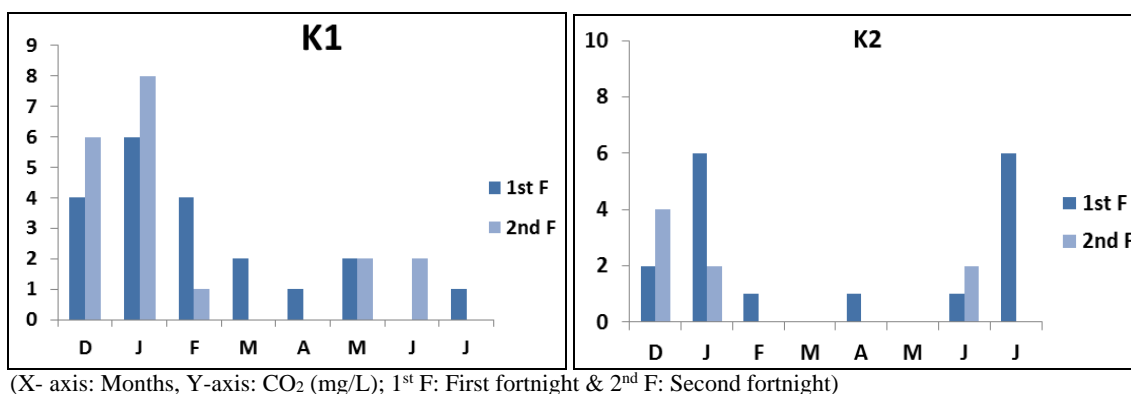
(X- axis: Months, Y-axis: D.O. (mg/L); 1st F: First fortnight & 2nd F: Second fortnight)

Fig 8: Fortnightly variations in D.O. content of water at selected stations

Carbon dioxide (CO₂)

Respiration, photosynthesis, decomposition of organic matter, diffusion and run-off etc. brings about changes in the carbon dioxide concentrations of water. During the present study, free CO₂ content varied from 0 mg/L to 6 mg/L (Mean \pm SD of 2.00 ± 1.98 mg/L) (Fig.9). Its absence or low concentrations recorded in most of the times may be due to

the alkaline nature of the water. More or less higher values observed during monsoon and post-monsoon seasons can be attributed to decomposition of allochthonous organic matter that have entered in to the reservoir through runoff. Similar type of observations were made by Saxena and Saksena [20] in case of Raipur reservoir (0 to 9.3 mg/L), Lianthumluaia *et al.* [21] in case of Savitri reservoir (0 to 8.93 mg/L).



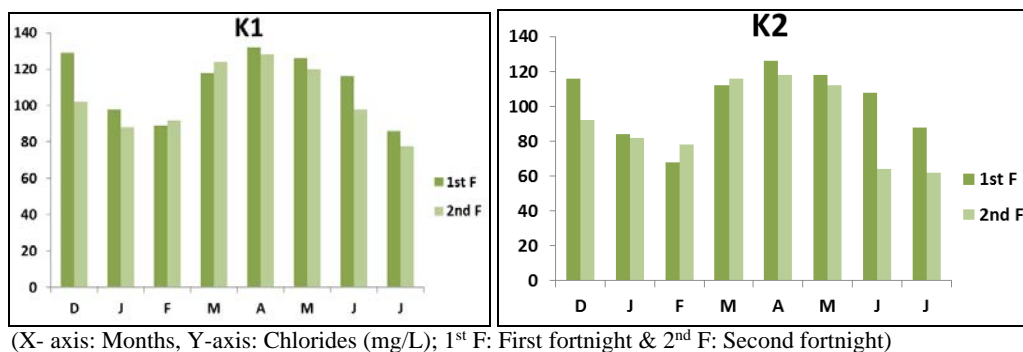
(X- axis: Months, Y-axis: CO₂ (mg/L); 1st F: First fortnight & 2nd F: Second fortnight)

Fig 9: Fortnightly variations in CO₂ content of water at selected stations

Chlorides

Chlorides occur naturally in waters. Discharge of sewage contributes to chlorides there by their concentration serves as an indicator of pollution by sewage, though they occur naturally in waters to certain extent. During the present study, the concentration of chlorides fluctuated between 70 mg/L and 129 mg/L (Mean \pm SD of 102.13 ± 18.95 mg/L) (Fig.10). Compared to post-monsoon, higher values of chlorides were

observed during pre-monsoon and monsoon samplings. Higher values of pre-monsoon could be attributed to high rate of evaporation, whereas, high monsoonal values might be due to the entry of runoff from the catchment area. Piska *et al.* [22] also reported chlorides in the range of 33.25 to 97.93 mg/L from the waters of Ibbrahim reservoir. Jadoon *et al.* [23] also observed chlorides in the concentrations ranging from 57.5 to 100.1 mg/L in case of Darbandikhan reservoir, Iraq.



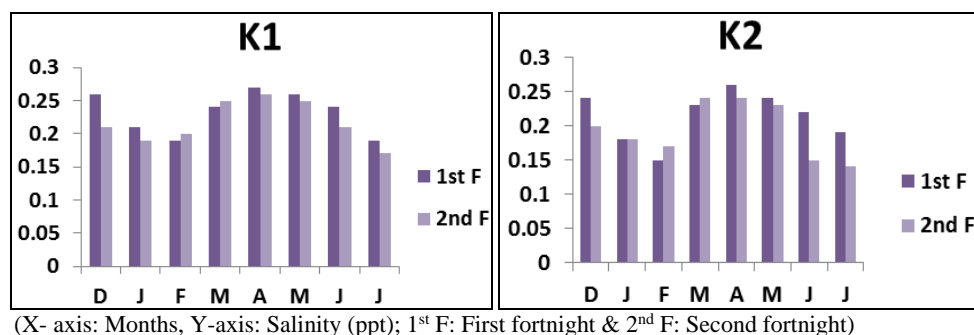
(X- axis: Months, Y-axis: Chlorides (mg/L); 1st F: First fortnight & 2nd F: Second fortnight)

Fig 10: Fortnightly variations in chloride content of water at selected stations

Salinity

Salinity refers to the total concentration of all dissolved ions in water. During the present study, salinity of water from Kanigiri reservoir between 0.16 ppt and 0.26 ppt (Mean \pm SD of 0.21 ± 0.03 ppt) (Fig.11). Comparatively high values of salinity were noticed during pre-monsoon (summer) followed by N-E monsoon seasons. Summer high values could be

attributed to evaporative water loss, while the entry of inorganic constituents in to the reservoir through runoff from the catchment area might be the reason for high values observed during N-E monsoon, which constituted major fraction of the total precipitation received in the study area. Mathavan and Nambirajan ^[18] also observed salinity in the range of 0.159 to 0.182 ppt in Grand Anicut waters.



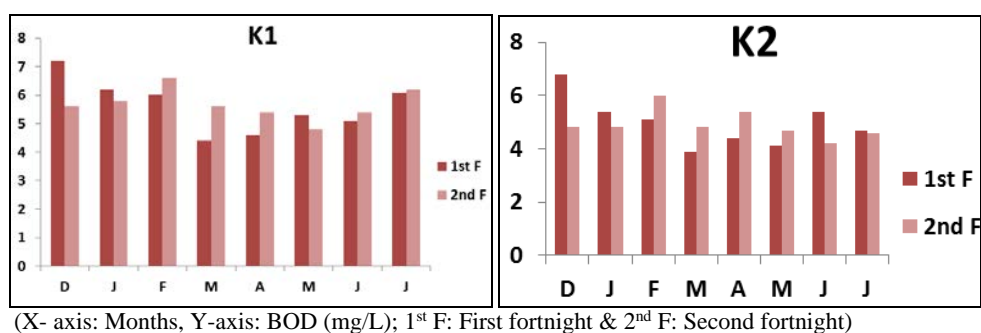
(X- axis: Months, Y-axis: Salinity (ppt); 1st F: First fortnight & 2nd F: Second fortnight)

Fig 11: Fortnightly variations in salinity of water at selected stations

Biochemical Oxygen Demand (BOD)

BOD serves as an indicator of organic pollution of water. It gives a quantitative measure of biodegradable carbonaceous organic matter present in the water. During the present study, BOD of water from Kanigiri reservoir varied between 4.15 mg/L and 7.00 mg/L (Mean \pm SD of 5.29 ± 0.67 mg/L) (Fig.12). The observed higher (slightly) BOD values in monsoon and post-monsoon seasons compared to summer

season might be due to entry of allochthonous organic matter through runoff during rainy season, and which up on being subjected to aerobic degradation might have resulted in those slightly higher BOD values. Bhadja and Vaghela ^[15] also recorded BOD values ranging from 3.95 to 5.14 mg/L in case of Lalpari reservoir. Gayathri *et al.* ^[24] also observed BOD values ranging from 5.51 to 6.2 mg/L in case of Manchanabele reservoir.



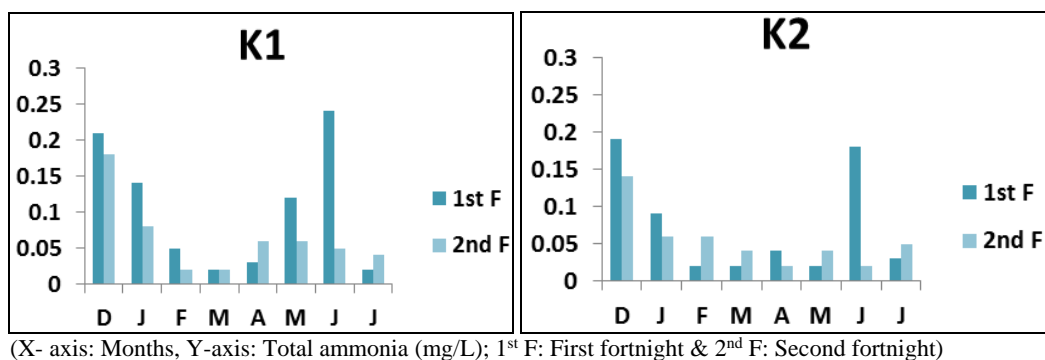
(X- axis: Months, Y-axis: BOD (mg/L); 1st F: First fortnight & 2nd F: Second fortnight)

Fig 12: Fortnightly variations in BOD of water at selected stations

Total ammonia

Total ammonia includes both ionized (NH_4^+) and unionized (NH_3) fractions. Ammonia toxicity increases with increase in pH, as at higher pH, most of the ammonia remains in its gaseous (unionized) form. During the present study, ammonia content varied between 0.02 mg/L and 0.21 mg/L (Mean \pm SD of 0.07 ± 0.06 mg/L) (Fig.13). In most of the instances, higher ammonia content observed during monsoon and subsequent

post-monsoon seasons can be conveniently attributed to the decomposition of organic matter that has entered into the reservoir during monsoon season from the catchment area. Pawaiya *et al.* ^[13] also observed ammonia concentrations in the range of 0.39 to 0.84 mg/L from Harsi reservoir. Pulugandi ^[25] also documented ammonia concentrations ranging from 0.49 to 1.08 mg/L from the waters of Vembakottai reservoir.



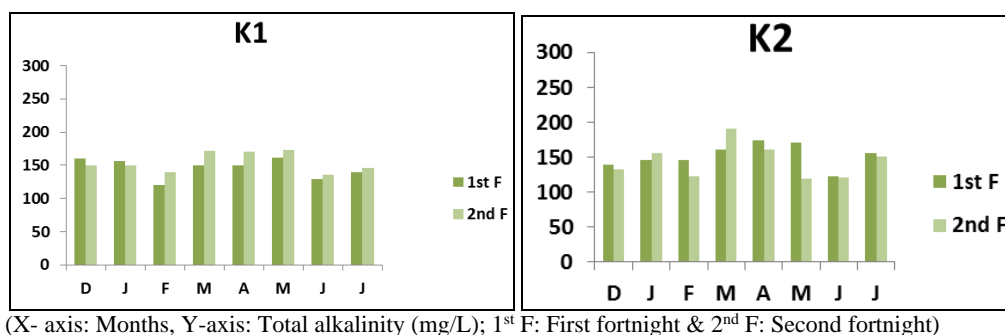
(X- axis: Months, Y-axis: Total ammonia (mg/L); 1st F: First fortnight & 2nd F: Second fortnight)

Fig 13: Fortnightly variations in total ammonia content of water at selected stations

Total alkalinity

Alkalinity helps in stabilizing the pH of water, thereby imparting buffering capacity to water. During the present investigation, alkalinity values fluctuated between 126 mg/L & 181 mg/L (Mean \pm SD of 149 ± 14.61 mg/L) (Fig.14) and thereby fall under the category of moderate alkalinity waters. Higher values observed during pre-monsoon (summer) compared to monsoon and post-monsoon seasons might have

resulted from the effect of pH on the relative proportions of different forms (CO_2 , HCO_3^- and CO_3^{2-}) of inorganic carbon. Hussain *et al.* [16] also documented total alkalinity in the range of 100 to 119 mg/L in a flood plain reservoir on river Ravi. Pulugandi (2014) also observed alkalinity values ranging from 144.3 to 582 mg/L in case of Vembakottai reservoir, Tamil Nadu.



(X- axis: Months, Y-axis: Total alkalinity (mg/L); 1st F: First fortnight & 2nd F: Second fortnight)

Fig 14: Fortnightly variations in total alkalinity content of water at selected stations

Total hardness

The major ions imparting hardness to water are the divalent cations, especially calcium and magnesium in case of surface waters. During the present investigation, hardness values fluctuated between 139 mg/L & 268 mg/L (Mean \pm SD of 211.22 ± 34.74 mg/L) (Fig.15). Higher monsoonal and post-monsoonal values of hardness observed during are probably due to the addition of dissolved minerals from sedimentary

rocks, large quantities of sewage and detergents in to the reservoir through surface runoff from surrounding watershed area that might have received them from nearby residential areas. In Harsi reservoir, Pawaiya *et al.* [137] also recorded total hardness in the range of 63 to 103 mg/L. Gayathri *et al.* [24] also documented hardness values ranging from 174 to 192 mg/L in the waters of Manchanabele reservoir.

Table 1: Suitability of the reservoir (based on observed limnological characteristics) towards good fish production

Sl. No.	Parameter	Observed value Range (Mean \pm SD)	Supporting remarks
1	pH	7.70 to 8.45 (8.11 ± 0.21).	Boyd and Lichtkoppler [26] reported pH range of 6.09 to 8.45 as being ideal for supporting aquatic life including fish.
2	TDS (mg/L)	131.5 to 227.5 (186.91 ± 28.78)	Jhingran and Sugunan [27] noticed a total TDS content of up to 200 mg/L in case of medium productive reservoirs and more than 200 mg/L in case of high productive reservoirs.
3	D.O (mg/L)	4.6 to 8.35 (6.79 ± 0.88)	Boyd [28] reported that D.O concentration of 3 mg/L to 12 mg/L will promote the growth and survival of fish in reservoirs.
4	CO_2 (mg/L)	0 to 6 (2.00 ± 1.98)	Free CO_2 concentration of more than 15 mg/L is detrimental to fish [29].
5	Chlorides (mg/L)	70 to 129 (102.13 ± 18.95)	Unni [30] have designated moderate domestic pollution with chlorides from 50.9 to 129.9 mg/L.
6	BOD (mg/L)	4.15 to 7.00 (5.29 ± 0.67)	Water bodies with BOD of 225 to 323 mg/L are called septic and anaerobic systems [31].
7	Total ammonia (mg/L)	0.02 to 0.21 (0.07 ± 0.06)	The Water Encyclopedia, page 472 "Guidelines for Evaluating Quality for aquatic life" recommends that free NH_3 should not exceed 0.5 mg/L [32].
8	Total alkalinity (mg/L)	126 to 181 (149 ± 14.61)	Phillipose [33] suggested that a water body with total alkalinity greater than 100 mg/L is nutritionally rich. Alkalinity values above 300 mg/L have been reported to adversely affect the spawning and hatching of fresh water fish [34].
9	Total hardness (mg/L)	139 to 268 (211.22 ± 34.74)	Sawyer [35] categorized waters as hard waters with hardness of 151 to 300 mg/L. High hardness of aquatic ecosystem points out towards eutrophication [36].

Table 2: Correlation Co-efficient values observed between different limnological characteristics of water at Station K1

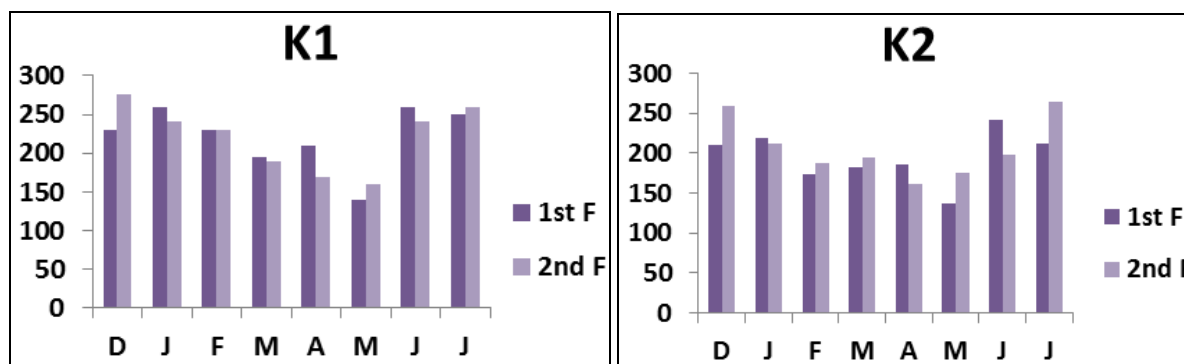
Parameters	Air temp.	Water temp.	Transparency	TSS	TDS	TS	pH	DO	CO ₂	Chlorides	Salinity	BOD	NH ₃	Total Alkalinity	Total Hardness
Air Temp.	1	.941**	.813**	-.778**	.656**	.581*	.445	.432	-.202	.635**	.632**	-.478	-.374	.785**	-.804**
Water Temp.		1	.760**	-.673**	.636**	.576*	.270	.323	-.029	.540*	.536*	-.309	-.276	.828**	-.796**
Transparency			1	-.869**	.633**	.539*	.555*	.669**	-.364	.588*	.616*	-.612*	-.366	.553*	-.918**
TSS				1	-.582*	-.461	-.609*	-.592*	.521*	-.377	-.395	.618*	.595*	-.447	.803**
TDS					1	.990**	.099	.268	.153	.336	.339	-.547*	-.377	.334	-.689**
TS						1	.001	.189	.258	.301	.301	-.489	-.308	.286	-.612*
pH							1	.501*	-.764**	.466	.469	-.419	-.513*	.154	-.503*
DO								1	-.529*	.656**	.673**	-.499*	-.011	.190	-.617*
CO ₂									1	-.285	-.298	.255	.336	-.055	.340
Chlorides										1	.996**	-.426	.228	.591*	-.655**
Salinity											1	-.435	.213	.586*	-.674**
BOD												1	.214	-.133	.440
NH ₃													1	-.042	.312
Total Alkalinity														1	-.619*
Total Hardness															1

** . Correlation is significant at the 0.01 level (2-tailed). * . Correlation is significant at the 0.05 level (2-tailed).

Table 3: Correlation Co-efficient values observed between different limnological characteristics of water at Station K2

Parameters	Air temp.	Water temp.	Transparency	TSS	TDS	TS	pH	DO	CO ₂	Chlorides	Salinity	BOD	NH ₃	Total Alkalinity	Total Hardness
Air Temp.	1	.927**	.816**	-.774**	.505*	.417	.667**	.594*	-.420	.684**	.685**	-.336	-.453	.595*	-.603*
Water Temp.		1	.785**	-.657**	.646**	.577*	.478	.527*	-.285	.639**	.639**	-.196	-.366	.415	-.658**
Transparency			1	-.848**	.455	.356	.775**	.576*	-.602*	.539*	.523*	-.382	-.564*	.276	-.760**
TSS				1	-.263	-.139	-.778**	-.406	.498	-.266	-.254	.534*	.830**	-.425	.698**
TDS					1	.992**	.140	.320	.115	.496	.517*	-.051	-.151	.258	-.426
TS						1	.042	.276	.183	.474	.497*	.018	-.047	.209	-.346
pH							1	.466	-.724**	.439	.433	-.273	-.455	.239	-.452
DO								1	-.408	.507*	.503*	-.138	-.173	.172	-.397
CO ₂									1	-.278	-.254	.118	.265	-.137	.419
Chlorides										1	.998**	.023	.140	.429	-.419
Salinity											1	.013	.142	.434	-.407
BOD												1	.649**	-.333	.169
NH ₃													1	-.409	.594*
Total Alkalinity														1	-.326
Total Hardness															1

** . Correlation is significant at the 0.01 level (2-tailed). * . Correlation is significant at the 0.05 level (2-tailed).

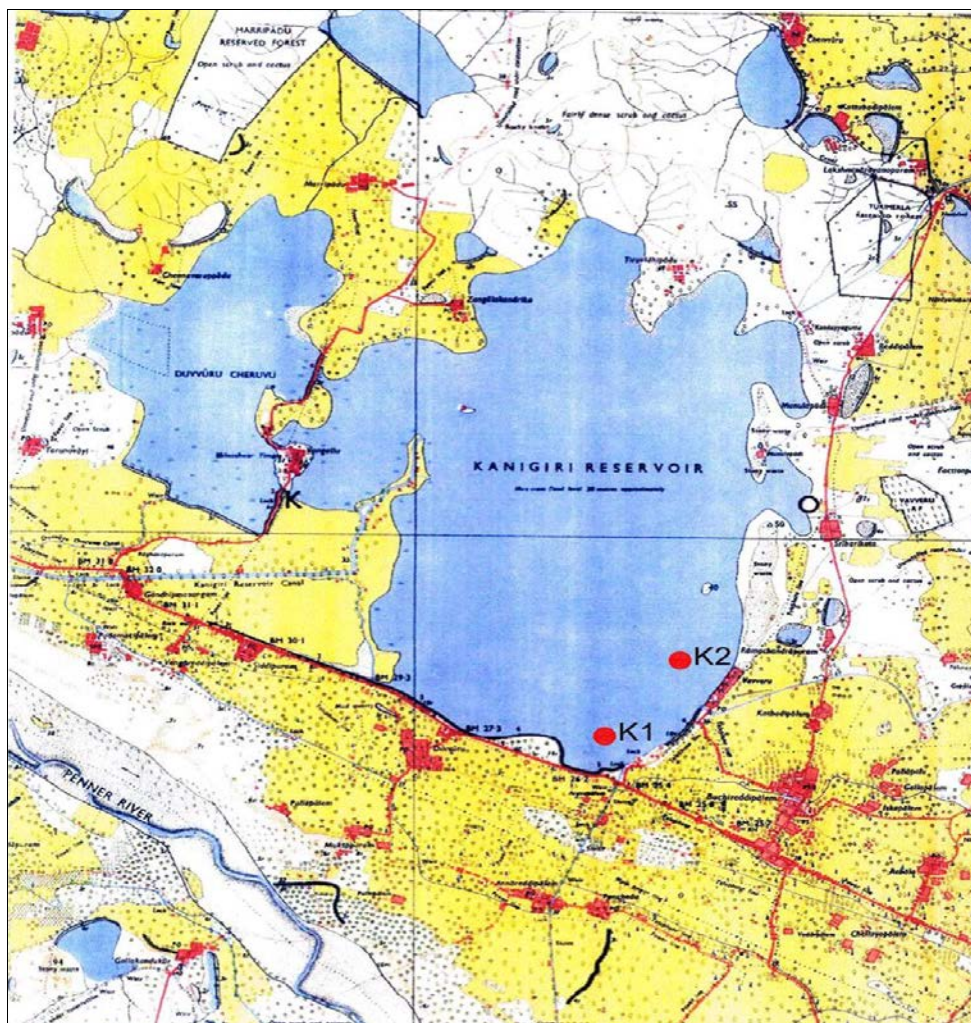


(X- axis: Months, Y-axis: Total hardness (mg/L); 1st F: First fortnight & 2nd F: Second fortnight)

Fig 15: Fortnightly variations in total hardness of water at selected stations

Map showing the sampling stations

Map showing location of Study area with sampling stations

**Conclusion**

From the present study it can be concluded from fisheries point of view that, the reservoir can support good fish production with respect to many observed parameters as mentioned in table 1. Correlation observed between the parameters under study were represented in table 2 & table3.

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