

Original Research Article

Physicochemical Assessment of Water Quality in the Thamirabarani River Basin

ABSTRACT

The abstract should be concise and informative. It should not exceed 300 words in length. It should briefly describe the purpose of the work, techniques and methods used, major findings with important data and conclusions. Different sub-sections, as given below, should be used. No references should be cited in this part. Generally non-standard abbreviations should not be used, if necessary they should be clearly defined in the abstract, at first use.

Aims: This study aims to assess the water quality of the Thamirabarani River by analyzing a comprehensive set of parameters to understand the extent of pollution from anthropogenic sources and to identify potential areas for conservation efforts.

Study Design: This is a cross-sectional observational study. Place and Duration of Study: The study was conducted along four stations of the Thamirabarani River, Tamil Nadu, India, between January 2022 and December 2022.

Methodology: Water samples were collected from four different stations along the Thamirabarani River. The parameters analyzed included pH, total dissolved solids (TDS), hardness, chloride, calcium, magnesium, electrical conductivity, ammonia, nitrate, turbidity, alkalinity, fluoride, and iron, using standard analytical methods. These parameters were compared against permissible limits to evaluate the extent of water pollution. The sources of contamination, such as untreated sewage, industrial effluents, and agricultural runoff, were also identified.

Results: The analysis revealed significant deviations from permissible limits at Stations 1 and 2, indicating severe contamination. For example, pH levels ranged from 4.3 to 8.5 at Station 1 and 4.8 to 8.2 at Station 2, both outside the acceptable range of 6.5 to 8.5. Total dissolved solids (TDS) exceeded 500 mg/L at these stations, suggesting high levels of contamination from anthropogenic sources. In contrast, Station 4 showed acceptable levels across all parameters, indicating better water quality. These findings suggest significant spatial variability in water quality along the river, largely attributed to human activities.

Conclusion: The study highlights the critical need for sustainable water management practices in the Thamirabarani River to mitigate pollution from anthropogenic sources. Remedial measures, such as treatment of effluents, public education, and source water protection, are essential to safeguard public health and maintain ecosystem integrity. Further research is needed to monitor water quality trends and evaluate the effectiveness of implemented conservation strategies.

Keywords: Water quality assessment, Thamirabarani River, Anthropogenic pollution, Environmental impact, Sustainable water management

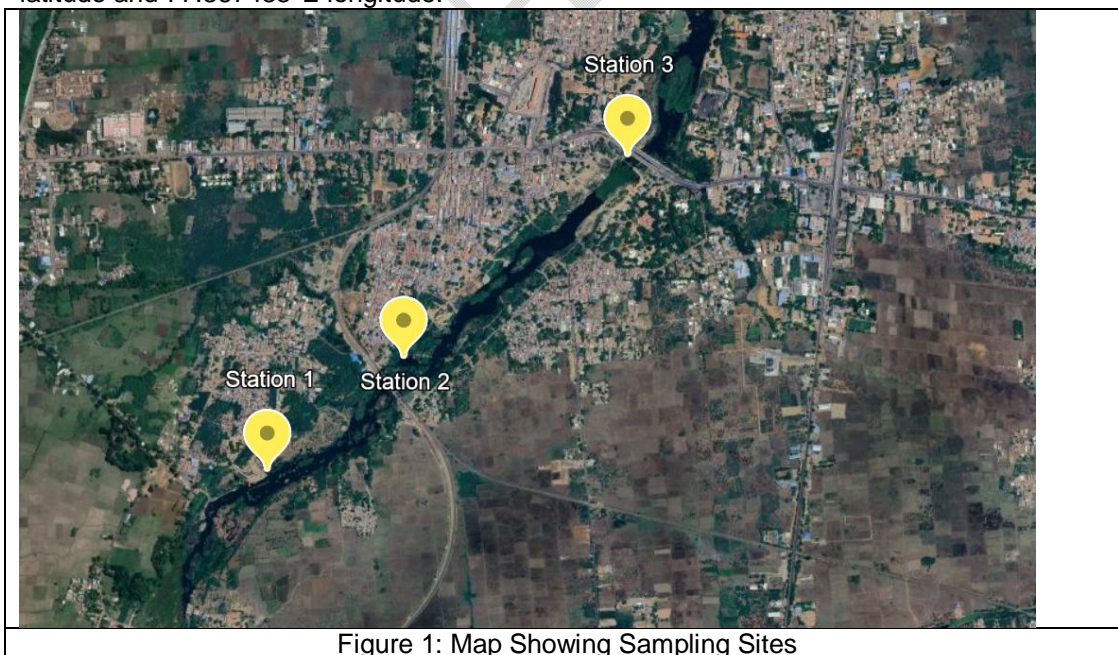
1. INTRODUCTION

Water, often referred to as the lifeblood of our planet, plays a crucial role in sustaining all forms of life. It is a fundamental resource that impacts human survival, well-being, and the overall ecological balance. [1] However, access to clean drinking water is a privilege that billions of people worldwide are deprived of. Human activities, such as industrialization, urbanization, agriculture, and pollution collectively known as anthropogenic activities significantly alter the quality of water. [2]. These activities introduce bio-chemical components and pollutants into water bodies, resulting in contamination. This contaminated water poses serious health risks to humans and other living organisms, disrupting the ecological balance [3]. The present investigation is aimed to assess the quality of water by considering the physical and chemical properties of water samples collected from four stations of the Tamiraparani river basin.

2. MATERIAL AND METHODS

Study Area

The study has been conducted in the basin of the Thamirabarani River, situated between Latitude $08^{\circ} 8'N$ and $09^{\circ} 23'N$, and Longitude $77^{\circ} 09'E$ and $77^{\circ} 54'E$. Samples were collected in September 2023 at four stations. The first three stations were selected based on the presence of visible contamination, while the fourth station was considered as the control. Station 1 is located at $8.717177^{\circ}N$ latitude and $77.701308^{\circ}E$ longitude. Station 2 is situated at $8.721217^{\circ}N$ latitude and $77.706396^{\circ}E$ longitude. Station 3 is found at $8^{\circ}43'42''N$ latitude and $77^{\circ}42'52''E$ longitude. Station 4(control) is positioned at $8.708648^{\circ}N$ latitude and $77.367435^{\circ}E$ longitude.



Water samples were collected in bottles with precautions. They were analyzed for different Physicochemical parameters (Table 1) such as Total solids, turbidity, pH, hardness,

chloride ion, dissolved oxygen, iron ion, and alkalinity by the standard protocols of IS: 3025. The Permissible amount of each parameter was tabulated in Table 2.

| S. No | Water Quality Parameter | Method of Analysis |
|--------------|---------------------------------------|--|
| 1. | Solid (TDS, TSS, and volatile solids) | Water and soil analysis kit model no 161 |
| 2. | Turbidity | Turbidity meter |
| 3. | pH | pH meter |
| 4. | Hardness | EDTA method |
| 5. | Chloride | Chemical method |
| 6. | Dissolved Oxygen | Winkler's method |
| 7. | Iron | Chemical method |
| 8. | Calcium (Ca) | Flame photometer |
| 9. | Magnesium (Mg) | Flame photometer |
| 10. | Nitrate (NO ₃) | Spectrophotometric methods |
| 11. | Fluoride (F) | Ion-selective electrode method |
| 12. | Ammonia (NH ₃) | Ion-selective electrode method |
| 13. | Conductivity | Conductivity meter |

3. RESULTS AND DISCUSSION

The maximum pH was observed to be 8.11 in station 1 and the minimum of 7.24 observed in station 4. This range falls within the permissible limits but suggests potential anthropogenic influences at station 1. Comparatively, [4] reported a wider pH range of 6.70-8.30 in the Thamirabarani River, attributing fluctuations to agricultural runoff and industrial effluents. Variations in both studies likely stem from diverse pollutant sources and seasonal changes. (Table 2)

The maximum TDS was found to be 979 mg/L in station 2 and the minimum of 23 mg/L in station 4. This range is highly deviated compared to other Thamiraparani studies, such as 185-384 mg/L reported by [5] and 254-462 mg/L by [6]. The higher maximum in our study suggests increased pollution at certain points, possibly due to intensified agricultural runoff or industrial discharge (Table 2)

The maximum total hardness was found to be 288 mg/L in station 1 and minimum of 13 mg/L observed in station 4, wider than the 98-236 mg/L reported by [7]. The higher maximum suggests increased mineral content, possibly due to geological variations or

anthropogenic activities. Fluctuations may result from seasonal changes in water flow and pollutant concentrations. (Table 2)

The maximum chloride level was found to be 268 mg/L in station 2 and minimum of 8 mg/L was observed in station 4, exceeding the range of 32-186 mg/L reported by [8]. The higher maximum suggests increased pollution, possibly from urban runoff or industrial discharge. Fluctuations may be due to seasonal variations in water flow and localized anthropogenic activities along the river. (Table 2)

The maximum calcium level was to be found to be 52 mg/L in station 1 and minimum of 2 mg/L in station 4. The lower range suggests less geological influence or reduced agricultural runoff. Fluctuations may result from seasonal variations in water flow and localized erosion patterns. (Table 2)

The maximum magnesium level was found to be 38 mg/L (Station 1) and a minimum of 2 mg/L was observed in station 4., which differs from the range of 12-29 mg/L reported by [9]. Our wider range suggests greater variability in magnesium concentrations along the river. Fluctuations may be due to differences in sampling locations, seasonal variations in water flow, and localized impacts of agricultural runoff or industrial discharges. (Table 2)

The maximum of observed EC level was found in station 1 and minimum EC was observed in station 4., significantly that are wider than the 310-820 $\mu\text{S}/\text{cm}$ reported by [10]. Our higher maximum suggests increased ionic concentrations, possibly due to greater pollution loads. Fluctuations may result from variations in discharge points, seasonal changes, and differing land use patterns along the river course. (Table 2)

The maximum ammonium level was found to be 27.4 mg/L (station 2) and the minimum of 0.32 was observed in station 3 & 4. This is higher than the 0.028 to 1.96 mg/L found in Thamiraparani River reported by [11]. Changes may be due to farm runoff, sewage, or factory waste. (Table 2)

Our study found controlled nitrate levels below 45 mg/L across all stations, meeting the acceptable limit. This range is lower than the 0.9-48.0 mg/L reported by [11]. Fluctuations may be attributed to seasonal changes in agricultural activities, rainfall patterns, and variations in industrial discharges. (Table 2)

The maximum turbidity was found to be 9 mg/L in 2 and the minimum of 1 mg/L in station 4. This range differs from the 1.8-4.2 NTU reported by [11]. Fluctuations may result from erosion, runoff, and algal growth. (Table 2)

The maximum of Total alkaline level was found to be 332 mg/L in station 2 and the minimum of 4 mg/L was observed in station 4. This range differs from the 92-240 mg/L reported by [11]. Fluctuations may be due to variations in carbonate-rich rock weathering, industrial effluents, and agricultural runoff. Higher alkalinity often correlates with higher pH levels in water bodies. (Table 2)

Our study found consistent fluoride levels of 0.2 mg/L across all stations, below the 1 mg/L limit. This contrasts with the 0.2-1.5 mg/L range in [11]. Consistency suggests minimal geological or anthropogenic fluoride sources. (Table 2)

The maximum of iron level was found to be 0.35 mg/L (Station 1, 3&4) and the minimum of 0.25 mg/L in station 2. This differs from the 0.01-0.03 studied by [11]. Fluctuations may result

from geological sources, industrial effluents, or corrosion of water distribution systems.
(Table 2)

| Table 2. Water quality Parameters and Acceptable limit | | | | | | | | |
|---|-----------------------------|-------------|---|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|
| S.no | Parameters | Unit | Test Method | Result Station 1 | Result Station 2 | Result Station 3 | Result Station 4 | Acceptable limit |
| 1 | pH | - | IS 3025 Part 11-1983 | 8.11 | 7.89 | 7.69 | 7.24 | 6.5-8.5 |
| 2 | Total Hardness | mg/L | IS 3025 Part 21-2009 | 288 | 260 | 35 | 13 | 200 |
| 3 | Total Alkalinity | mg/L | IS 3025 Part 23-1986 | 224 | 332 | 39 | 4 | 200 |
| 4 | Chloride (Cl) | mg/L | IS 3025 Part 32-1988 | 178 | 268 | 19 | 8 | 250 |
| 5 | Nitrate (NO ₃) | mg/L | APHA 23rd Edition 2017-4500-NO ₃ B | 2 | <2 | <2 | <2 | 45 |
| 6 | Fluoride (F) | mg/L | APHA 23rd Edition 2017-4500-F-D | <0.2 | <0.2 | <0.2 | <0.2 | 1.0 |
| 7 | Turbidity | NTU | APHA 23rd Edition 2017-2130 B | 4 | 9 | 6 | 1 | 1 |
| 8 | Total Dissolved solid (TDS) | mg/L | APHA 23rd Edition 2017-2540 B | 699 | 979 | 94 | 23 | 500 |
| 9 | Conductivity | µS/cm | APHA 23rd Edition 2017-2510 B | 1029 | 1440 | 138 | 34 | - |
| 10 | Calcium (Ca) | mg/L | APHA 23rd Edition 2017-3500 Ca B | 51 | 48 | 6 | 2 | 75 |
| 11 | Magnesium (Mg) | mg/L | APHA 23rd | 38 | 34 | 5 | 2 | 30 |

| | | | | | | | | | | | | | | | |
|----|-------------------------------------|-------|--------|--------|--------|---------------|----------|--------|--------|--------|--------|--------|----------|---|--|
| 13 | Nitrate (NO₂) | 0.749 | 0.7219 | 0.4248 | 0.4095 | 0.9934 | -0.09389 | 0.4643 | 0.4621 | 0.6993 | 0.7272 | 0.2258 | -0.08225 | 1 | |
|----|-------------------------------------|-------|--------|--------|--------|---------------|----------|--------|--------|--------|--------|--------|----------|---|--|

The water quality assessment conducted at various stations provides valuable insights into the environmental conditions and potential risks associated with water resources. ‘

Station 1 (Murugankoil Road, CN Village, Tirunelveli)

It exhibited deviations from permissible limits in several parameters, including total hardness, alkalinity, chloride, total dissolved solids (TDS), conductivity, calcium, and magnesium, indicating potential contamination from anthropogenic sources. Conversely,

Station 2 (Pulenthoppu Street, Meenakshipuram, Tirunelveli)

It demonstrated elevated levels of most parameters, such as total hardness, alkalinity, chloride, turbidity, TDS, conductivity, calcium, magnesium, and ammonia, suggesting significant anthropogenic influence and potential health hazards.

Station 3 (Tirunelveli town, CN Village, Tirunelveli)

It presented a mix of parameters within and exceeding permissible limits, indicating a moderate level of contamination and environmental stressors.

Station 4 (Papanasam Dam, Papanasam)

It showcased commendable adherence to acceptable limits across all parameters, reflecting relatively pristine water quality and minimal anthropogenic impact. These findings underscore the importance of continued monitoring and conservation efforts to safeguard water resources and ensure public health and ecosystem sustainability.

4. CONCLUSION

The water quality assessment conducted in this study provides valuable insights into the environmental conditions and potential risks associated with water resources in the Thamirabarani River basin. The results highlight areas of concern where certain water quality parameters exceed permissible limits, as well as locations where the water quality is relatively pristine. Station 1 and Station 2 exhibited deviations from acceptable limits across multiple parameters, indicating potential contamination from anthropogenic sources such as untreated sewage, industrial effluents, and agricultural runoff. These findings underscore the need for better management of waste discharges and implementation of appropriate treatment measures to protect water resources.

5.Suggestions:

In contrast, Station 4 showcased commendable adherence to water quality standards, reflecting a relatively undisturbed environment with minimal anthropogenic impact. This station can serve as a benchmark for assessing the effectiveness of conservation and remediation efforts in the other affected areas. The study highlights the importance of ongoing monitoring, implementation of remedial actions, and enhanced source water protection measures to maintain and improve water quality in the region. A comprehensive, long-term water quality management plan that incorporates continuous monitoring, public education, and sustainable practices is essential for safeguarding aquatic ecosystems, preserving this valuable natural resource, and ensuring the health and well-being of local communities

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