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Water quality status of Warwand reservoir of Daund Tahsil of Maharashtra

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Abstract
The reservoirs are an invaluable freshwater source for drinking water supply, irrigation, electricity generation and aquatic animals. Currently, it has become vulnerable to degradation due to human activities, natural calamities and climate change. The present study has investigated the physicochemical properties of the Warwand reservoir located in the Pune district of Maharashtra. The water samples were collected from three selected sites between period February 2022 and January 2023 followed by physicochemical analysis for selected parameters including pH, temperature, electrical conductivity, dissolved oxygen, phosphate and nitrate concentrations. The analysis revealed high seasonal variations with higher temperature, electrical conductivity and phosphate levels in the summer season may be attributed to high mineralization. The monsoon season reported the dilution effect while the winter season showed a higher dissolved oxygen level. This study highlighted the significant influence of seasonal dynamics on water quality and provided a baseline for planning of management and conservation strategies.

Keywords: Reservoir, physicochemical analysis, seasonal variation, warwand reservoir, etc

Introduction

The reservoirs are an invaluable freshwater source for drinking water supply, irrigation, electricity power plants and aquatic life (Amrita *et al*., 2024) [1]. Currently, such important resources are becoming more vulnerable due to increased anthropogenic activities, natural disasters and climate change which lead to a reduced water quality (Jadhav *et al*., 2022) [8]. Also, the bioaccumulation of heavy metals has become a serious issue for major aquatic bodies especially well known fishery sites (Chordiya and Chandanshive, 2023) [3, 4]. This degradation is commonly associated with changes in the physicochemical characteristics of the reservoir including important parameters such as pH, dissolved oxygen, temperature, turbidity and nutrient concentrations like nitrates and phosphates. They not only indicate the current status of the reservoir but also help in detecting sources of pollution, predicting ecological changes and ensuring the survival of aquatic animals. A small change in these parameters can have large consequences leading to algal blooms, the death of aquatic animals and reduced water utility (Reddy and Parameshwar, 2016) [12]. Such analysis provides a fundamental basis for the enforcement of water management strategies.

Although there are few reports available on the water quality status of nearby water bodies from the Pune district of Maharashtra, the work on the Warwand reservoir has not been studied (Kamble *et al*., 2008; Jadhav and Khare,2010; Shaikh *et al*., 2013; Sonawane, 2019; Jadhav *et al*., 2022; Nigam, 2022; Thorat and Dandawate, 2024; Ghule *et al*., 2023; Deb *et al*., 2023; Chordiya and Chandanshive, 2023; Raut *et al*., 2025) [3, 4, 5, 6, 7, 8, 9, 10, 11, 13, 14, 15]. The present study has been conducted on the physicochemical analysis of the Warwand reservoir in order to gain insights into the current health status and seasonal changes for the productivity of the reservoir.

Methodology

a. Site selection: The Warwand reservoir has been selected as a study site for the current work. It is situated in the Warwand village of the Pune district of Maharashtra at 18°43'26" N latitude and 74°40'93" E longitude. It is the largest reservoir and major fishery site in the Daund Tahsil of Maharashtra, built in 1876 in the British era and distributed over 310 acres of land with a storage capacity of 200 million cubic feet. Also, the Irrigation Department supplies water to Kurkumbh MIDC, Janai-Shirsai Scheme and Winery Project of Roti from this lake. This lake is filled through the Khadakwasla Dam Canal and after filling the lake, water is supplied according to the requirement.

b. Sample collection and analysis: Water samples were collected from three sites of the study area between February 2022 and January 2023. The samples were analyzed in triplicate for different physicochemical parameters including temperature, pH, turbidity, electrical conductivity, dissolved oxygen, phosphate and nitrate. All the analysis was carried out by standard methods of Trivedy and Goel (1986) and APHA (2017) [2]. The temperature was measured using glass thermometer having range between 0 to 50^{0}C. The pH was measure using digital pH meter. The turbidity was measured using Nephelometer. The electrical conductivity was measured using conductivity meter. The dissolved oxygen was measured by wrinkle method. The phosphate was analyzed by Vanadomolybdophosphoric acid colorimetric method (4500-P C). The nitrate was analyzed by UV spectrophotometric screening method (4500-NO_3^- B). The statistical data analysis was performed using PAST Version 4.2 software. All the values were in Mean ± SE.

Results

The water temperature was recorded in a range between 21.83°C and 27.70°C with a maximum value of 27.70°C in July and a minimum value of 21.83°C in December. The higher values noticed during the summer season with mean of 26.28 ± 0.31°C, while the lower during the winter season with a mean of 22.01 ± 0.13°C (Table-1).

The pH was ranged between 7.43 and 8.36 with a maximum value of 8.36 in August and a minimum value of 7.43 in February. The winter season reported higher values with mean of 8.26 ± 0.02, while the lower during the summer season with a mean of 7.71 ± 0.13 (Table-1).

The turbidity was reported in a range between 0.27 NTU and 1.10 NTU. The maximum value of 1.10 NTU noticed in February while minimum value of 0.27 NTU in August. The higher values were noticed during the summer season with mean of 0.76 ± 0.16 NTU, while the lower during the monsoon season with a mean of 0.45 ± 0.07 NTU (Table-1).

The electrical conductivity was ranged within 60.67 to 186.67 µS/cm. The maximum value 186.67 µS/cm was noticed in March and a minimum 60.67 µS/cm in August. The higher values noticed during the summer season with mean of 179.08 ± 3.38 µS/cm, while the lower during the monsoon season with mean of 72.33 ± 7.60 µS/cm (Table-1).

The dissolved oxygen was ranged between 5.07 mg/l to 7.30 mg/l. The maximum value 7.30 mg/l noticed in January and minimum value of 5.07 mg/l in May. The winter season reported the higher values with mean of 7.17 ± 0.07 mg/l, while the lower during the summer season with a mean of 5.58 ± 0.20 mg/l (Table-1).

The phosphate recorded in a range between 0.07 mg/l and 0.90 mg/l. The maximum value 0.90 mg/l was noticed in February and minimum 0.07 mg/l in August. The summer season showed higher values with mean of 0.80 ± 0.04 mg/l, while the lower during the winter season with a mean of 0.12 ± 0.01 mg/l (Table-1).

The nitrate was ranged between 4.33 mg/l and 7.84 mg/l. The maximum value 7.84 mg/l was recorded in December and minimum value of 4.33 mg/l in February. The higher values were noticed during the winter season with mean of 7.18 ± 0.55 mg/l, while the lower during the summer season with a mean of 4.80 ± 0.40 mg/l (Table-1).

Table 1: Physicochemical analysis of water of Warwand reservoir (All values are in Mean ± SE)

Parameter	Month											
	February	March	April	May	June	July	August	September	October	November	December	January
Temperature (in °C)	26.60 ± 0.62	26.37 ± 0.28	25.37 ± 0.64	26.77 ± 0.52	27.50 ± 0.47	27.70 ± 0.42	26.67 ± 0.37	26.53 ± 0.03	22.27 ± 0.60	22.27 ± 0.30	21.83 ± 0.58	21.93 ± 0.62
pH	7.43 ± 0.03	7.99 ± 0.07	7.86 ± 0.02	7.58 ± 0.06	8.19 ± 0.03	8.18 ± 0.02	8.36 ± 0.02	7.79 ± 0.14	8.19 ± 0.01	8.25 ± 0.01	8.29 ± 0.06	8.24 ± 0.07
Turbidity (in NTU)	1.10 ± 0.31	0.37 ± 0.09	0.90 ± 0.32	0.67 ± 0.03	0.63 ± 0.12	0.50 ± 0.12	0.27 ± 0.12	0.30 ± 0.10	0.57 ± 0.19	0.63 ± 0.03	0.47 ± 0.15	0.30 ± 0.10
Electrical Conductivity (in µS/cm)	170.33 ± 1.86	186.67 ± 0.33	180.67 ± 0.88	178.67 ± 1.20	64.33 ± 0.33	66.00 ± 0.58	60.67 ± 0.33	68.33 ± 0.33	102.33 ± 0.33	108.33 ± 0.33	126.00 ± 0.58	116.00 ± 0.58
Dissolved Oxygen (in mg/l)	5.73 ± 0.20	6.00 ± 0.10	5.50 ± 0.10	5.07 ± 0.12	6.23 ± 0.12	6.23 ± 0.03	6.17 ± 0.24	6.37 ± 0.30	7.00 ± 0.25	7.10 ± 0.17	7.10 ± 0.23	7.30 ± 0.21
Phosphate (in mg/l)	0.90 ± 0.03	0.71 ± 0.01	0.79 ± 0.04	0.79 ± 0.02	0.29 ± 0.03	0.18 ± 0.01	0.07 ± 0.01	0.13 ± 0.01	0.18 ± 0.03	0.14 ± 0.01	0.11 ± 0.01	0.12 ± 0.01
Nitrate (in mg/l)	4.33 ± 0.14	4.39 ± 0.14	4.51 ± 0.22	5.99 ± 0.15	6.63 ± 0.78	6.99 ± 0.06	7.69 ± 0.09	6.60 ± 0.92	7.60 ± 0.02	7.62 ± 0.01	7.84 ± 0.54	6.09 ± 0.53

Discussion

There are few reports available on physicochemical analysis of different lake and reservoirs across Pune district of Maharashtra. The studies on Khadakwasla reservoir (2005–2006) revealed seasonal variations in parameters like pH, conductivity and dissolved oxygen with some exceeding permissible limits (Kamble *et al*., 2008) [9]. This indicated early signs of pollution. A similar observation was made at Pashan Lake of Pune where siltation reduced lake depth from 30–40 ft in 1980 to 15–20 ft by 2001–02. The increased shallowness led to ecological changes and significant surface water pollution due to surrounding urban discharge (Jadhav and Khare, 2010) [7]. The physicochemical analysis of water in Katraj lake of Pune also noticed similar levels of pH, turbidity and hardness (Shaikh *et al*., 2013) [13]. The Yedgaon Dam area from Junner tahsil reported a pH range between 7.30 and 7.85. The high concentration of nitrate was noticed in the same study indicated the need for continuous monitoring of water bodies (Sonawane, 2019) [14].

The Mula-Mutha River was also exhibited high BOD, COD, chloride and magnesium levels, confirming the effect due to growing urban pollution (Jadhav *et al*., 2022) [8]. In contrast, a more optimistic assessment of Khadakwasla reservoir found that water body was suitable for conservation of the endangered Mahseer fish due to favorable chemical conditions and sufficient food availability (Nigam, 2022) [10]. A study on five stations of Yashwant Sagar backwaters in Karjat and Shrigonda reported that physico-chemical parameters including DO, CO_2 and turbidity were within optimal ranges and suggesting well-maintained water quality (Thorat and Dandawate, 2024) [15].

The Ujani reservoir was also investigated across various locations and seasons and showed that several parameters like turbidity, TDS, BOD, COD and hardness exceeded WHO limits. The primary causes were identified as domestic sewage, industrial effluents and agricultural runoff (Ghule *et al*., 2023) [6]. On the similar plane, other recent study also noted seasonal variations with higher values of total hardness in summer and reduced DO likely due to increased organic load (Chordiya and Chandanshive, 2023) [3, 4]. A study on physicochemical analysis in correlation with aquatic beetles from the Khadakwasla dam also reported that pH was ranged within 7.6 to 8.1 and dissolved oxygen between 5.8 to 6.8 mg/l (Deb *et al*., 2023) [5]. The present work also made similar observations. The Tarangwadi lake of Indapur tahsil also reported fluctuating parameters and was found to all within the permissible limits and showed good water quality (Raut *et al*., 2025) [11]. Similarly the present investigation evaluated seasonal variation among physicochemical parameters and showed a significant change depending on the weather and

hydrological cycle. Temperature was higher in summer due to the presence of more sunlight and less water flow, whereas the lowest values were observed in winter and monsoon, which could be due to carbonate buffering and better photosynthetic performance. The highest turbidity was obtained in summer and this may be attributed to higher evaporation and dissolving of sediments, whereas lower values were obtained during the monsoon as a result of rainwater diluting the water.

Electrical conductivity was maximum in summer which indicated the high concentration of dissolved ions due to evaporation. Monsoon rains decreased conductivity to a large extent. Dissolved oxygen exhibited a low level in summer because of the high temperature and high metabolic activity and the highest level in winter when the cooler conditions were more favorable to oxygen dissolution. Concentrations of phosphates were found to be higher in summer may be due to higher runoff and organic decomposition with low values in winter, indicating that there are lower nutrient inputs. The monsoon and winter had higher nitrate levels, which may be attributed to the agricultural runoff and reduced uptake by aquatic biota due to lower temperatures. The findings investigated that seasonal changes are a major factor in controlling the water quality in both the dynamics of nutrients and ecological balance.

Conclusion

The physicochemical evaluation of water conducted over seasons reported seasonal differences. The temperature was maximum during the summer, whereas pH and dissolved oxygen were maximum during the winter. The summer had higher turbidity and phosphate levels compared to the monsoon which had lower conductivity, turbidity and phosphate levels. The electrical conductivity was higher in the summer representing the elevated ionic concentration and fell drastically during the monsoon. The nitrate concentrations were always higher in the winter and monsoon seasons than in the summer. The study noticed the significant impact of seasonal changes on water quality. The summer season was prone to higher levels of mineralization and nutrient loading. The monsoon was associated with dilution and winter with oxygen enrichment.

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