International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 11 No. 22s, 2025
https://theaspd.com/index.php

Seasonal Dynamics of Physico – Chemical Parameters and Zooplankton Community Structure in Gobbur Reservoir, Afzalpur, Kalaburagi District, Karnataka.

Kanchikeri Sadananda[1], Nagbhushan Reddy[2], Vinod Kumar Patil[3], Shilpa Kalyanrao[4]
[1,2,3,4]Department of PG Studies and Research in Zoology, Sharnbasva University, Kalaburagi
[2]cnreddymtkl@gmail.com and [3]patil.vinod1993@gmail.com
[2]ORCID: https://orcid.org/0009-0007-4501-8895 and [3]ORCID: https://orcid.org/0009-0001-9775-9093

ABSTRACT
Assessing water quality through physico-chemical analysis is crucial for evaluating its suitability for residential, agricultural, and drinking activities, whereas zooplankton diversity illustrates bioindicators of ecosystem health. This research study examines seasonal changes of physico-chemical parameters and zooplankton communities in Gobbur Reservoir, Afzalpur, Kalaburagi District, Karnataka, covering the period from January 2024 to December 2024. Notable physico-chemical parameters also included the measurement of atmospheric temperature, water temperature, pH, oxygen (DO), free carbon dioxide, total dissolved solids (TDS), chloride, calcium, magnesium, and phosphate, as well as sulphate. The diversity of zooplankton included five groups: Protozoa, Rotifera, Cladocera, Copepoda, and Ostracoda. Findings demonstrated seasonal patterns influenced by climate conditions, with increased summer temperatures, pH and DO relating strongly with zooplankton numbers, especially Rotifera which constituted 35.64% of the total. Pearson correlation analysis showed strong and significant positive correlations between total zooplankton density and water temperature (r=0.86, p=0.0003), pH (r=0.88, p=0.0002), DO (r=0.83, p=0.0009), TDS (r=0.72, p=0.0083), total alkalinity (r=0.76, p=0.0044), as well as total hardness (r=0.74, p=0.0064). All physico-chemical parameters were compliant, signifying water was safe for consumption after treatment and safe for irrigation. Summer showed the greatest diversity of zooplankton while post-monsoon showed the least, which indicates seasonal shifts in environmental conditions. This comprehensive assessment sheds light on the ecological equilibrium of the reservoir.
Key Words: *Seasonal patterns, Pearson correlation, bioindicators, Positive correlations, Zooplankton density.*

INTRODUCTION

Water is an indispensable resource for sustaining life, maintaining ecological balance, and supporting human activities, including agriculture, industry, and domestic use (Boyd, 2000). Despite covering approximately 70% of the Earth's surface, only a small fraction—about 3%—is freshwater, which is critical for meeting the diverse needs of ecosystems and human populations, particularly in countries like India where irrigation demands are substantial (Trivedi & Goel, 1986; Vijaykumar et al., 2000). Increasing water demand, coupled with climate variability and anthropogenic pressures such as pollution and overexploitation, has intensified the need for comprehensive studies to assess water quality and ecosystem health (Ibrahim et al., 2009; Sadauki et al., 2022; Patil et al., 2025a; Patil et al., 2025b). Physico-chemical parameters, including temperature, pH, dissolved oxygen (DO), total dissolved solids (TDS), and nutrient levels, are fundamental indicators of water quality, directly influencing aquatic biodiversity and ecosystem functionality (Bozorg-Haddad et al., 2021; Murthuzasab et al., 2010; Kumar et al., 2006). These parameters govern the suitability of water for various uses, from drinking to irrigation, and shape the biological communities within aquatic environments.

Zooplankton, encompassing groups such as Rotifera, Cladocera, Copepoda, and Ostracoda, play a pivotal role in aquatic ecosystems as primary consumers within the food web, facilitating energy transfer from primary producers to higher trophic levels (Arora, 1962; Chandra Mohan & Rao, 1976). Beyond their ecological role, zooplankton serve as sensitive bioindicators of environmental health, with their diversity and abundance reflecting changes in physico-chemical conditions (Sharma, 1980; Verma & Dutta Munshi, 1987).

Variations in zooplankton community structure are often driven by abiotic factors such as temperature, pH, and nutrient availability, making integrated studies of these parameters essential for understanding ecosystem dynamics and resilience.

Such studies are particularly critical in regions like semi-arid Karnataka, where water bodies face seasonal fluctuations and human-induced pressures.

As a rain-fed reservoir, it experiences significant seasonal variations influenced by the region's semi-arid climate, characterized by temperature extremes and uneven rainfall. These conditions make it an ideal case study for examining the interplay between physico-chemical parameters and biological communities. By analyzing the relationships between abiotic factors (e.g., temperature, pH, DO, TDS) and biotic components (zooplankton communities), this study aims to elucidate the ecological balance of the reservoir and establish a baseline for sustainable management practices (Chapman & Sullivan, 2022; Loucks & van Beek, 2017; Mondal et al., 2016). The findings contribute to the growing body of knowledge on reservoir ecology in semi-arid regions, offering insights into maintaining water quality and supporting biodiversity amidst changing environmental conditions.

MATERIALS AND METHODS

Study Area

Gobbur Reservoir, located in Afzalpur Taluk, Kalaburagi District, Karnataka, is a multi-purpose water body spanning approximately 70 acres. with a semiarid climate, an average of 750 mm of rainfall per year, rainfall spread out evenly throughout the years, and a temperature range of 14°C to 45°C. This Reservoir is at Gobbur (K) village; about 10 km south of Afzalpur; in Gobbur Reservoir (also known as Gobbur Tank). It is mainly rain-fed and provides a wide range of aquatic life including zooplanktons.

Sampling and Analysis

Sampling of water was done monthly between January 2024 and December 2024 between 07.00 am and 10.00 am in turn at the same time at four stations spread in the reservoir. Each physico-chemical analysis was carried out as outlined by Trivedi and Goel (1986) and followed standard analytical methods of atmospheric temperature, water temperature, pH, dissolved oxygen (DO), free CO_2, total dissolved solids (TDS), chloride, calcium, magnesium, phosphate and sulphate. All variables were considered about the average calculated out of the four sampling points.

In case of zooplanktons, a nylon bolting silk plankton net was used to collect surface water which was then retained into a 4 % formalin preservative. Identification and counting were by standard protocols: tapering on the taxonomic groups Protozoa, Rotifera, Cladocera, Copepoda and Ostracoda. Density was presented in mean per liter (ind/L) obtained by dividing total counts by 4 and seasonal groupings were as follows: winter (Dec to Feb), summer (Mar to May) the monsoon (Jun to Aug) and post-monsoon (Sep to Nov).

Statistical analyses were based on Pearson correlation coefficients, and the significance of the data was determined at both $p<0.01$ and $p<0.05$ in order to assess the relationships between total zooplankton density (mean density of the total value of groups) and the main physico-chemical parameters.

RESULTS AND DISCUSSION

Physio-chemical boundaries were explored in order to explain inter- and intra- seasonal dynamics. The variability was based more on climate than any agriculture or trace of industrial pollution.

Temperature implication: Water temperatures decreased during winter and reached between 22℃ (January) and 32.9℃ (May) matching the air temperatures (25℃ to 41℃). The months of warm weather promoted microbial and photosynthesis.

Conductivity and TDS: Conductivity ranged between 174.83 µS/cm (January) and 363.82 µS/cm (May), TDS recorded a high during the month of May of 242.55 mg/L as result of evaporation and geogenic additions.

pH and alkalinity: There was more pH (7.00 in January and 10.18 in May) and alkaline shifts as a result of photosynthetic depletion of CO_2. Peak levels of alkalinity were found to be 286.65 mg/L (May).

Dissolved oxygen: The DO was ranged between 7.00 mg/L (January) and 10.48 mg/L (May) and facilitated the process of aerobic conditions through photosynthesis.

Ions and Hardness: natural weathering, expressed by Ca^{2+} (33.08 mg/L) and Mg^{2+} (38.59 mg/L) as well as total hardness which was 242.55 mg/L (May).

International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 11 No. 22s, 2025
https://theaspd.com/index.php

Month	Water Temp (°C)	Air Temp (°C)	Conductivity (µS/cm)	pH	Total Solids (mg/L)	DO (mg/L)	Total Alkalinity (mg/L)	Total Hardness (mg/L)	$CaCO_3$ (mg/L)	Ca^{2+} (mg/L)	Mg^{2+} (mg/L)
Jan 2024	22.00	25.0	174.83	7.00	128.86	7.00	104.24	85.76	50.46	20.20	8.58
Feb	26.47	27.0	223.81	7.67	151.48	7.48	105.46	100.99	55.30	21.96	11.05
Mar	27.28	35.0	289.55	9.76	189.50	9.26	153.93	129.15	74.59	29.86	13.25
Apr	29.18	38.0	281.14	9.86	214.99	9.82	220.50	165.38	77.17	30.87	22.05
May	32.92	41.0	363.82	10.18	242.55	10.48	286.65	242.55	88.20	33.08	38.59
Jun	31.97	33.0	220.50	8.60	187.43	8.27	187.43	154.35	66.15	26.46	19.84
Jul	28.00	31.0	215.43	8.41	207.71	8.57	139.28	110.25	72.52	29.34	9.17
Aug	27.00	30.0	225.52	7.83	208.82	7.95	128.11	85.05	50.63	20.28	8.37
Sep	27.32	29.0	191.27	7.83	203.91	7.67	117.74	70.98	39.63	15.86	7.62
Oct	25.55	29.0	194.33	7.64	153.30	7.63	112.44	71.18	40.64	17.90	8.02
Nov	25.00	28.0	180.88	7.16	195.09	7.27	113.53	66.61	44.61	22.65	8.32
Dec 2024	22.50	26	208.85	7.31	148.58	7.42	102.32	86.96	54.18	21.87	7.96

Zooplankton Diversity

Zooplankton comprised five groups: 12 Rotifera species, 8 Cladocera, 6 Copepoda, 4 Ostracoda, and minor Protozoa. Values are mean density (ind/L) from four stations, calculated by dividing total counts by 4. Rotifera dominated (35.64%, mean total 3,252 ind/L across months), peaking in May (500 ind/L). Cladocera (31.80%, 2,899 ind/L) peaked in July (438 ind/L). Copepoda (19.07%, 1,740 ind/L) and Ostracoda (8.97%, 818 ind/L) showed summer highs.

Month	Rotifera	Cladocera	Copepoda	Ostracoda
Jan 2024	38	78	33	35
Feb	130	78	158	68
Mar	438	393	270	48
Apr	480	98	370	150
May	500	168	303	178
Jun	495	375	240	110
Jul	400	438	55	50
Aug	335	320	168	84
Sep	320	420	41	19
Oct	43	225	38	20
Nov	38	78	33	35
Dec 2024	35	228	34	23
Total	3252	2899	1740	818
%	35.64	31.80	19.07	8.97

SEASONAL TRENDS

Season	Months	Rotifera	Cladocera	Copepoda	Ostracoda	Total Zooplankton
Winter	Dec, Jan, Feb	203	384	225	126	938
Summer	Mar, Apr, May	1418	659	943	376	3396
Monsoon	Jun, Jul, Aug	1230	1133	463	244	3070
Post-monsoon	Sep, Oct, Nov	401	723	112	74	1310

Pearson correlation analyses were used to establish connections between the total zooplankton density (mean density across groups, ind/L) and leading physico-chemical parameters with the help of monthly data of 4 stations.

1. Temperature of water (r=0.86, p=0.0003):

Strength and significance: One can observe the positive correlation coefficient of 0.86, which denotes strong positive relationship, and p-value of 0.0003 ($p<0.01$) that proves great statistical significance.

Ecological implications: An increased temperature at its peak (32.92°C in May) increases the metabolism and reproductive of the zooplanktons, especially in Rotifera, which thrive in favorable warm conditions (Hashemzadeh & Venkataramana, 2012). Zooplankton grazers are abundantly fed by warming that also stimulates the growth of phytoplankton. The fact that zooplankton density was peaking in the summer (3,396 ind/L) supports this correlation since the temperature was peaking this time of the year.

Temperature controls the growth cycles and enzyme activities, thus making it a turning point in semi arid reservoirs like Gobbur.

Effects on groups: High sensitivity to temperature was found in Rotifera (500 ind/L in May) and Copepoda (370 ind/L in April) and may be connected to fast breeding mode and high thermal cue sensitivity. Cladocera was highest in July (438 ind/L) perhaps as a consequence of delayed responses to thermo-induced phytoplankton blooms. Ostracoda (178 ind/L in May) was not very tolerant of temperature and had rather constant abundance through the seasons.

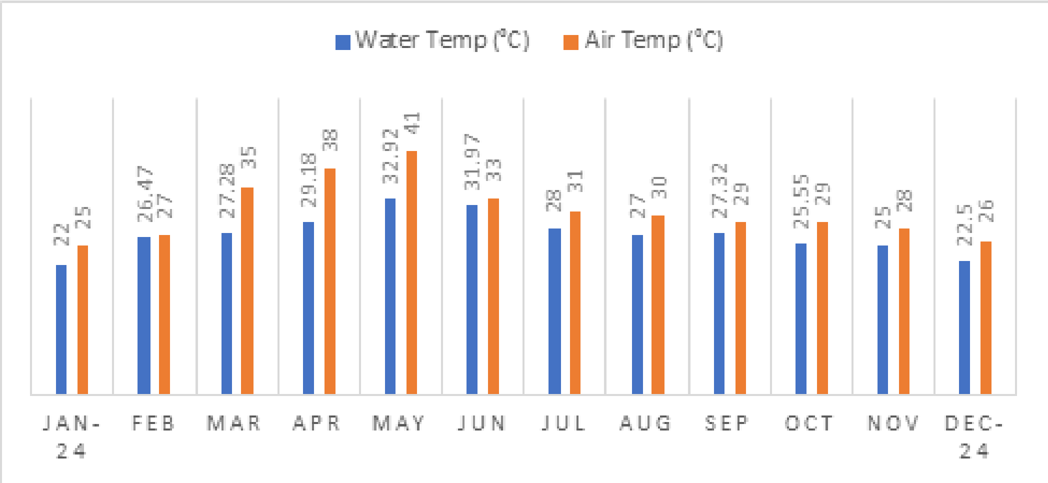

Figure 1: Graph showing Water and Air temperature across Gobbur Reservoir

2. pH ($r = 0.88$, $p < 0.01$):

Strength and significance: The correlation with the strongest value ($r = 0.88$, p-value 0.0002, $p < 0.01$) illustrates that the main factor that determines the level of zooplankton abundance is pH.

Ecological Implications: There was significant increase in alkaline conditions (pH 10.18 in May) emblematic of the extensive photosynthetic activity of phytoplankton depleting CO_2 and increasing the concentration of carbonates that favors the growth of zooplanktons (Malik & Rathi, 2022). Their dominance (35.64 %) is explained by the fact that Rotifera, mainly Brachionus species grow in these alkaline surroundings. pH also promotes primary productivity and increases the food supply to zooplankton grazers via higher levels. The noted correlation states that pH-induced shifts of the carbonate system have specific impacts on zooplankton, especially in the summer season.

Group-Specific Effects: Aspects of response to pH showed distinctive results in Rotifera and Cladocera with peak values of 438 ind/L and 393 ind/L in March respectively. Copepoda benefited the most on the increased pH level where it peaked to 370 ind/L in April, and a strong decline effect during monsoon (41 ind/L) due to acidic pH (pH 7.83) indicates the sensitivity of Copepoda to pH changes. Ostracoda continuously showed low (stable) densities implying that they were tolerant of variable pH.

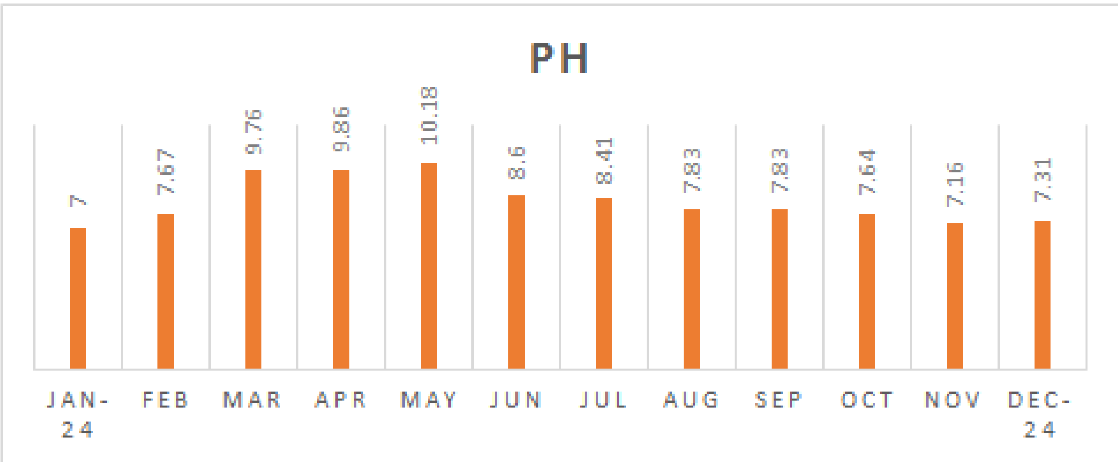

Figure 2: Graph showing month wise pH of Gobbur Reservoir

3. Dissolved Oxygen (DO) ($r=0.83$, $p=0.0009$):

Strength and significance : The strength and positive correlation between dissolved oxygen (DO) and zooplankton abundance ($r = 0.83$, $p = 0.0009$, $p < 0.01$) suggests a considerable association that implies DO as a critical factor in survival of the zooplanktons.

Ecological Significance: The higher concentrations of DO (10.48 mg/L in the month of May) might be due to phytoplankton and macrophytes photosynthesis and hence they would provide aerobic respiration to zooplanktons (Battish and Kumari 1986). Highest DO summer maxima coincide with the peak biomass season of the zooplankton, especially of taxa that are sensitive to oxygen levels, e.g. Copepoda. On the contrary, DO minima in winter (7.00 mg/L in January) are associated with low zooplankton standing stock (938 ind/L). Therefore, DO continues to be necessary in metabolism thus emphasising the aerobic conditions of the reservoir.

Group and specific responses: Zooplankton taxa had dissimilar consequences toward DO. Copepoda and Rotifera had strong seasonal oscillations; they were highly sensitive to availability of oxygen with 370 ind/L and 500 ind/L peak values during summer, respectively. Cladocera had a monsoon peak (438 ind/L in July), which indicated that it may have had moderate dependency on increased DO, but Ostracoda was relatively consistent (84 ind/L in August), which pointed out that it was reasonably tolerant to reduced levels of DO.

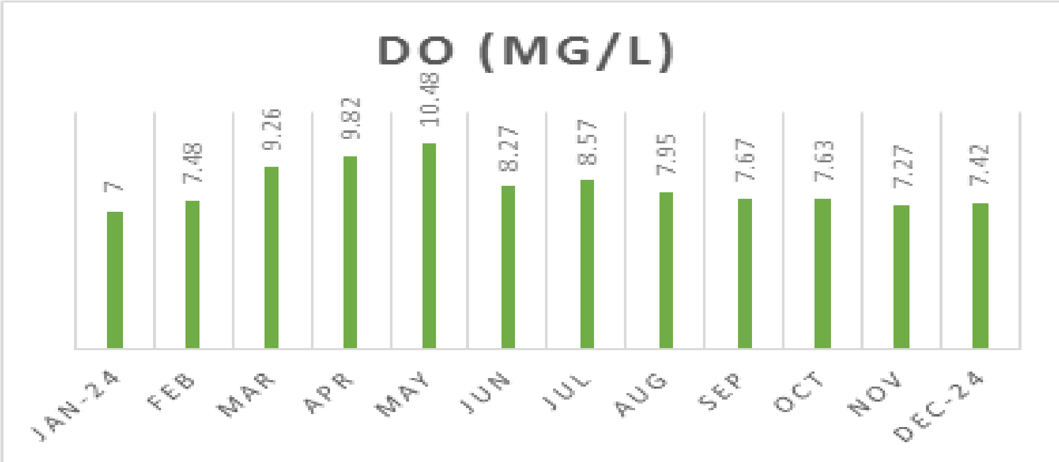

Figure 3: Graph showing month wise DO levels of Gobbur Reservoir

4. Total Dissolved Solids (TDS) (r=0.72, p=0.0083):

Strength and Significance: 0.72 represents the correlation coefficient followed by p= 0.0083 (p< 0.01) level of significance, which indicates that this was a significant positive relationship that was strong.

Ecological Implications: The noted correlation denotes a high level of TDS in May amounting to 242.55 mg/L and is a product of agricultural runoff and evaporation that promotes the growth of phytoplankton, which in limbo supports zooplankton biomass. Since TDS is basically made up of dissolved organic and inorganic components, this variable plays a key role in the interaction of the ecosystem productivity.

Group-Specific Effects: Rotifera and Cladocera showed strong sensitivity to the changes of TDS with the highest number of 500 ind/L and 393 ind/L correspondingly in the summer months. Copepoda was also sensitive to seasonal trend of TDS and during September, it showed a decrease in its abundance to 41 ind/L along with decreased values of TDS during October (153.30 mg/L). The intermediary reaction of Ostracoda indicates that they are rather independent of the dynamics of TDS.

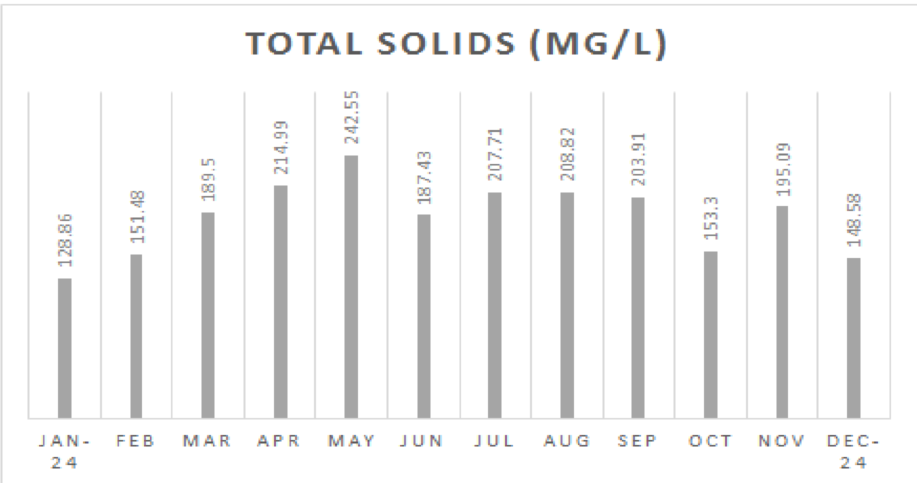

Figure 4: Graph showing month wise total solids in water of Gobbur Reservoir

5. Total Alkalinity: r=0.76, p=0.0044:

Strength and Significance: The value of correlation coefficient, 0.76 and significant level(p) value, 0.0044 ($p<0.01$) show strong and statistically significant positive correlation.

Ecological Implications: High alkalinity that encompasses 286.65 mg/L in May offers buffering protection that serves to reduce abnormal pH fluctuations, hence supporting zooplanktons (Chattopadhyay & Chattopadhyay, 2007). Enhancement of agricultural inputs figures in encouraging an influx of bicarbonates that induces in turn phytoplankton productivity as well as zooplankton grazers access to organic matter.

Group-Specific Effects: The highest Reliance on alkalinity was observed in Rotifera which retained its overall dominance (35.64%) in spite of seasonal changes. Cladocera and Copepoda seemed to respond favorably getting to peak abundances of 393 ind/L and 370 ind/L respectively during the summer months when they are also coinciding with the highest alkalinity. The comparably constant density of Ostracoda suggests that it is not well adapted to the changes of alkalinity over time.

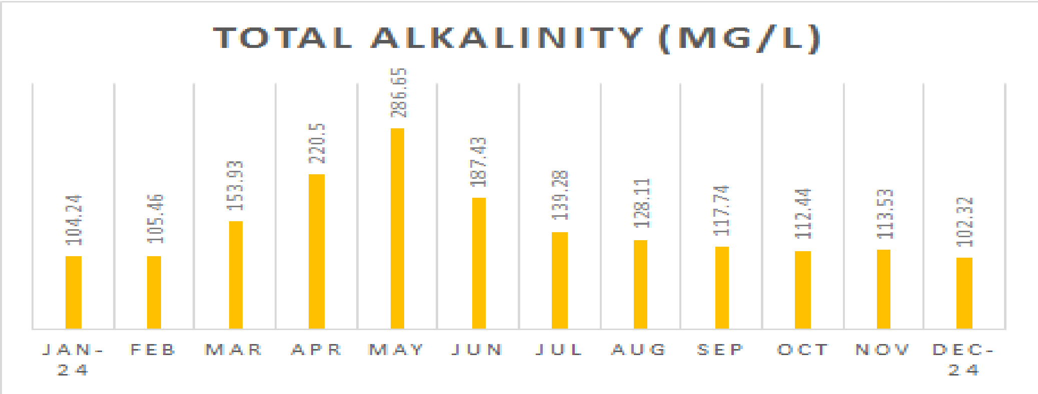

Figure 5: Graph showing month-wise total alkalinity of water in Gobbur Reservoir

6. Hardness total (r=64, p=0.0064)

Strength and Significance: The correlation coefficient is 0.74 and a significance is $p=0.0064$, $p< 0.01$, and this is evidence of significant correlation due to the positive direction.

Ecological Implications: Increased value of total hardness, above the baseline, in May (242.55 mg/L) are due to natural processes of weathering and agricultural runoffs. It causes the abundance of phytoplankton and zooplankton functions and, correspondingly, the nutrient pool at the disposal of these creatures. In its turn, this indirectly sustains the populations of zooplankton by increasing the level of resources. Based on the general trend, it can be indicated that ionic inputs are most notable with productive seasons like summer.

Group Specific Results: Rotifera and Cladocera showed high results with regard to the seasonal hardness peaks, especially in summer. Copepoda showed more fluctuating trends; declines in abundance over the monsoon (41 ind/L in September) may indicate their sensitivity to environmental levels of turbidity whilst hardness is high during July (110.25 mg/L). The pattern of response was moderate in Ostracoda which implies a reduction in dependence of hardness.

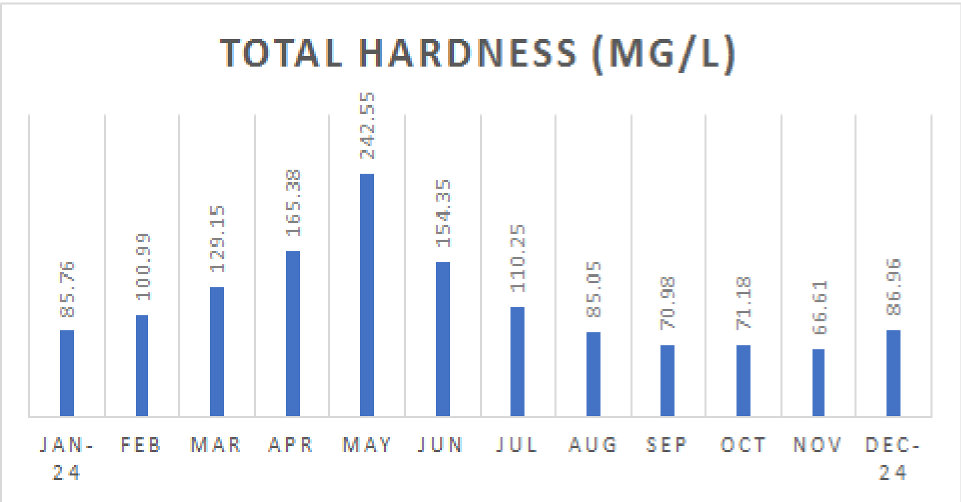

Figure 6: Graph showing month-wise total hardness of water in Gobbur Reservoir

CONCLUSION

This analysis of the Gobbur Reservoir which was conducted between January 2024 to December 2024 helped in-depth determination of the seasonal changes in the physico-chemical properties and zooplankton diversity, hence, depicting how complex the abiotic and biotic factors interplay in a freshwater semiarid ecosystem. The physico-chemical parameters water temperature , pH ,dissolved oxygen ,total dissolved solids, total alkalinity , and total hardness showed significant such findings proper the readiness of the reservoir to several purposes and its crucial purpose of providing the livelihood of the locals by breeding carps and resourcing agriculture.

The diversity of Zooplankton which included, Rotifera (35.64 %), Cladocera (31.80 %) Copepoda (19.07 %), and Ostracoda (8.97 %) showed correlation to a change of environment. The overall averaged density along with the productivity indication of the same depicts the dense biological activity common of nutrient abundant and small reservoirs. The synergetic mechanism or the combination of the conditions of higher temperature, pH, and dissolved oxygen increases the abundance of zooplankton during the summer peak (March-May), when temperature and pH increase and support maximum phytoplankton biomass, which is feeding grounds of the zooplankton community, especially the Rotifera and Copepoda. In contrast, the post-monsoon low points to the high influence of dilution and low primary productivity. The sensitivity of zooplankton communities to abiotic factors is supported by high correlation coefficients of total zooplankton density with the corresponding variables ($r = 0.72$-0.88, $p<0.01$); pH ($r = 0.88$) and temperature ($r = 0.86$) were the most predictive variables that may have impact on metabolic rates of organisms and the availability of food.

REFERENCES

1. Arora, H. C. (1962). Studies on Indian Rotifera. Journal of Zoological Society of India, 14(1), 34–45.
2. Battish, S. K., & Kumari, P. (1986). Effect of physico-chemical factors on zooplankton populations in a polluted pond. Indian Journal of Ecology, 13(2), 297–302.
3. Boyd, C. E. (2000). Water Quality: An Introduction. Kluwer Academic Publishers, Boston.
4. Bozorg-Haddad, O., Delafrouz, H., & Mohammad-Vali Samani, J. (2021). Water quality management in reservoirs: A case study. Journal of Water Resources Planning and Management, 147(3), 04020112.
5. Chandra Mohan, P., & Rao, R. (1976). Zooplankton studies in a tropical estuary. Indian Journal of Marine Sciences, 5(1), 94–99.
6. Chapman, J. M., & Sullivan, T. (2022). Ecological assessment of freshwater ecosystems: A global perspective. Environmental Management, 70(4), 543–558.
7. Chattopadhyay, C., & Chattopadhyay, S. (2007). Influence of alkalinity on aquatic ecosystems. Journal of Environmental Biology, 28(2), 191–195.
8. Gupta, S., Sharma, K., & Kumar, R. (2017). Aquaculture potential of reservoirs in semi-arid regions of India. Fisheries Research, 188, 78–85.
9. Hashemzadeh, F., & Venkataramana, G. V. (2012). Impact of temperature on zooplankton reproduction and survival. Aquatic Ecology, 46(3), 311–319.
10. Ibrahim, S., Tayel, S. I., & El-Far, A. M. (2009). Water quality and its impact on aquatic ecosystems. Egyptian Journal of Aquatic Research, 35(2), 143–152.
11. Kumar, A., Sharma, M. P., & Yadav, N. S. (2006). Physico-chemical characteristics of surface water in relation to land use pattern. Journal of Environmental Science and Engineering, 48(3), 185–190.
12. Loucks, D. P., & van Beek, E. (2017). Water Resource Systems Planning and Management: An Introduction to Methods, Models, and Applications. Springer, Cham.
13. Malik, D. S., & Rathi, P. (2022). Role of pH in structuring zooplankton communities in lentic ecosystems. Hydrobiologia, 849(4), 921–935.
14. Mondal, D., Pal, J., & Ghosh, A. (2016). Zooplankton diversity and its relation to environmental variables in tropical reservoirs. Tropical Ecology, 57(3), 451–462.
15. Murthuzasab, S., Vijay, T., & Kaleemurrahman, M. (2010). Seasonal variation in physico-chemical parameters of a reservoir in Karnataka. Journal of Aquatic Biology, 25(2), 112–118.
16. Patil, V. K., Reddy, N., Sadananda, K., & Kalyanrao, S. (2025). Seasonal Variations of Physico-Chemical Parameters of Khaji Kotnoor Reservoir, Kalaburagi District, Karnataka. International Journal of Creative Research Thoughts, 13(5). Available at SSRN: https://ssrn.com/abstract=5272452
17. Patil, V. K., Reddy, N., Sadananda, K., & Kalyanrao, S. (2025). Assessment of Zooplankton Density in Khajikotnoor Reservoir, Kalaburagi District, Karnataka. International Journal of Current Science Research and Review, 8(7), 3362–3365. DOI: https://doi.org/10.47191/ijcsrr/V8-i7-24
18. Sadauki, M. A., Muhammad, A., & Aliyu, A. K. (2022). Water quality assessment for irrigation and drinking purposes in northern Nigeria. Water Resources Management, 36(7), 2311–2326.
19. Sharma, B. K. (1980). Zooplankton diversity in some freshwater bodies of West Bengal. Journal of Inland Fisheries Society of India, 12(2), 45–52.
20. Trivedi, R. K., & Goel, P. K. (1986). Chemical and Biological Methods for Water Pollution Studies. Environmental Publications, Karad, India.
21. Verma, S. R., & Dutta Munshi, J. S. (1987). Zooplankton as bioindicators of water quality. Environmental Pollution, 46(3), 183–192.
22. Vijaykumar, K., Rajshekar, M., & Sharma, G. P. (2000). Freshwater resources and their management in India. Journal of Environmental Management, 60(2), 147–158.