Water Quality Monitoring for the Sustainable Management of Aquatic Ecosystem in the Markandeya Dam Reservoir, Kolar District, Karnataka, India

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ABSTRACT

Water is an irreplaceable natural resource and the cornerstone of aquatic and terrestrial ecosystems alike. Dams and reservoirs are critical infrastructure that support biodiversity, agriculture, potable water supply, hydropower generation, flood mitigation, and recreation. Despite their ecological importance, reservoir water quality remains vulnerable to seasonal fluctuations, anthropogenic pollution, and nutrient enrichment. The present study evaluates the physico-chemical characteristics and plankton community structure of Markandeya Dam, Kolar District, Karnataka, India, across pre-monsoon, monsoon, and post-monsoon seasons from February to July 2025. Phytoplankton (22 taxa) and zooplankton (14 taxa) were enumerated and subjected to nine diversity indices. A Water Quality Index (WQI) computed via the Weighted Arithmetic Index method yielded a value of 46.57, classifying the reservoir as moderately polluted. Nygaard's Water Quality Indices (NWQI) further indicated a mesotrophic trophic status. Most physico-chemical parameters conformed to WHO and BIS drinking-water standards; however, dissolved oxygen variability and elevated faecal coliform counts signal localized organic pollution and microbial contamination risks. Shannon–Wiener diversity indices for both phytoplankton (H' = 0–1.45) and zooplankton (H' = 0–0.92) indicated moderate pollution, with dominance by Chlorophyceae and Monogononta rotifers, respectively. Seasonal patterns revealed higher diversity and species richness during cooler pre-monsoon months and greater dominance during warm transitional periods. The integration of WQI, NWQI, and multi-index plankton assessment constitutes a robust and replicable framework for the ecological monitoring and sustainable management of tropical reservoir ecosystems.

Keywords: Physico-chemical parameters; Water Quality Index; Nygaard's Water Quality Indices; Phytoplankton diversity; Zooplankton community; Mesotrophic reservoir; Kolar District; Karnataka

INTRODUCTION

Water is fundamental to life, shaping public health, economic productivity, and the structural integrity of natural ecosystems. Although approximately 71% of the Earth's surface is covered by water, only a minute fraction exists as accessible freshwater, rendering inland water bodies of exceptional ecological and socio-economic significance (Miller & Lake, 2014). Reservoirs and dam systems are engineered freshwater ecosystems that simultaneously serve as water-supply infrastructure and as habitats for diverse aquatic communities. They regulate streamflow, recharge groundwater, support irrigation, enable hydropower, and provide recreational and cultural services (Johnson & Wang, 2020).

Despite these multifaceted services, reservoirs are susceptible to a range of stressors that progressively degrade water quality and ecological function. Anthropogenic pressures—including agricultural runoff carrying nutrients and pesticides, untreated sewage discharge, land-use change in catchment areas, and increasing human water demand—exacerbate natural seasonal fluctuations in temperature, precipitation, and nutrient dynamics (Chen *et al*., 2021; Smith *et al*., 2018). The cumulative outcome is nutrient loading, eutrophication, dissolved-oxygen depletion, and microbial contamination, all of which compromise the use of reservoir water for drinking, fisheries, and agriculture.

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Plankton communities are sensitive ecological indicators of water quality and trophic status. Phytoplankton—comprising diatoms, green algae, cyanobacteria, and dinoflagellates—occupy the base of the aquatic food web and mediate oxygen production and carbon cycling (Falkowski & Raven, 2007).

Zooplankton link primary producers to higher trophic levels and modulate phytoplankton biomass through grazing pressure (Balseiro *et al*., 2023; Mohammed *et al*., 2023). The composition and diversity of both groups respond rapidly to environmental perturbations, making them ideal biomonitors (Kour *et al*., 2022; Enawgaw *et al*., 2023).

The Water Quality Index (WQI) is a widely adopted aggregation tool that distils multiparametric physico-chemical data into a single dimensionless score, facilitating public communication and decision-making (Horton, 1965).

Nygaard's Water Quality Indices (NWQI) complement WQI by providing a phytoplankton-based assessment of trophic state (Hutchinson, 1967, after Nygaard, 1949). Together, these frameworks deliver a comprehensive picture of reservoir health that neither chemical nor biological approaches achieve in isolation.

Regional studies have documented varied water quality conditions in South Indian reservoirs. Manjare et al. (2010) characterised the physico-chemistry of Tamdalge tank in Maharashtra, while Basavaraj and Kadadevaru (2024) evaluated physico-chemical parameters and zooplankton in Gopalaswamy tank, Chitradurga. Asulabha et al. (2022) catalogued phytoplankton diversity across Bangalore lakes, identifying 58 genera.

Farnaz and Rahmatullah (2021) and Garg (2022) have similarly characterised water quality in Bihar and Haryana ponds, respectively, using physico-chemical indices. However, Markandeya Dam—a historically significant irrigation and water-supply reservoir in Kolar District, Karnataka—remains poorly characterised with respect to integrated biological and chemical monitoring.

The present study therefore aims to: (i) characterise seasonal variation in physico-chemical water quality across pre-monsoon, monsoon, and post-monsoon periods; (ii) assess phytoplankton and zooplankton community structure and diversity; (iii) determine the Water Quality Index and Nygaard trophic classification; and (iv) identify monitoring and management priorities for sustainable utilisation of the reservoir's water resources.

Description of the Study Area

Markandeya Dam is situated at geographic coordinates 16°2'0" N, 74°38'30" E, near Budikote village in Malur Taluk, Kolar District, Karnataka, India (Fig. 1).

Constructed between 1936 and 1940, the dam impounds the Markandeya River, which bifurcates in the vicinity of the structure. The crest elevation is 30 m, the dam wall extends 750 m in length, and the surrounding terrain lies at an average elevation of approximately 794 m above mean sea level.

The reservoir has a storage capacity of 553.61 TMC ft and drains a catchment area of approximately 19.71 km². It was constructed at a project cost of Rs. 43.20 crore with the primary objective of supplying potable and irrigation water to 184 villages in Bangarpet Taluk via a 14 km pipeline extending to Tekal village.

The region experiences a semi-arid tropical climate characterised by a hot dry season (March–May), a southwest monsoon (June–September), and a mild post-monsoon winter (October–February), with mean annual rainfall of approximately 750 mm.

The dam's catchment is predominantly agricultural, with crops of ragi, groundnut, and vegetables. Human settlements, livestock grazing, and the absence of a buffer zone around the reservoir margin render the water body vulnerable to non-point-source pollution. The study was conducted at a single representative sampling station located near the dam wall at a depth of 0.5–1.0 m, representing the principal water abstraction zone.

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Figure : 1 – Location map of Markandeya Dam.

MATERIALS AND METHODS

Sample Collection and Preservation — Physico-chemical Analysis

Water samples were collected monthly from February to July 2025, covering post-monsoon (February), early pre-monsoon (March–May), onset of monsoon (June), and mid-monsoon (July) periods. Surface grab samples were collected at 0.5 m depth between 08:00 and 09:00 h using acid-washed 1 L polyethylene containers. All containers were pre-rinsed three times with sample water prior to collection. Samples were labelled with site, date, and time to prevent misidentification. Temperature and pH were measured in situ using a calibrated mercury glass thermometer and a portable digital pH meter (±0.01 unit resolution), respectively. Remaining samples were transported on ice to the laboratory and analysed within 24 h following the Standard Methods for the Examination of Water and Wastewater (APHA, 2005).

Parameters determined in the laboratory included total dissolved solids (TDS; gravimetric method), electrical conductivity (EC; conductivity bridge), dissolved oxygen (DO; Winkler's iodometric titration), biochemical oxygen demand (BOD; 5-day BOD test at 20°C), chemical oxygen demand (COD; dichromate reflux method), chloride (argentometric titration), total alkalinity (titrimetric method), total hardness (EDTA complexometric titration), phosphate (molybdenum blue spectrophotometric method), nitrate (UV spectrophotometry at 220 nm), sulphate (barium sulphate turbidimetric method), and faecal coliform (membrane filtration technique). All reagents were of analytical grade.

Sample Collection and Preservation — Plankton Analysis

Plankton samples were collected concurrently with physico-chemical samples. Qualitative and quantitative phytoplankton samples were collected using a 25 µm mesh plankton net via both vertical and horizontal hauls. For quantitative enumeration, unconcentrated phytoplankton samples were collected from beneath the surface at 0.5 m depth, while zooplankton samples were obtained at 1.0 m depth. All plankton samples were preserved immediately in Lugol's iodine solution (1% final concentration). Plankton cells and organisms were counted under a compound microscope using a Sedgwick-Rafter (S-R) counting cell. Identification to genus and species level was conducted following APHA (2005) standard taxonomic keys.

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Statistical and Index Analyses

Physico-chemical data were analysed using SPSS v. 16.0 (SPSS Inc., Chicago, IL, USA). Pearson's correlation coefficients (r) were computed to evaluate pairwise relationships among the 15 parameters. The Water Quality Index (WQI) was determined following the Weighted Arithmetic Index (WAI) method of Horton (1965), comprising four steps: (i) parameter selection, (ii) sub-index (Q-value) generation, (iii) weight factor (Wi) assignment, and (iv) aggregation to a composite WQI score. The trophic status of the reservoir was determined using Nygaard's Composite Quotient and associated algal indices (Hutchinson, 1967, after Nygaard, 1949).

Plankton diversity was characterised using nine indices computed in PAST v. 4.0 (Hammer et al., 2001): Shannon–Wiener diversity index (H'), Simpson's diversity index (1 – D), Pielou's evenness (J'), Dominance index (D), Menhinick's richness index, Margalef's richness index, Fisher's alpha index, and the Berger–Parker dominance index. Water quality interpretation of H' values followed the classification of Wilhm and Dorris (1968): $H' > 3$ = clean water; $1 \leq H' \leq 3$ = moderate pollution; $H' < 1$ = heavy pollution.

RESULTS

Physico-chemical Parameters

Monthly variation in the 15 physico-chemical parameters measured from February to July 2025 is presented in Table 1. Atmospheric temperature ranged from 28.0°C to 29.0°C (mean 28.73 ± 0.40°C), reflecting the consistently warm tropical climate of the study region. Water temperature tracked atmospheric temperature closely, ranging from 26.0°C to 30.5°C (mean 27.83 ± 1.91°C); peak values in April–May are consistent with pre-monsoon solar heating, while monsoon season values (June–July) were moderated by cloud cover and rainfall. These temperature ranges are within the tolerance limits of most tropical freshwater organisms.

Water pH fluctuated between 6.0 (May) and 8.0 (June) with a mean of 7.00 ± 0.70, spanning near-neutral to slightly alkaline conditions. All values fell within the BIS permissible range (6.5–8.5) for drinking water, indicating adequate buffering capacity. TDS ranged from 248 to 289 mg/L (mean 272.50 ± 16.40 mg/L), substantially below the BIS acceptable limit of 500 mg/L, affirming low mineralisation and good palatability. Electrical conductivity (EC) ranged from 370.14 to 431.34 µS/cm (mean 406.71 ± 24.49 µS/cm), commensurate with the TDS values and consistent with freshwater systems of low ionic strength.

Dissolved oxygen (DO) exhibited the greatest variability of any parameter, ranging from 1.0 mg/L (July) to 10.4 mg/L (May), with a mean of 4.06 ± 3.34 mg/L. Values below 4 mg/L, observed in February and July, represent hypoxic conditions that can compromise aerobic aquatic life; the peak in May likely reflects intense algal photosynthesis during a bloom event. BOD ranged from 1.0 to 4.4 mg/L (mean 2.46 ± 1.16 mg/L), indicating moderate biodegradable organic loading. COD showed wider fluctuation (1.6–25.6 mg/L; mean 11.73 ± 8.56 mg/L), with the February peak (25.6 mg/L) suggesting elevated non-biodegradable organic or chemical inputs during the post-monsoon residual period.

Chloride concentrations were low (48–60 mg/L; mean 55.16 ± 4.66 mg/L), well within the BIS limit of 250 mg/L, ruling out significant saline or sewage influence on ion balance. Total alkalinity exhibited the highest coefficient of variation of all parameters (range: 8–348 mg/L; mean 123.66 ± 122.66 mg/L), with the June peak (348 mg/L) likely reflecting concentration of bicarbonates from catchment weathering following the onset of monsoon inflow. Total hardness ranged from 28 to 204 mg/L (mean 76.33 ± 67.85 mg/L), indicative of soft to moderately hard water. Phosphate concentrations remained low (0.0–1.0 mg/L; mean 0.41 ± 0.37 mg/L), as did nitrate (0–10 mg/L; mean 2.50 ± 4.18 mg/L)—both well below WHO thresholds. Sulphate ranged from 8 to 26 mg/L (mean 19.00 ± 7.01 mg/L), far below the BIS acceptable limit of 200 mg/L.

Faecal coliform counts ranged from 126 to 450 cfu/100 mL (mean 297.33 ± 106.48 cfu/100 mL). These levels substantially exceed the WHO guideline of 0 cfu/100 mL for drinking water and 100 cfu/100 mL for recreational use, indicating significant faecal contamination attributable to open defecation, livestock watering, and surface runoff from agricultural fields in the catchment.

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Table : 1 - Monthly variation in physico-chemical parameters of Markandeya Dam, Kolar District, Karnataka (February–July 2025).

Sl. No.	Parameter	Feb	Mar	Apr	May	Jun	Jul	Max	Min	Mean ± SD
1	Atm. Temperature (°C)	28.5	29.0	29.0	29.0	28.9	28.0	29.0	28.0	28.73 ± 0.40
2	Water Temperature (°C)	26.0	26.5	30.0	30.5	27.0	27.0	30.5	26.0	27.83 ± 1.91
3	pH	7.5	6.5	7.0	6.0	8.0	7.0	8.0	6.0	7.00 ± 0.70
4	TDS (mg/L)	286	278	289	277	248	257	289	248	272.50 ± 16.40
5	EC (µS/cm)	426.9	414.9	431.3	413.4	370.1	383.6	431.3	370.1	406.71 ± 24.49
6	DO (mg/L)	1.8	4.0	4.2	10.4	3.0	1.0	10.4	1.0	4.06 ± 3.34
7	BOD (mg/L)	2.6	2.4	1.0	4.4	2.8	1.6	4.4	1.0	2.46 ± 1.16
8	COD (mg/L)	25.6	9.6	9.6	1.6	6.4	17.6	25.6	1.6	11.73 ± 8.56
9	Chloride (mg/L)	60	60	55	56	52	48	60	48	55.16 ± 4.66
10	Total Alkalinity (mg/L)	106	80	8	36	348	164	348	8	123.66 ± 122.66
11	Total Hardness (mg/L)	42	102	28	46	204	36	204	28	76.33 ± 67.85
12	Phosphate (mg/L)	0.5	0.5	0.5	0.0	1.0	0.0	1.0	0.0	0.41 ± 0.37
13	Nitrate (mg/L)	0.0	10.0	0.0	5.0	0.0	0.0	10.0	0.0	2.50 ± 4.18
14	Sulphate (mg/L)	20	26	26	8	14	20	26	8	19.00 ± 7.01
15	Faecal Coliform (cfu/100 mL)	450	320	260	342	126	286	450	126	297.33 ± 106.48

Biostatistical (Correlation) Analysis

Pearson's correlation matrix revealed several ecologically meaningful parameter relationships. A significant positive correlation between water temperature and DO (r = 0.631) suggests that photosynthetic oxygen production by phytoplankton, rather than physical dissolution, governs DO during warmer months. The positive pH–COD correlation (r = 0.423) implies that organic matter decomposition under alkaline conditions drives chemical oxygen demand. The positive COD–sulphate association (r = 0.426) may reflect anaerobic sulphate reduction mediated by organic substrates during stratification.

Strong negative correlations were observed for pH–nitrate (r = −0.676) and pH–DO (r = −0.720), indicating that elevated biological activity and carbon dioxide production during algal blooms can suppresses pH while concurrently depleting dissolved oxygen. The positive DO–nitrate correlation (r = 0.444) is consistent with nitrification processes that occur

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under aerobic conditions. The total hardness–phosphate correlation (r = 0.588) likely reflects geochemical co-leaching of calcium, magnesium, and phosphorus from catchment soils during high-intensity monsoon rainfall events.

Water Quality Index (WQI)

The WQI was computed for seven key parameters using the Weighted Arithmetic Index method; results are summarised in Table 2. The water quality index (WQI) was calculated using weighted arithmetic index (WAI) approach (refer equation 1,2 and 3). The objective of water quality index was originally proposed by Horton (1965). A commonly-used water quality index (WQI) was developed by the National Sanitation Foundation (NSF) in 1970 (Brown *et al*. 1970). Parameters as dissolved oxygen, fecal coliforms, pH, biological oxygen demand, phosphate, nitrate and total dissolved solids were recognized as preliminary indication of quality as is used in calculating quality index. In the present study the composite WQI score of 46.57 classifies the reservoir as 'moderately polluted' water.

Table : 2 - Water Quality Index (WQI) determination for Markandeya Dam, Kolar District, Karnataka (Weighted Arithmetic Index method; Horton, 1965).

Sl. No.	Parameter	Unit	Estimated Value (Mi)	Q-Value (Qi)	Weight Factor (Wi)	WiQi	WQI
1	DO	mg/L	4.006	124.175	0.166	20.613	46.57 (Moderate)
2	Faecal Coliform	cfu/100 mL	297.33	235.900	0.0079	1.864	
3	pH	—	7.000	0.000	0.105	0.000	
4	BOD	mg/L	2.46	41.000	0.166	6.806	
5	Phosphate	mg/L	0.41	8.200	0.200	1.640	
6	Nitrate	mg/L	2.50	5.550	0.022	0.122	
7	TDS	mg/L	272.5	54.500	0.002	0.109	

$\sum Wi = 0.668$ $\sum WiQi = 31.154$

$$Q_i = \frac{M_i - I_i}{S_i - I_i} \times 100 \qquad (1)$$

Where : Q_i = quality rating corresponding to the i^{th} parameter is a number reflecting the relative value of the parameter, M_i = estimated values of the parameters in the laboratory, I_i = Ideal values of the i^{th} parameter (ideal values are taken as zero except for pH = 7 and DO =14) and S_i = standard values of the i^{th} parameter.

$$W_i = k \qquad (2)$$

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S_i

Where : W_i = unit weight ; k = 1 ; S_i = recommended standards of the corresponding parameter .

$$WQI = \frac{\sum W_i Q_i}{\sum W_i} \qquad (3)$$

Where : WQI = the overall water quality index.

Table : 3 - Correlation of physico-chemical parameters in Markandeya Dam during Feb-July 2025

	AT	WT	pH	TDS	EC	DO	BOD	COD	Chloride	TA	TH	Phosphate	Nitrate	Sulphate	FC
AT	1	.469	-.242	.334	.334	.631	.323	-.701	.532	-.215	.323	.412	.468	-.070	-.220
WT		1	-.554	.312	.312	.777	.203	-.667	-.108	-.523	-.354	-.370	.000	-.328	-.117
pH			1	-.431	-.431	-.720	-.365	.423	-.242	.749	.534	.751	-.676	.121	-.401
TDS				1	1.000**	.268	-.092	.191	.736	-.885*	-.675	-.219	.226	.391	.703
EC					1	.268	-.092	.192	.736	-.885*	-.675	-.219	.226	.391	.704
DO						1	.723	-.755	.248	-.435	-.119	-.345	.444	-.591	.083
BOD							1	-.428	.270	.057	.211	-.167	.370	-.843*	.182
COD								1	.117	.004	-.357	-.033	-.402	.426	.558
Chloride									1	-.472	-.110	.180	.538	.226	.610
TA										1	.835*	.588	-.341	-.291	-.646
TH											1	.777	.074	-.226	-.709
Phosphate												1	-.159	.189	-.511
Nitrate													1	.102	.202
Sulphate														1	.108
FC															1

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

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

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Table : 4 - The rating of the Trophic state Indices of Nygaard's is presented below:

4.4 Phytoplankton Community and Diversity

A total of 22 phytoplankton taxa were identified from Markandeya Dam across the study eperiod. The taxonomic composition was dominated by Chlorophyceae (10 taxa), followed by Cyanophyceae (3 taxa), Bacillariophyceae (2 taxa), Zygnematophyceae (1 taxon), Oligohymenophora (1 taxon), Tubulinea (1 taxon), Ulvophyceae (2 taxa), Dinophyceae (1 taxon), and Chrysophyceae (1 taxon). The percentage composition of the phytoplankton groups are shown in Figure : 2.

Phytoplankton diversity indices revealed pronounced seasonality. The Shannon–Wiener index (H') peaked at 1.45 in February (moderate pollution) and fell to 0 in June (heavy pollution), indicating low diversity. The Dominance index reached 1 in May, corresponding to a near-monoculture bloom, while the Berger–Parker index confirmed that a single taxon constituted 50–100% of the community depending on season. Margalef's richness was highest in February (1.35) and collapsed to 0 in May, consistent with bloom-induced competitive exclusion of minor taxa. Fisher's alpha was highest in Feb (1.8). Collectively, the indices indicate pre-monsoon as the period of highest ecological resilience and monsoon-onset as a period of ecological stress or bloom disturbance.

Asulabha et al. (2022) reported 58 phytoplankton genera across Bangalore lakes, indicating substantially higher regional phytoplankton richness than observed in Markandeya Dam (22 taxa). The comparatively lower richness in the present study may reflect the semi-arid location of Kolar District and the relatively shallow, fluctuating nature of the reservoir.

Table : 5 - Diversity index of Phytoplankton Group in Markandeya dam during Feb –July 2025

	Feb	**March**	**April**	**May**	**June**	**July**
Taxa_S	7	6	5	1	3	3
Individuals	85	105	117	68	102	132
Dominance_D	0.3188	0.3968	0.3927	1	0.5002	0.5005
Shannon_H	1.456	1.152	1.125	0	0.7563	0.7773
Simpson_1-D	0.6812	0.6032	0.6073	0	0.4998	0.4995
Evenness_e^H/S	0.6124	0.5275	0.6159	1	0.7101	0.7252
Menhinick	0.7593	0.5855	0.4623	0.1213	0.297	0.2611
Margalef	1.351	1.074	0.84	0	0.4324	0.4096
Equitability_J	0.748	0.6431	0.6988		0.6884	0.7075
Fisher_alpha	1.808	1.381	1.061	0.1662	0.5796	0.5463
Berger-Parker	0.5059	0.5238	0.5128	1	0.5882	0.6061

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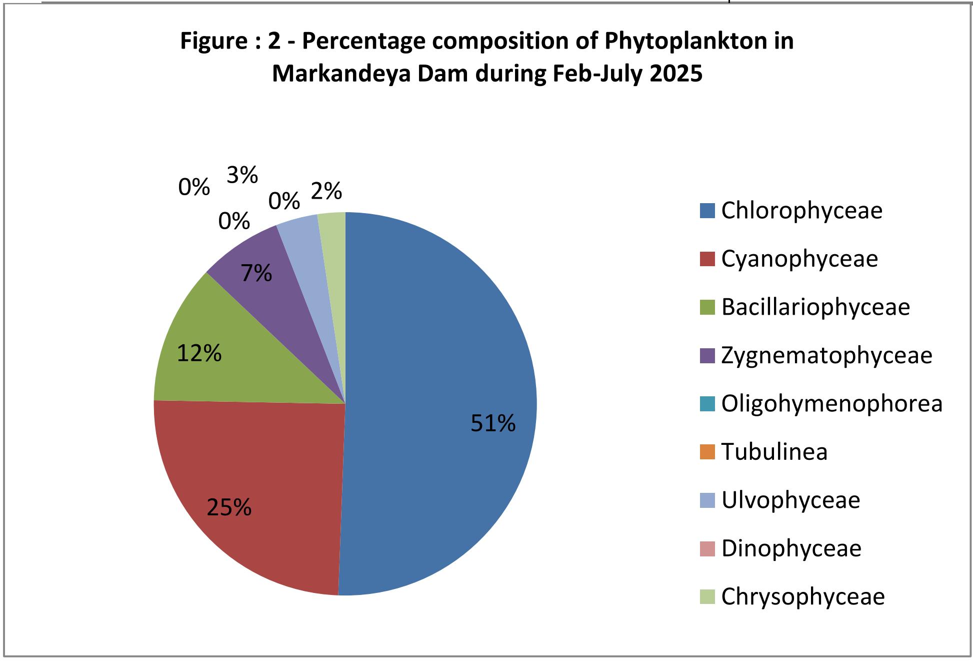

Zooplankton Community and Diversity

Fourteen zooplankton taxa were identified, with a community heavily dominated by Monogononta rotifers (7 taxa; 77% of total taxa), including Brachionus calyciflorus and Keratella cochlearis as codominant species. Additional groups comprised Eurotatoria (3 taxa; 14%), Maxillopoda copepods (3 taxa; 5%), and Crustacea (1 taxon; 8%). The predominance of hardy, pollution-tolerant rotifers is characteristic of eutrophic or anthropogenically stressed freshwater systems in which rapid rotifer reproduction confers a competitive advantage over more sensitive crustacean zooplankton (Kour et al., 2022; Enawgaw et al., 2023).

Zooplankton Shannon–Wiener diversity was consistently low (H' = 0.25–0.92), peaking in April (H' = 0.92) and falling to its lowest in May (H' = 0.25). Dominance was complete in February and March (Dominance index = 1.0; Berger–Parker index = 1.0), consistent with single-species rotifer dominance during cooler, drier conditions. The Margalef index increased from 0 in February–March to 0.70 in July, suggesting monsoon-driven recruitment of taxa from inflowing streams. These patterns parallel those of phytoplankton and reinforce the narrative of seasonal community restructuring driven by temperature, hydrology, and trophic dynamics.

Numerous investigations have demonstrated the utility of zooplankton as ecological and water quality indicators in tropical reservoirs (Imoobe & Akoma, 2008; Beyene et al., 2022; Ginatullina et al., 2023; Oh et al., 2023; Ndah et al., 2022; Rashid & Prakash, 2022). The present findings corroborate this body of evidence: low zooplankton diversity, rotifer dominance, and depressed crustacean presence collectively signal moderate ecological stress and water quality degradation in Markandeya Dam.

	Feb	March	April	May	June	July
Taxa_S	1	1	3	2	3	4
Individuals	2	10	34	28	69	70
Dominance_D	1	1	0.455	0.8673	0.5026	0.5751
Shannon_H	0	0	0.9291	0.2573	0.8596	0.8449
Simpson_1-D	0	0	0.545	0.1327	0.4974	0.4249
Evenness_e^H/S	1	1	0.8441	0.6467	0.7874	0.5819

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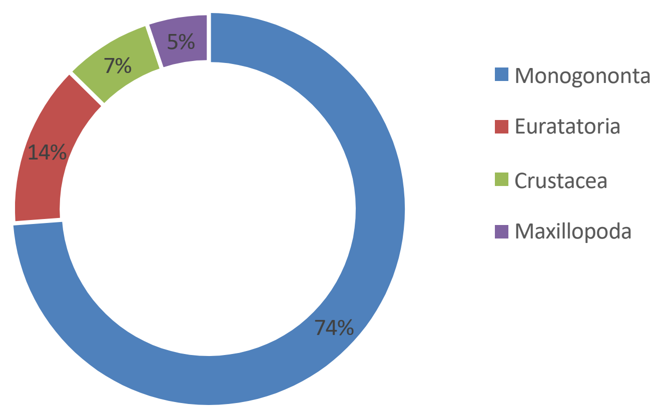
Menhinick	0.7071	0.3162	0.5145	0.378	0.3612	0.4781
Margalef	0	0	0.5672	0.3001	0.4724	0.7061
Equitability_J	0	0	0.8457	0.3712	0.7825	0.6095
Fisher_alpha	0.7959	0.2766	0.7935	0.493	0.6396	0.9208
Berger-Parker	1	1	0.6176	0.9286	0.6667	0.7429

Table : 6 - Diversity indices of Zooplankton group in Markandeya Dam during Feb-July 2025

Figure : 3 - Percentage composition of Zooplankton In Markandeya Dam during Feb-July s2025



DISCUSSION

The physico-chemical profile of Markandeya Dam broadly conforms to acceptable standards for freshwater reservoirs in tropical India, with most parameters within BIS and WHO limits. The reservoir can be characterised as a low-mineralisation, near-neutral to slightly alkaline system with moderate organic loading—a profile consistent with its semi-arid, largely agricultural catchment. However, several parameters warrant management attention.

Dissolved oxygen variability (1.0–10.4 mg/L) is the most ecologically critical finding from the physico-chemical survey. Hypoxic conditions (<4 mg/L) in February and July likely reflect decomposition of accumulated organic matter during post-monsoon stagnation and monsoon-onset stratification, respectively. Such conditions can trigger fish kills, promote anaerobic decomposition pathways, and release sediment-bound phosphorus, potentially triggering internal nutrient loading and accelerating eutrophication—a feedback loop widely documented in shallow tropical reservoirs (Johnson & Wang, 2020).

Faecal coliform counts exceeding 126–450 cfu/100 mL represent the most acute water quality concern for human health. These values indicate persistent faecal contamination exceeding WHO recreational and drinking-water guidelines by 1–2 orders of magnitude. The contamination pathway is most plausibly diffuse: open defecation and livestock access to the reservoir margin, combined with surface runoff from periurban agricultural areas. Without source-control interventions, the dam water requires multi-barrier treatment (coagulation, filtration, and chlorination) prior to domestic use.

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The WQI value of 46.57 is situated in the 'moderately polluted' band (26–50), confirming that the reservoir is not pristine but retains ecological and utilitarian value. Nygaard's trophic indices, corroborated by Chlorophyceae dominance and cyanobacterial co-occurrence in phytoplankton, consistently classify the reservoir as mesotrophic. Mesotrophy represents a transitional trophic state that, under continued nutrient loading, may shift toward eutrophy—a trajectory observed in many peri-urban South Indian reservoirs (Asulabha et al., 2022). The integrated WQI–NWQI framework provides a more complete assessment than either approach in isolation, as WQI captures chemical hazards and NWQI reflects biological nutrient status.Bloom-forming cyanobacteria produce cyanotoxins that are hazardous to livestock, fish, and humans and are resistant to conventional water treatment (Falkowski & Raven, 2007).

Zooplankton rotifer dominance and suppression of cladocerans and copepods—the primary phytoplankton grazers—signal a trophic cascade that may reduce top-down control of algal biomass. In less-disturbed oligotrophic to mesotrophic systems, cladocerans such as Daphnia provide substantial phytoplankton grazing pressure; their absence or scarcity in Markandeya Dam may allow phytoplankton biomass to accumulate unchecked during nutrient-rich monsoon periods. Restoring zooplankton community structure through reduction of anthropogenic nutrient loading could therefore yield co-benefits for algal control.

The seasonal pattern of increasing diversity in February (pre-monsoon winter) and declining diversity in May–June (hot season and monsoon onset) is consistent with the intermediate disturbance hypothesis, under which intermediate levels of physical disturbance (thermal mixing in winter) promote coexistence, while thermal stratification and bloom events suppress it. This pattern has ecological management implications: pre-monsoon monitoring windows capture maximum biodiversity and therefore offer the most sensitive baseline for detecting chronic pollution impacts.

CONCLUSION

This study provides the first comprehensive integrated assessment of water quality and plankton biodiversity in Markandeya Dam, Kolar District, Karnataka. The principal conclusions are as follows:

(1) Most physico-chemical parameters conform to BIS and WHO standards, supporting the reservoir's potential for irrigation and treated drinking water supply; however, dissolved oxygen variability and elevated faecal coliform counts (297.33 ± 106.48 cfu/100 mL) indicate persistent organic pollution and microbial contamination that require immediate remediation.

(2) A composite WQI of 46.57 classifies Markandeya Dam as moderately polluted water. Nygaard's trophic assessment categorises the reservoir as mesotrophic, with a risk of eutrophication progression under continued anthropogenic pressure.

(3) Twenty-two phytoplankton and 14 zooplankton taxa were recorded. Shannon diversity indices (H' = 0–1.45 and H' = 0–0.92, respectively) and taxonomic composition confirm moderate pollution conditions, with Chlorophyceae and Monogononta rotifers as diagnostic dominants.

(4) Seasonal diversity maxima in February and minima in May–June reflect the interplay of temperature, thermal stratification, and bloom dynamics, with pre-monsoon periods providing the most sensitive monitoring window.

(5) The concurrent application of WQI, NWQI, and multi-index plankton biodiversity assessment constitutes a replicable, cost-effective framework for the ecological surveillance and sustainable management of tropical dam reservoirs.

Management recommendations include: installation of riparian buffer strips to intercept agricultural runoff; prohibition of livestock access to the reservoir margin; construction of community sanitation facilities in surrounding villages; regular cyanotoxin monitoring during pre-monsoon bloom periods; and long-term quarterly monitoring to detect trophic trajectory shifts. Future investigations should extend the sampling period to a full hydrological year,

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incorporate sediment nutrient analysis, and employ molecular (metabarcoding) approaches to enhance taxonomic resolution of the plankton community.

Declarations

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Conflicts of Interest

The authors declare no conflicts of interest.

Author Contributions

Gayathri S.: Conceptualisation, Methodology, Formal Analysis, Writing — Original Draft. Tejushree H. S.: Sample Collection, Laboratory Analysis. Yashaswini R.: Data Curation, Validation. Shashikumar C.: Supervision, Shravani. K. Writing — Review and Editing.

Data Availability Statement

The datasets generated and analysed during the current study are available from the corresponding author upon reasonable request.

Ethical Approval

This study involved water and plankton sample collection from a public reservoir and did not involve vertebrate animals requiring ethical committee approval. Field sampling was conducted in compliance with local environmental regulations.

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