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# Assessment of Physico-Chemical Parameters using the Water Quality Index of Kotepally Reservoir, Vikarabad District, Telangana State, India

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**Abstract:** The present study evaluated water quality index and the environmental influences on the Kotepalli Reservoir and measured the degree of pollution at various stations. The primary aim of calculating the water quality index was to convert complicated water quality data into clearly comprehensible and useable information. Water samples were taken from the Kotepally Reservoir at the three specified points once every fifteen days. The water samples were analyzed using industry standard procedures at the Water Quality Laboratory. From December 2021 to November 2022, the average outcomes of various parameters were investigated. Pre-monsoon (39.248) at Kotepally check Dam (S1), monsoon (22.37) at Morangapally (S2), and post-monsoon (31.02) at Gangaram indicate statistical average values of Water Quality Index ($\sum Wn \times Qn$). High nitrate ($NO_3^-$) readings identify water quality degradation caused by wastewater runoff into lakes. The minimum "-ve" values are negatively correlated and the minimum "+ve" values are moderately and less positively correlated. The recorded twenty-two water quality parameters were estimated from various sources by using ANOVA to compare the means of six groups. In all seasons, the test statistic F is equal, which is in the 95% area of the acceptability threshold, and the observed effect size f is small. The findings on water quality parameters revealed that the variance in the majority of the parameters is low and within the acceptable limit range.

**Keywords:** Water Quality Index, Monsoon, Post-monsoon, Pre-monsoon, Correlation. ANOVA, $H_0$ hypothesis, F-Statistic

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## Introduction

Water Quality Index (WQI) is a useful technique for assessing water quality by combining numerous water quality measures into a single value. It is one of the most effective methods for communicating water quality information to concerned individuals and policymakers (Pathak, 2020). Water quality index (WQI) is one-of-a-kind number that exposes the state of water by integrating numerous water characteristics such as total hardness, dissolved oxygen, sulphate and nitrate (Uddin *et al.*, 2021). Furthermore, by reducing the aggregate data of numerous water characteristics to a single number, it simplifies and conveys logical data. Water quality evaluation provides thorough information on water supplies as well as contamination risk for diverse purposes such as drinking, agriculture and fishing (Bora, 2017; Tiwari and Tiwari, 2020).

The WQI is a useful tool for assessing reservoir water quality. It contributes in determining the overall state of individual water quality for home use (Khandare *et al.*, 2020). Horton established the notion of depicting water quality status for the first time in 1965 and he later developed a number of water quality indices that may rapidly and reliably estimate a region's total water quality. Later, in 1970, Brown presented the generic WQI, which has now undergone a more sophisticated version that is better suited for a different purpose (Lkr *et al*.,, 2020).

WQI was established to reduce enormous volumes of water quality data into basic words that control and the public can comprehend. Based on multiple water quality parameters, WQI provides a single value that expresses overall water quality at a certain location and time. WQI is a collection of standards used to monitor changes in water quality over time in an acceptable river extent and differentiate between different portions of the river. This indicator provides for a broad study of water quality at various levels, indicating a stream's ability to support life. WQI illustrates the cumulative impact of many water quality metrics and interfaces water quality facts to the public and judiciary ruling. The majority of river regions are continually condensed, potentially as a result of siltation and anthropogenic interference, such as agricultural, industrial, storm water runoff, and eutrophication. The current study intends to measure physicochemical parameters and the water quality index in Kotepally from December 2021 to November 2022. The purpose of this study was to assess the water quality parameter and its relationship with biodiversity indices, which might allow for a wide variety of ecological issues in correlation with ichthyofauna diversity. This research helps with water quality inspections as well as periodic monitoring to limit human activities in this region.

## Materials and Methods

*Study area and sample collection*:

Water samples were drawn from the Kotepally Reservoir at three monitoring locations once every fifteen days from December 2021 to November 2022. Kotepally check Dam 17.349901, 77.748987 (S1), Morangapally 17.378953, 77.739239 (S2) and Gangaram 17.367252, 77.759482 (S3) were chosen as sample locations (Fig. 1).

To minimize the change in chemical composition, all water samples were collected in a clean, sterile polypropylene wide mouth reagent container with a 1 L capacity, delivered to the laboratory and maintained at 40°C. Water samples were analyzed using established procedures at Vasudha Enviro Labs Pvt., Kukatpally, Hyderabad, India. Temperature, pH, Transparency, dissolved oxygen (DO), BOD, COD, Total Hardness, Carbonates, Bicarbonates, $Ca^{2+}$, magnesium (Mg), Ammonia and Nitrites were used to compute water quality index (WQI).

*Water quality index calculation*:

The following methods were used to test the water quality: Winkler's method with azide modification was used to analyze dissolved oxygen; the stannous chloride method was used to estimate phosphates; the total alkalinity of the sample was determined by the standard titrimetric method using phenolphthalein and methyl orange; the total hardness is determined by the EDTA titrimetric method; and and nitrates were estimated by the UV/visible spectroscopy method. ICMR (1975); Brucine method Stojda and Dojlido (1983); Eaton and Clescer (1998); CPHEEO (1991); Bureau of Indian Standards (BIS, 1991); The American Public Health Association (2005);


Fig. 1: Kotepally reservoir (17.3633° N, 77.7481° E).

World Health Organization (2006); and Atef (2015) permissible limits for drinking water quality (Table 1) are compared in these study results.

WQI was calculated with the help of index method (Brown *et al*., 1972). Calculation of WQI was performed by following the weighted arithmetic index method using the equation:

WQI = ∑QiWi/ ∑Wi (Weighted Arithmetic Water Quality Index formula)

Qi = 100 [(Vi – V0 / Si – S0)] (Quality Rating for each parameter); Wi = K/Si (Relative Weight for each parameter); K = proportionality constant; K = 1/ ∑(1/Si); Si = recommended standard value of $i^{th}$ parameter; V0 = ideal value of parameter in pure water V0 = 0 (except pH = 7.0 & D.O. = 14.6 mg/l); Vi = estimated concentration of $i^{th}$ parameter in the analyzed water.

The appropriateness of WQI values are mentioned in Table 2 (Dinius, 1987; Tiwari and Manzoor 1988; Mishra and Patel, 2001).

The values of Xi, Wi and Xr are given in Tables 1 and 2. Hence by multiplying Wi and Xr we can get the value of WQI. Similar WQI was given by Mariappan *et al.* (1998) by using nine important water quality parameters. Modified WQI methods are reported by Tiwari and Manzoor (1988), Kumar and Raju (1985) and Tyagi *et al*. (2013).

*Multivariate analysis*:

A correlation examination is a statistical tool for representing the relationship between two variables. Correlation coefficient values near +1 or -1 indicate the likelihood of a linear link between the x and y variables (Bhandari and Nayal, 2008).

$$r = \frac{\sum(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum(x_i - \bar{x})^2 (y_i - \bar{y})^2}}$$

The one-way ANOVA test for independent measurements compares the means of many independent samples determined by using the Tukey's HSD online calculator.

The one-way ANOVA formula is as follows:

$$F = \frac{MST}{MSE}$$

$$MST = \frac{\sum_{i=1}^{k}(T_i^2/n_i) - G^2/n}{k-1}$$

$$MSE = \frac{\sum_{i=1}^{k}\sum_{j=1}^{n_i} Y_{ij}^2 - \sum_{i=1}^{k}(T_i^2/n_i)}{n-k}$$

## Results and Discussion

Statistical analysis of nine physical properties have been given as Mean ± SD and the parameters are Temperature (°C), pH, Electric Conductivity (µs/cm), Colour (TCUs), Total dissolved solids

Table 1: *ICMR strands (1975), **CPHEEO Strands (1991), @ WHO

| **Physical Parameters** | **Standard values** | | **Chemical parameters** | **Standard values** |
|---|---|---|---|---|
| pH | 7-8.5 | | Magnesium ( mg/l) | < 30 |
| Electric Conductivity | 300 | | Flourides (F) | < 1.0 |
| Colour | < 5 | | Chlorides | < 250 |
| Transparency (cm) | 5-25* | | Iron (Fe) | < 0.3 |
| Turbidity | < 1 | | Phosphates ($PO_4$) | 1 |
| Total dissolved solids | < 500 | | DO (mg/l) | >5* |
| Total suspended solids | < 100 | | BOD ( mg/l) | 5* |
| **Chemical parameters** | **Standard values** | | COD ( mg/l) | 20 |
| Total alkalinity as caco3 | <200 | | Ammonia ($NH_3$) ( mg/l) | <0.5 |
| Total Hardness (mg/l) $CaCO_3$ | <300 | | Nitrates ( mg/l) | <50* |
| Carbonates (mg/l) | 120 | | Sulphates | < 200 |
| Bicarbonates (mg/l) | 200 | | Total coliforms | 0 |
| $Ca^{2+}$ (mg/l) | < 75* | | Fecal coliforms | 0 |

Table: 2: WQI values

| Value of WAWQI | Rating of water Quality |
|---|---|
| 0-25 | Excellent |
| 26-50 | Good Water Quality |
| 51-75 | Poor Water Quality |
| 76-100 | Very Poor Water Quality |
| 100 & above | Unsuitable for drinking purpose |

(mg/l) and Total suspended solids (mg/l), Transparency (cm), Total coli forms (CFU/ml) and Fecal coli forms (CFU/ ml). The sixteen chemical parameters are-- Alkalinity (mg/l), Carbonates (mg/l), Bicarbonates (mg/l), Total Hardness (mg/l), Fluorides (mg/l), Chlorides (mg/l), DO (mg/l), BOD ( mg/l), COD (mg/l), $Ca^{2+}$ (mg/l), Phosphates (mg/l), Magnesium (mg/l), Iron (mg/l), Sulphates (mg/l), Ammonia (mg/l) and Nitrites (mg/l) were recorded in Kotepally reservoir during the study period from December 2021 to November 2022.

In the current investigation the recorded highest and lowest values range of physico-chemical parameters are-- Temperature (28.2±1.4 - 24.1±1.23°C), pH (7.86±0.8 - 7.0±0.25), EC (500.2±12.2 -282.6±11.2 µs/cm), In the current investigation the recorded highest and lowest values range of physico-chemical parameters of Temperature (28.2±1.4 - 24.1±1.23°C), pH (7.86±0.8 - 7.0±0.25), EC (500.2±12.2 -282.6±11.2 µs/cm), Color (3.2± 0.04 - 1.2±0.08 TCUs), Total dissolved solids (250±7.3 - 138±7.24 mg/l), Total suspend solids (188±4.31 - 42±2.31mg/l), Transparency (57.5±2.12 - 36±1.84 cm), Total coli forms (3.1x $10^4$ - 2.0 x$10^4$ CFU/ml), Fecal coli forms (1.2x $10^3$ - 0.8 x$10^3$ CFU/ml), Alkalinity (200±6.19 - 54±6.23 mg/l), Carbonates (57.2±1.6-38.94±1.04 mg/l), Carbonates (57.2±1.6 - 38.94±1.04 mg/l), Bicarbonates (96.1±2.41 - 64.65±1.5 mg/l), Total Hardness (120±4.56 - 52.2±2.1 mg/l), Fluorides (0.5±0.02 - 0.2±0.01 mg/l), Chlorides ( 56.42±2.4 - 15±1.24 mg/l), DO (5.5±0.12 -3.85±0.11 mg/l), BOD (14.7±0.85 - 8.2±0.78 mg/l), COD (38.5±2.68 - 21.8±0.89 mg/l), and $Ca^{2+}$ (42.8±2.5 - 23.84±1.56 mg/l). Sarikar and Vijaykumar (2022) observed a similar tendency, reporting that the pH of Bhosga reservoir from five sample locations ranged from 7.43 to 7.8, indicating that the water in Bhosga reservoir is practically neutral to alkaline. . Bora and Goswami (2017) found a maximum hardness of water 296 mg/l and a lowest value of 52 mg/l in the Kolong

River. Total alkalinity (TA) is largely determined by carbonate hydroxide concentration and includes phosphate contributions.

The present investigation recorded phosphate (0.6±0.02 - 0.3± 0.02 mg/l) in Kotepally reservoir. Phosphate ($PO_4^{3-}$) is essential for organism's growth as well as nutrients that limit primary production of the ecosystem. Phosphate is present in low concentrations, yet it serves as a high nutrient, contributing to algal blooms (Murthuzasab *et al*., 2010). The value of $PO_4^{3-}$ ranges from 1.62 to 2.2 mg/l. The lowest mean values were observed at 1.78±0.09 mg/l during the monsoon season, while the highest average value was 2.03±0.13 mg/l during the post-monsoon season (Swetha and Vijayakumar, 2022). The current study reported Magnesium (12.5±1.1 - 8.4±0.52 mg/l), Iron (0.08±0.004 - 0.02±0.005 mg/ml). Sulphates (24.1± 3.25 - 12.0 ±2.31 mg/ml), Ammonia (0.05±0.002 - 0.1±0.002 mg/l) and Nitrites (2.6±0.6 -1.2±0.35 mg/l) (Table 3). Sulfate ($SO_4^{2-}$) is present in high amounts in all natural waters, especially with high salt content. $SO_4^{2-}$ values fluctuated between 3.65 to 4.5 mg/l. The lowest mean sulphate content measured was 4.05±0.24 mg/l during the monsoon season, while the highest value reported was 4.34±0.10 mg/l during the post-monsoon season (Bouslah *et al*., 2017). The observed levels were within the acceptable limits of 150 mg/l as defined by BIS regulations. The statistical average value of Water Quality Index (∑Wn × Qn) was 40.312 in pre-monsoon at Kotepally check Dam (S1), 22.36 in monsoon at Morangapally (S2) and 31.01 post-monsoon at Gangaram. High nitrate ($NO_3^-$) levels detect deterioration in water quality caused by wastewater discharged into lakes. Nitrates are the most prevalent type of inorganic nitrogen introduced into freshwater. Nitrate concentrations in freshwater appear to be rising in Unnao Balaji, MP, as a result of fertilizer, manure, and sewage pollution (Yadav *et al*., 2015). The $NO_3^-$ concentration in the Bhosga reservoir ranges from 1.74 to 2.18 mg/l based on five sample sites. The nitrate levels in all water tests are much below the BIS permissible threshold of 45 mg/l. The total and feacal coli forms (CFU/ml) was recorded in pre-monsoon > post-monsoon > monsoon (Table 3, Fig. 2).

The station wise seasonal WQI was observed highest as 40.312 during pre-monsoon period > 31.01 in post-monsoon > 22.36 in monsoon at Kotepally check Dam (S1). The similar trend was observed as 39.255 during pre-monsoon period > 30.700 in post-monsoon > 21.545 in monsoon at Gangaram (S3). WQI was reported as 38.188 during pre-monsoon period > 31.755 in post-monsoon > 22.572 in monsoon at Morangapally (S2) (Fig. 3). The results indicate good quality at Gangaram (S3) station in all seasons, followed by Morangapally (S2) and Kotepally check Dam (S1) (Fig. 4). Out of the recorded 25 water quality parameters, 22 parameters were considered for WQI statistical analysis for the entire study period. According to Brown *et al.* (1972) the WQI was recorded as 31.236, and it indicates good water quality in Kotepally reservoir. During the study period the WQI value was 22.365 in monsoon period, followed by 31.01 in post-monsoon period and 40.312 in pre-monsoon period (Table 4).

Ramita and Aarif (2018) reported that the WQI values during pre-monsoon season samples were poor, ranging between 50.50 and 64.174, with the highest and lowest sampling locations, whereas the WQI of post-monsoon samples showed poor status, ranging between 51.5 and 70.604, with the lowest sampling location being Govind Ballabh Pant Sagar Reservoir. The monsoon season produced the best WQI data, with a mean WQI value of 48.14 from all five locations, whereas the pre and post-monsoon seasons produced mean WQI values of 46.08 and 43.68, respectively.

Overall, the WQI rating indicates that the water in Bhosga Reservoir, Karnataka, was of excellent quality, making it suitable for residential use (Sarikar and Vijaykumar, 2022). The solids dissolved in water come from natural sources and fluctuate depending on area, rainfall, and the amount of water inflowing into Kanigiri Reservoir (Chalapathi *et al*., 2018). The TDS level varies

Table 3: Average Physico-chemical Parameters for Water Quality Index at three sampling station from December 2021 to November 2022

| S. No. | Parameters | Pre-Monsoon | | | Monsoon | | | Post-Monsoon | | |
|---|---|---|---|---|---|---|---|---|---|---|
| I | **Physical parameters** | S1 | S2 | S3 | S1 | S2 | S3 | S1 | S2 | S3 |
| 1 | Temperature (°C) | 28.2±1.4 | 20.1±1.3 | 20.3±1.1 | 26.2±2.4 | 26.2±1.84 | 26.2±2.34 | 24.2±1.56 | 24.1±1.23 | 24.2±1.61 |
| 2 | pH | 7.86±0.8 | 7.15±0.5 | 7.19±0.5 | 7.2±0.72 | 7.1±0.81 | 7.2±0.56 | 6.98±0.36 | 7.1±0.78 | 7.0±0.25 |
| 3 | EC (µs/cm) | 500.2±12.2 | 454.32±7.85 | 476.74±9.33 | 342±11.61 | 364±15.2 | 356±18.5 | 282.6±11.2 | 300±14.5 | 285±13.4 |
| 4 | Colour (TCUs) | 3.2± 0.04 | 2.8±0.06 | 3.1± 0.12 | 1.2±0.08 | 1.5±0.05 | 1.4±0.03 | 1.8±0.05 | 1.8±0.06 | 1.8±0.05 |
| 5 | Total dis. Solids (mg/l) | 250±7.3 | 237±5.4 | 244± 8.4 | 212±6.45 | 210±10.4 | 198±8.54 | 141.4±5.82 | 142.5±6.32 | 138±7.24 |
| 6 | Total susp. Solids (mg/l) | 126±2.6 | 112±1.6 | 118± 3.7 | 188±4.31 | 176±5.25 | 182±7.54 | 42±2.31 | 45±3.41 | 43±2.65 |
| 7 | Transparency (cm) | 55.2±3.3 | 55.7±2.2 | 57.5±2.12 | 45±1.57 | 45±2.14 | 36±1.84 | 62±2.76 | 58±2.31 | 60±1.86 |
| 8 | Total coli forms (CFU/ ml) | 3.1x $10^4$ | 2.8x $10^4$ | 3.0x $10^4$ | 2.2 x$10^4$ | 2.0 x$10^4$ | 2.2 x$10^4$ | 2.9 x$10^4$ | 2.2 x$10^4$ | 2.2 x$10^4$ |
| 9 | Fecal coli forms (CFU/ ml) | 1.2x $10^3$ | 1.1x $10^3$ | 1.2x $10^3$ | 0.8 x$10^3$ | 1.2 x$10^3$ | 0.8x$10^3$ | 1.0 x$10^3$ | 1.2 x$10^3$ | 1.2 x$10^3$ |
| II | **Chemical parameters** | | | | | | | | | |
| 1 | Alkalinity (mg/l) | 200±6.19 | 186±5.58 | 164±5.32 | 154±6.23 | 186±5.89 | 160±4.54 | 200±8.21 | 185±6.27 | 180±5.63 |
| 2 | Carbonates (mg/l) | 52.10±1.5 | 57.2±1.6 | 48.2±1.2 | 46.23±1.23 | 38.94±1.04 | 42.67±2.56 | 52.21±3.2 | 54.75±3.74 | 50.62±2.56 |
| 3 | Bicarbonates (mg/l) | 84.6±1.16 | 96.1±2.41 | 82.5±1.58 | 64.65±1.5 | 74.5±2.31 | 74.5±2.95 | 76.42±3.5 | 75.12±2.8 | 78.64±4.1 |
| 4 | Total Hardness (mg/l) | 68.6±2.3 | 52.5±3.1 | 72.3±2.8 | 82.5±3.2 | 52.2±2.1 | 78.87±3.6 | 120±4.56 | 110±3.61 | 118±2.65 |
| 5 | Fluorides (mg/l) | 0.5±0.02 | 0.5±0.03 | 0.4± 0.02 | 0.2±0.01 | 0.2±0.01 | 0.2±0.02 | 0.2±0.02 | 0.2±0.01 | 0.2±0.01 |
| 6 | Chlorides (mg/l) | 53.17±2.1 | 56.42±2.4 | 48.2±2.35 | 18±1.11 | 15±1.24 | 18±1.32 | 22.6±1.4 | 25.2±1.81 | 24.7±1.65 |
| 7 | DO (mg/l) | 4.54±0.14 | 4.25±0.1 | 5.5±0.12 | 5.02±0.61 | 4.82±0.42 | 4.54±0.21 | 3.85±0.11 | 4.22±0.27 | 4.12±0.19 |
| 8 | BOD ( mg/l) | 14.7±0.85 | 11.5±0.73 | 14.5±0.84 | 10.4±0.75 | 9.4±0.62 | 8.2±0.78 | 12±0.64 | 14±0.23 | 12±0.81 |
| 9 | COD ( mg/l) | 25.4±0.4 | 22.8±1.1 | 28.1±0.8 | 21.3±0.25 | 22.4±1.5 | 21.8±0.89 | 35±2.12 | 38.5±2.68 | 36.4±2.74 |
| 10 | $Ca^{2+}$ ( mg/l) | 35.6±1.4 | 42.8±2.5 | 39.5±2.8 | 24.6±1.54 | 25.32±1.23 | 23.84±1.56 | 30.4±2.1 | 32.4±2.36 | 30.4±2.64 |
| 11 | Phosphates ( mg/l) | 0.6±0.02 | 0.6±0.03 | 0.6± 0.02 | 0.3±0.02 | 0.3±0.04 | 0.3±0.03 | 0.4±0.02 | 0.4±0.01 | 0.4±0.01 |
| 12 | Magnesium ( mg/l) | 12.3±0.5 | 12.2±0.6 | 12.5±1.1 | 8.4±0.52 | 8.5±0.62 | 9.1±0.81 | 10.6±0.01 | 10.5±0.92 | 10.5±0.74 |
| 13 | Iron (mg/l) | 0.08±0.007 | 0.08±0.004 | 0.08± 0.008 | 0.02±0.007 | 0.02±0.005 | 0.02±0.007 | 0.04±0.008 | 0.04±0.004 | 0.04±0.008 |
| 14 | Sulphates (mg/l) | 22.0±1.37 | 20.0±1.12 | 24.1± 3.25 | 12.3±2.54 | 12.0 ±2.31 | 12.5±1.89 | 16.2±2.68 | 18.1±2.78 | 16.4±2.11 |
| 15 | Ammonia ( mg/l) | 0.02±0.002 | 0.02±0.001 | 0.02±0.003 | 0.05±0.003 | 0.05±0.004 | 0.05±0.002 | 0.1±0.001 | 0.1±0.002 | 0.1±0.001 |
| 16 | Nitrites ( mg/l) | 2.4±0.07 | 2.6±0.6 | 1.8±0.6 | 1.4±0.5 | 1.2±0.35 | 1.4±0.24 | 1.8±0.12 | 1.8±0.23 | 1.8±0.24 |
| | **WQI = ∑Wn × Qn** | **40.301** | **38.188** | **39.255** | **23.00** | **22.572** | **21.545** | **30.597** | **31.755** | **30.700** |

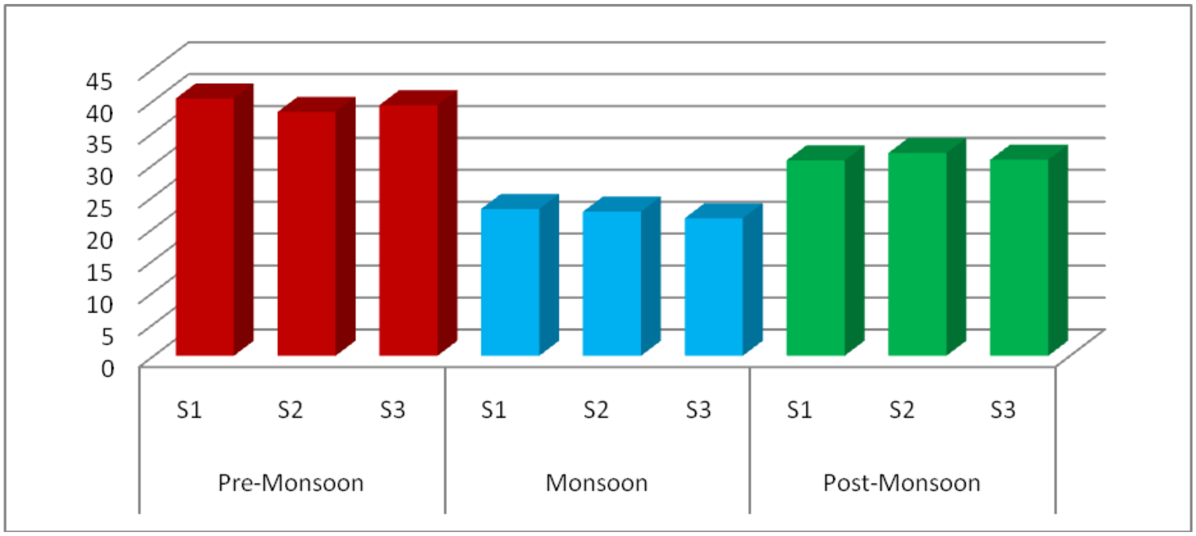
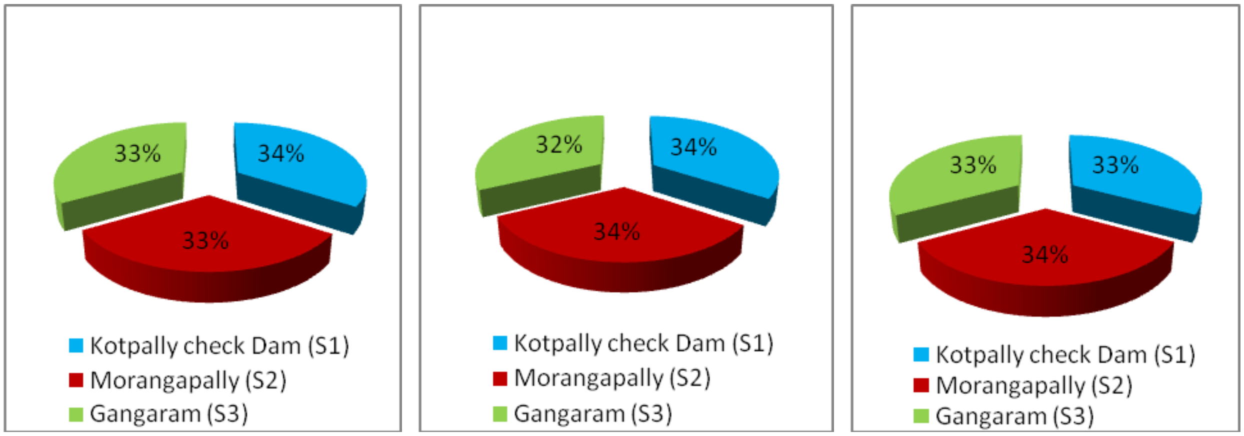



Fig. 2 : Water Quality Index

Table: 4. Seasonal variation Water Quality Index

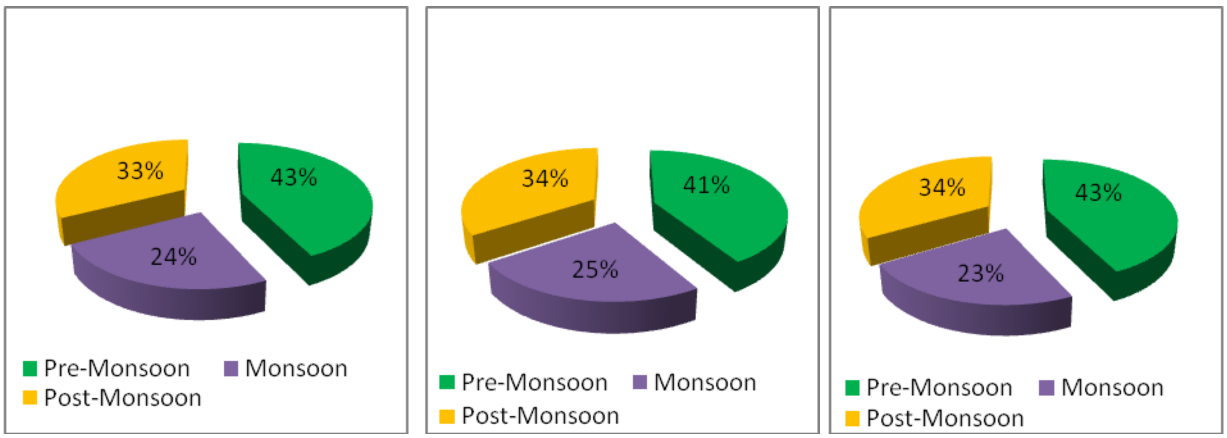
| Parameters | Pre-monsoon | Monsoon | Post-monsoon | Total period |
|---|---|---|---|---|
| pH | 7.50 | 7.16 | 7.02 | 7.2267 |
| Electric Condu. (µs/cm) | 272.75 | 354 | 289.2 | 305.32 |
| Colour (TCUs) | 3.15 | 1.36 | 1.8 | 2.1033 |
| Total dis. solids | 250 | 206.66 | 95.23 | 183.96 |
| Total susp. solids | 126 | 182 | 43.33 | 117.11 |
| Transparency (cm) | 56.13 | 42 | 60 | 52.71 |
| Alkalinity ( mg/l) | 180 | 166.66 | 188.33 | 178.33 |
| Carbonates (mg/l) | 52.5 | 42.61 | 52.52 | 49.21 |
| Bicarbonates (mg/l) | 74.76 | 71.21 | 76.72 | 74.23 |
| Total Hardness (mg/l) | 68.6 | 71.19 | 116 | 85.263 |
| Fluorides ( mg/l) | 0.5 | 0.2 | 0.2 | 0.3 |
| Chlorides ( mg/l) | 53.17 | 17 | 24.16 | 31.443 |
| DO (mg/l) | 4.76 | 4.79 | 4.06 | 4.5367 |
| BOD ( mg/l) | 14.7 | 9.33 | 12.66 | 12.23 |
| COD ( mg/l) | 25.4 | 21.83 | 36.63 | 27.953 |
| $Ca^{2+}$ ( mg/l) | 35.6 | 24.58 | 31.06 | 30.413 |
| Phosphates ( mg/l) | 0.6 | 0.3 | 0.4 | 0.4333 |
| Magnesium ( mg/l) | 12.3 | 8.66 | 10.53 | 10.497 |
| Iron (mg/l) | 0.08 | 0.02 | 0.04 | 0.0467 |
| Sulphates ( mg/l) | 22 | 12.26 | 16.9 | 17.053 |
| Ammonia (mg/l) | 0.02 | 0.05 | 0.1 | 0.0567 |
| Nitrites (mg/l) | 2.4 | 1.33 | 1.8 | 1.8433 |
| **WQI = $\sum Wn \times Qn$** | **40.312** | **22.365** | **31.01** | **31.236** |

Sample size: 22




Pre-monsoon Monsoon Post-monsoon

Fig. 3: Station-wise status of Water quality index.




Station 1 Station 2 Station 3

Fig. 4: Season- wise status of Water Quality Index.

From 138 to 175.8 mg/l. Minimum average values were recorded at 144.96±8.42 mg/l during the monsoon season, while highest average values were detected at 154.61±3.45 mg/l during the pre-monsoon season. According to BIS, the observed result was less than 500 mg/l. The DO ranges from 7.24 to 10.05 mg/l. Water dilution induced by rainfall addition resulted in the lowest mean levels of 7.89±0.52 mg/l during the MON season (Verma *et al.*, 2012). Because cold water contains more dissolved oxygen than warm water, the maximum mean levels were reported during the post-monsoon season as 9.23±0.47 mg/l.

*Correlation*:

The present results revealed that the pH was strongly correlated with colour, TDS, $Cl^-$, DO, $PO_4^{3-}$, $Mg^{2+}$, $Fe^{2+}$, $SO_4^{2-}$, and $NO^{2-}$. Colour, $CO_3^{2-}$ strongly correlated with F−, DO. Total Dissolved Solids are strongly correlated with TSS and DO. Transparency is strongly correlated with TA, $CO_3^{2-}$, $HCO_3^-$, BOD, COD, $Ca^{2+}$, $PO_4^{3-}$ and $Mg^{2+}$. Carbonates are strongly correlated with Colour, Transparency, TA, $HCO_3^-$, BOD, COD, $Ca^{2+}$, $PO_4^{3-}$, $Mg^{2+}$, $Fe^{2+}$, and $SO_4^{2-}$. Bicarbonates are strongly correlated with Transparency, TA, $CO_3^{2-}$, TH, BOD, COD, and $Ca^{2+}$. Fluorides are strongly correlated with pH, Colour, TDS, $Cl^-$, BOD, $Ca^{2+}$, $PO_4^{3-}$, $Mg^{2+}$, $Fe^{2+}$, $SO_4^{2-}$ and $NO^{2-}$. Chlorides are strongly correlated with pH, Colour, BOD, $Ca^{2+}$, $PO_4^{3-}$, $Mg^{2+}$, $Fe^{2+}$, $SO_4^{2-}$, and $NO^{2-}$. Dissolved oxygen was strongly correlated with pH, TDS, TSS, and TA. Biological oxygen demand was strongly correlated with Colour, Tran, TA, $CO_3^{2-}$, $HCO_3^-$, $F^-$, $Cl^-$, $Ca^{2+}$,

$PO_4^{3-}$, $Mg^{2+}$, $Fe^{2+}$, $SO_4^{2-}$ and $NO^{2-}$. Chemical oxygen demand was strongly correlated with Tran, TA, $CO_3^{2-}$, $HCO_3^-$, $F^-$, $Cl^-$, and $NH_3$. Calcium was strongly correlated with Colour, Tran, $CO_3^{2-}$, $HCO^{3-}$, $F^-$, $Cl^-$, $PO_4^{3-}$, $Mg^{2+}$, $Fe^{2+}$, $SO_4^{2-}$, and $NO^{2-}$. Phosphates was strongly correlated with pH, Colour, $CO_3^{2-}$, $F^-$, $Cl^-$, BOD, $Ca^{2+}$, $Mg^{2+}$, $Fe^{2+}$, $SO_4^{2-}$ and $NO^{2-}$. Magnesium was strongly correlated with pH, Colour, Tran, $CO_3^{2-}$, $F^-$, $Cl^-$, BOD, $PO_4^{3-}$, $Fe^{2+}$, $SO4^2$ and .$NO^{2-}$. Ferrous was strongly correlated with pH, Colour, $CO_3^{2-}$, $F^-$, $Cl^-$, BOD, $Ca^{2+}$, $SO_4^{2-}$, and $NO^{2-}$. Sulphates was strongly correlated with pH, Colour, Tran, $CO_3^{2-}$, $HCO_3^-$, $F^-$, Cl-, BOD, $Ca^{2+}$, $PO_4^{3-}$, $Mg^{2+}$, $Fe^{2+}$, and $NO^{2-}$. Ammonia strongly correlated with TH and $Ca^{2+}$. Nitrates strongly correlated with pH, Colour, $CO_3^{2-}$, $F^-$, $Cl^-$, BOD, $Ca^{2+}$, $PO_4^{3-}$ $Mg^{2+}$, $Fe^{2+}$, $SO_4^{2-}$ and $NH_3$. The "-ve" values are negatively correlated and the minimum "+ve" values are moderately and less positive correlation (Table 5). The recorded values are marginally deviated in Dissolved oxygen correlates highly with phosphate, sulfate and nitrate. pH and electrical conductivity exhibit a high resemblance. Total hardness is highly correlated with chloride, and total alkalinity in Bhosga reservoir (Swetha and Vijaykumar, 2022). Pearson Correlation Coefficient analysis was used in current work to determine the relationship between each pairing of physicochemical parameters of the Kotepally reservoir. The physicochemical correlation among the various parameters show strong positive correlation at 0.05 significant level in pre-monsoon and monsoon (r) = 0.9635 and p-value is 0.0001, pre-monsoon and post- monsoon (r) = 0.8703 and p-value is 0.001, Monsoon and post-monsoon (r) = 0.8913 and p-value is 0.004. The smaller the p-value the more it supports $H_1$ (Table 5). Vieira *et al*. (2012) stated that cluster analysis is a method of categorization that generates a collection of clusters in which items are connected to one another yet distinct from those in other groups.

*ANOVA*:

In the current study the difference in recorded data averages across all seasons is statistically significant. The p-value is 0.736595; the higher the p-value, the more strongly H0 is supported. The ANOVA findings on 22 water quality measures revealed that variation in the majority of the parameters is low and within the acceptable limit range in the present study. The quantile-quantile (q-q) scatter plot is determined for two data sets from variables with a common distribution. The points form a line that is roughly straight. A normal QQ plot does not follow the normal distribution when both sets of pre-monsoon and monsoon quantiles (p-value is 0.002), pre-monsoon and post-monsoon (p-value is 0.001), monsoon and post-monsoon (p-value is 0.004) (Figs. 5, 6, 7). Olagbemide and Owolabi (2019) report identical observations on twenty-four physicochemical parameters in Ekiti State, Nigeria. ANOVA was used to evaluate the significant differences between water quality variables at the dams. WQI in Egbe dam ranges from 118.00 - 164.67 (dry season) with a seasonal value of 145.69 and from 89.39 - 161.86 (rainy season) with a seasonal value of 120.59.

According to Milana *et al*. (2012), the statistical analysis of dissolved oxygen for all CPs showed substantial differences at the significance level p <0.01 (F=76.961, p=0.000). There are no significant differences between these numbers in Serbia's Veliki Baki canal. BOD, TDS, and EC are substantially associated with the first axis, indicating that these are the primary factors driving site separation. Jayawardana et al., (2016) reported the separation of sites is mostly due to nutrients ($NO_2^-$, $PO_4^{3-}$), dissolved ions ($F^-$), and hardness. According to Khalik *et al.* (2013) statistical analysis of one way ANOVA, all observed parameters in Bertam River in Cameron exhibited significant differences except for pH, DO, salinity, COD, and ammoniacal nitrogen. Turbidity levels differed significantly (p <0.05) between locations linked with different land use categories. Izonfuo and Bariweni (2001) reported that the Turbidity levels were noted to be very low in places with forest patches and higher in urban areas. Sheela *et al.* (2012) employed multivariate techniques to analyze water quality in Akkulam-Veli Lake in

Table 5: The physicochemical parameter's correlation coefficient (r) at the 0.05 significance level in the Kotepally Reservoir

| | $P^H$ | EC | Color | TDS | TSS | Tran | TA | $CO_3^{2-}$ | $HCO_3^-$ | TH | $F^-$ | $Cl^-$ | DO | BOD | COD | $Ca^{2+}$ | $PO_4^{3-}$ | $Mg^{2+}$ | $Fe^{2+}$ | $SO_4^{2-}$ | NH3 | $NO^{2-}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $P^H$ | 1 | | | | | | | | | | | | | | | | | | | | | |
| EC | -0.41 | 1 | | | | | | | | | | | | | | | | | | | | |
| Color | 0.86 | -0.81 | 1 | | | | | | | | | | | | | | | | | | | |
| TDS | 0.88 | 0.05 | 0.53 | 1 | | | | | | | | | | | | | | | | | | |
| TSS | 0.38 | 0.67 | -0.12 | 0.77 | 1 | | | | | | | | | | | | | | | | | |
| Trans | 0.03 | -0.92 | 0.52 | -0.43 | -0.91 | 1 | | | | | | | | | | | | | | | | |
| TA | -0.15 | -0.83 | 0.36 | -0.59 | -0.97 | 0.98 | 1 | | | | | | | | | | | | | | | |
| $CO_3^{2-}$ | 0.23 | -0.98 | 0.68 | -0.24 | -0.80 | 0.97 | 0.92 | 1 | | | | | | | | | | | | | | |
| $HCO_3^-$ | -0.12 | -0.85 | 0.39 | -0.57 | -0.96 | 0.98 | 0.99 | 0.93 | 1 | | | | | | | | | | | | | |
| TH | -0.75 | -0.27 | -0.32 | -0.97 | -0.89 | 0.62 | 0.76 | 0.45 | 0.74 | 1 | | | | | | | | | | | | |
| $F^-$ | 0.95 | -0.65 | 0.97 | 0.71 | 0.11 | 0.31 | 0.13 | 0.49 | 0.16 | -0.54 | 1 | | | | | | | | | | | |
| $Cl^-$ | 0.88 | -0.78 | 0.99 | 0.57 | -0.07 | 0.48 | 0.31 | 0.65 | 0.34 | -0.37 | 0.98 | 1 | | | | | | | | | | |
| DO | 0.69 | 0.35 | 0.24 | 0.95 | 0.92 | -0.69 | -0.81 | -0.53 | -0.79 | -0.99 | 0.46 | 0.29 | 1 | | | | | | | | | |
| BOD | 0.58 | -0.98 | 0.91 | 0.13 | -0.52 | 0.83 | 0.71 | 0.92 | 0.73 | 0.08 | 0.78 | 0.89 | -0.17 | 1 | | | | | | | | |
| COD | -0.54 | -0.53 | -0.05 | -0.87 | -0.98 | 0.82 | 0.91 | 0.68 | 0.89 | 0.96 | -0.28 | -0.10 | -0.98 | 0.36 | 1 | | | | | | | |
| $Ca^{2+}$ | 0.61 | -0.97 | 0.92 | 0.17 | -0.49 | 0.80 | 0.68 | 0.91 | 0.71 | 0.05 | 0.81 | 0.90 | -0.13 | 0.99 | 0.33 | 1 | | | | | | |
| $PO_4^{3-}$ | 0.81 | -0.86 | 0.99 | 0.44 | -0.22 | 0.60 | 0.44 | 0.75 | 0.47 | -0.23 | 0.94 | 0.98 | 0.15 | 0.94 | 0.04 | 0.95 | 1 | | | | | |
| $Mg^{2+}$ | 0.67 | -0.95 | 0.95 | 0.25 | -0.41 | 0.75 | 0.62 | 0.87 | 0.64 | -0.03 | 0.85 | 0.93 | -0.05 | 0.99 | 0.24 | 0.99 | 0.97 | 1 | | | | |
| $Fe^{2+}$ | 0.81 | -0.86 | 0.99 | 0.44 | -0.22 | 0.60 | 0.44 | 0.75 | 0.47 | -0.23 | 0.94 | 0.98 | 0.15 | 0.94 | 0.04 | 0.95 | 1 | 0.97 | 1 | | | |
| $SO_4^{2-}$ | 0.70 | -0.93 | 0.96 | 0.29 | -0.37 | 0.72 | 0.58 | 0.85 | 0.61 | -0.07 | 0.87 | 0.95 | -0.01 | 0.98 | 0.20 | 0.99 | 0.98 | 0.99 | 0.98 | 1 | | |
| $NH_3$ | -0.92 | 0.04 | -0.61 | -0.99 | -0.70 | 0.34 | 0.51 | 0.14 | 0.48 | 0.94 | -0.78 | -0.65 | -0.91 | -0.24 | 0.82 | -0.27 | -0.53 | -0.35 | -0.53 | -0.39 | 1 | |
| $NO^{2-}$ | 0.73 | -0.92 | 0.97 | 0.33 | -0.33 | 0.69 | 0.55 | 0.82 | 0.57 | -0.11 | 0.89 | 0.96 | 0.03 | 0.97 | 0.16 | 0.98 | 0.99 | 0.99 | 0.99 | 0.99 | -0.43 | 1 |

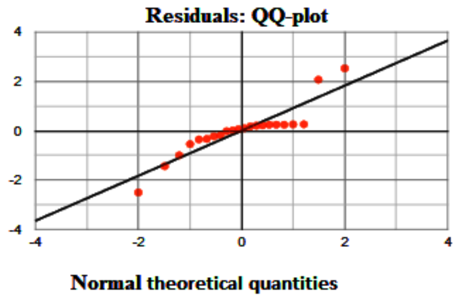



Fig. 5: Pre-monsoon and monsoon.

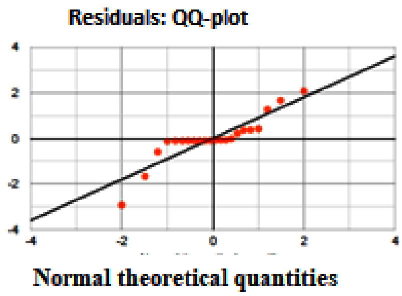



Fig. 6: Monsoon and Post-monsoon.

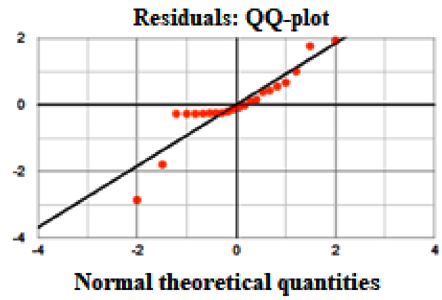



Fig. 7: Monsoon and post-monsoon.

India and discovered the sources of contaminants in connection to seasonal rainfall occurrences.

## Conclusion

The purpose of this study was to evaluate the environmental influences on the river's water quality and to measure the degree of pollution at various stations. The primary goal of calculating the water quality index (WQI) is to convert complicated water quality data into clearly comprehensible and useable information. The current study was carried out to assess the quality of the Kotepally reservoir utilizing a number of physic-chemical measures. The water samples were found to be safe to drink, and pollution levels were within the acceptable limit defined by BIS guidelines. The ANOVA findings on water quality parameters revealed that the variance in the majority of the parameters is low and within the acceptable limit range.

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