

Trophic State Assessment of Ramanpad Reservoir, Wanaparthy District, Telangana

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Abstract

Aquatic ecosystems are commonly classified based on their productivity using the concept of trophic state. The trophic state index (TSI) ranges from 0 to 100, where each step represents a doubling of algal biomass. Parameters such as total phosphorus, chlorophyll-a, and Secchi disc transparency are used to calculate this index. In the present study, the trophic status of Ramanpad Reservoir (Okachetty Vagu) in Wanaparthy district, Telangana, was evaluated. The results revealed that all sampling sites fall under oligotrophic condition, indicating low nutrient levels, high water clarity, and low algal growth.

Keywords: Trophic State Index, Chlorophyll-a, Secchi Depth, Phosphate, Water Quality

1. Introduction

Aquatic ecosystems depend on complex interactions between physical, chemical, and biological factors. These interactions help maintain ecological balance. However, human activities such as agriculture, urbanization, and waste disposal can disturb these systems.

Eutrophication is one of the major problems affecting water bodies. It occurs when excess nutrients, especially phosphorus and nitrogen, enter the water and promote excessive algal growth. In contrast, oligotrophic water bodies have low nutrient levels and low biological productivity.

The trophic state index (TSI), developed by Carlson (1977), is widely used to classify water bodies based on productivity. It uses chlorophyll-a, Secchi depth, and total phosphorus as key indicators. This study aims to evaluate the trophic status of Okachetty Vagu using the TSI method.

2. Materials and Methods

2.1 Study Area

The study was conducted at Okachetty Vagu (Ramanpad Reservoir) located in Wanaparthy district, Telangana. The region experiences a semi-arid climate with seasonal rainfall. The water body mainly receives water from rainfall and surface runoff. Human interference is limited compared to urban lakes.

2.2 Sample Collection and Analysis

Water samples were collected monthly for one year. The following parameters were analyzed:

- Chlorophyll-a ($\mu\text{g/L}$)
- Secchi depth (m)
- Total phosphorus ($\mu\text{g/L}$)

Standard methods (APHA, 2017) were followed.

2.3 Trophic State Index Calculation

Parameter	Formula
TSI (Chlorophyll-a)	$\text{TSI}(\text{CHL}) = 9.81 \times \ln(\text{Chl-a}) + 30.6$
TSI (Secchi Depth)	$\text{TSI}(\text{SD}) = 60 - 14.41 \times \ln(\text{SD})$
TSI (Total Phosphorus)	$\text{TSI}(\text{TP}) = 14.42 \times \ln(\text{TP}) + 4.15$
Overall TSI	$\text{TSI} = (\text{TSI}(\text{CHL}) + \text{TSI}(\text{SD}) + \text{TSI}(\text{TP})) / 3$

3. RESULTS AND DISCUSSION

The trophic status of (Ramanpad Reservoir) Okachetty Vagu was evaluated using chlorophyll-a, Secchi depth, and total phosphorus. These parameters are widely accepted indicators of nutrient enrichment and biological productivity in freshwater ecosystems.

3.1 Chlorophyll-a (Indicator of Algal Biomass)

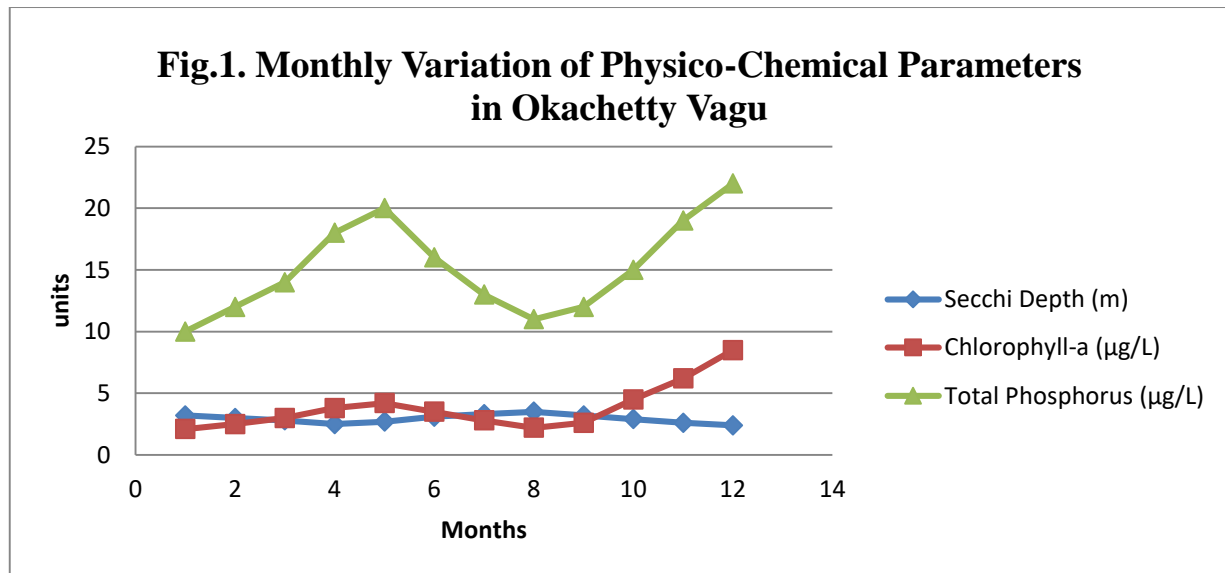
Chlorophyll-a values recorded during the study ranged from **1.5 to 8.5 $\mu\text{g/L}$** , indicating low phytoplankton biomass and confirming oligotrophic conditions. Chlorophyll-a is considered one of the most reliable indicators of trophic status because it directly reflects algal growth and biological response to nutrient availability (Carlson, 1977; Wetzel, 2001).

Recent studies have shown that chlorophyll-a has a strong relationship with nutrient enrichment, especially phosphorus, and is widely used in trophic classification models (Kumar & Sharma, 2020; Mishra et al., 2022). In eutrophic water bodies, chlorophyll-a concentrations often exceed 50 $\mu\text{g/L}$, resulting in dense algal blooms and reduced oxygen levels (Smith et al., 1999).

The low chlorophyll-a values observed in the present study suggest minimal primary productivity and absence of bloom conditions. Seasonal variation showed slightly higher values during summer, which may be due to increased solar radiation and temperature. However, the values remained within oligotrophic limits, indicating that nutrient availability is the limiting factor rather than light intensity.

Figure 1 shows the relationship between chlorophyll-a concentration and trophic state index (TSI) in Ramanpad Reservoir (Okachetty Vagu). Chlorophyll-a values show a gradual increase from early monsoon to summer season, followed by slight fluctuations. However, all values remain low, indicating limited algal biomass in the water body. The corresponding TSI values also remain in the oligotrophic range, showing a weak but positive relationship with chlorophyll-a. This indicates that even though there is slight seasonal increase in productivity, the system does not shift towards eutrophic conditions. The low chlorophyll-a concentration suggests that nutrient availability, especially phosphorus, is limited. Similar patterns have been reported in other oligotrophic freshwater systems where algal growth is controlled by nutrient limitation rather than temperature or light availability (Wetzel, 2001; Mishra et al., 2022).

Overall, the graph confirms that Ramanpad Reservoir (Okachetty Vagu) maintains low primary productivity and stable ecological conditions.



3.2 Secchi Depth (Water Transparency)

Secchi depth values ranged between **1.8 and 3.5 m**, indicating high water clarity. Transparency is inversely related to algal biomass and suspended particles, and is widely used as a simple indicator of water quality (Carlson, 1977). Higher Secchi depth values observed in this study indicate low turbidity and low phytoplankton density. Similar findings have been reported in relatively undisturbed freshwater systems where nutrient input is minimal (Dodds & Smith, 2016). Recent research highlights that Secchi depth remains a cost-effective and reliable parameter for trophic assessment when combined with chlorophyll-a and phosphorus (Mishra et al., 2022). However, it can sometimes be influenced by non-algal factors such as suspended sediments and dissolved organic matter (Wetzel, 2001). In the present study, the consistently high transparency suggests that such interference is minimal. A slight reduction in transparency during the monsoon season may be attributed to runoff carrying suspended particles into the water body. Similar seasonal variations have been reported in tropical aquatic systems (Kumar & Sharma, 2020).

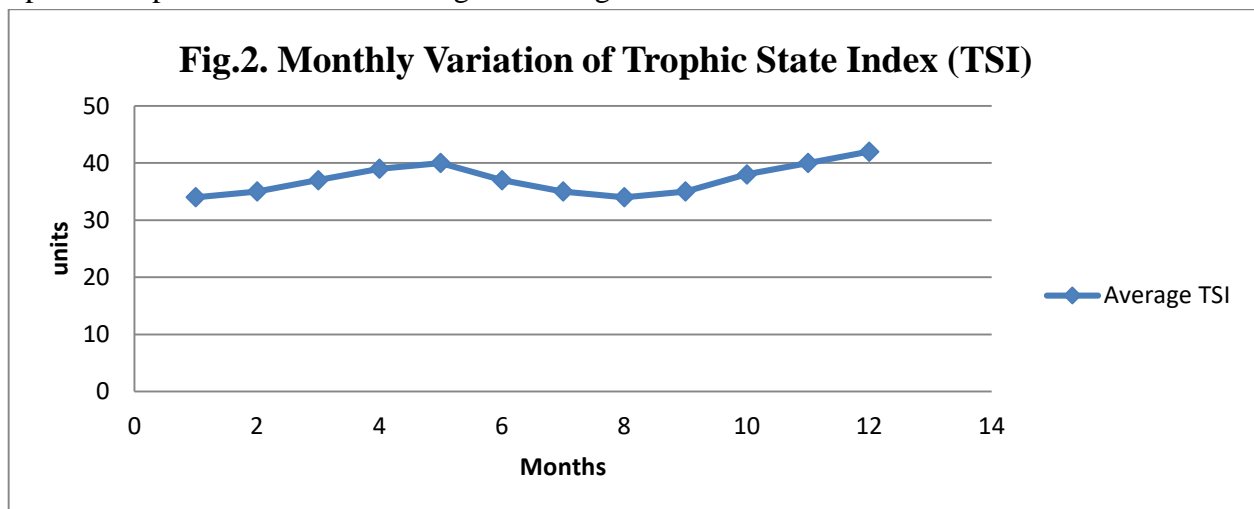
3.3 Total Phosphorus (Nutrient Status)

Total phosphorus concentrations ranged from **8 to 22 µg/L**, indicating low nutrient levels. Phosphorus is widely recognized as the key limiting nutrient in freshwater ecosystems and plays a major role in controlling algal growth (Smith et al., 1999). Studies have shown that water bodies with phosphorus levels below 25 µg/L generally remain oligotrophic and support low biological productivity (Dodds & Smith, 2016). The present findings are consistent with this threshold. Seasonal variation showed slightly higher phosphorus concentrations during the monsoon period, likely due to agricultural runoff and soil erosion. However, the concentrations remained within oligotrophic limits, suggesting limited external nutrient loading. Recent studies also confirm that controlling phosphorus input is essential to prevent eutrophication and maintain water quality (Mishra et al., 2022; Kumar & Sharma, 2020).

3.4 Trophic State Index (TSI) Evaluation

The calculated TSI values ranged between **25 and 42**, indicating oligotrophic to slightly mesotrophic conditions. According to Carlson's classification, TSI values below 40 represent oligotrophic systems characterized by low nutrient levels, clear water, and low algal biomass (Carlson, 1977). The TSI integrates physical, chemical, and biological parameters into a single value, making it a useful tool for water quality assessment and management (Wetzel, 2001). Recent studies indicate that many freshwater bodies worldwide are shifting toward eutrophic conditions due to increased anthropogenic activities (Mishra et al., 2022). In contrast, the present study shows that all sampling sites remain within oligotrophic limits, indicating low pollution levels and good ecological health.

Figure 2 represents the monthly variation of TSI values calculated from chlorophyll-a, Secchi depth, and total phosphorus. The TSI values range between approximately 34 and 42 throughout the study period. A slight increase in TSI is observed during summer months (April–May), which may be due to increased temperature and evaporation leading to higher nutrient concentration. However, the values do not exceed the oligotrophic threshold (TSI < 40–45), except for minor fluctuations, indicating that the water body remains largely in oligotrophic condition. During monsoon months, slight reductions in TSI are observed due to dilution effect caused by rainfall. This seasonal pattern is typical in tropical freshwater systems (Dodds & Smith, 2016). The overall stability of TSI values suggests that the system is not experiencing eutrophication pressure and maintains good ecological balance.



3.5 Comparison with Earlier and Recent Studies

The findings of this study differ from many reported water bodies in India, where eutrophication is a common problem due to sewage discharge and agricultural runoff.

For example, several studies have reported TSI values above 60 in urban lakes, indicating eutrophic conditions with high algal biomass and low water clarity (Kumar & Sharma, 2020). Similarly, global studies suggest that a large proportion of freshwater systems are experiencing nutrient enrichment and declining water quality (Dodds & Smith, 2016).

In contrast, the present study indicates oligotrophic conditions, which may be attributed to:

- ✚ Limited anthropogenic disturbance
- ✚ Low population pressure
- ✚ Natural hydrological conditions

✚ Reduced nutrient inflow

These findings are consistent with studies conducted on relatively undisturbed rural water bodies, which often maintain better ecological balance compared to urban systems (Mishra et al., 2022).

3.7 Overall Interpretation

All three parameters—chlorophyll-a, Secchi depth, and total phosphorus—consistently indicate low productivity and high water quality. The agreement among these parameters strengthens the reliability of the trophic classification.

The study clearly demonstrates that Ramanpad Reservoir (Okachetty Vagu) remains an **oligotrophic and ecologically stable water body**.

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