Evaluating Water Quality through Macroinvertebrate Diversity and Physicochemical Parameters in the Thamirabarani River Basin

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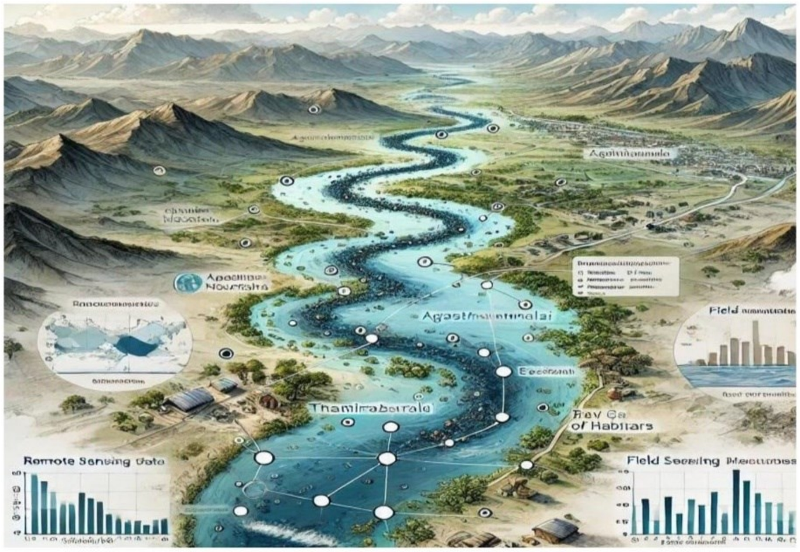
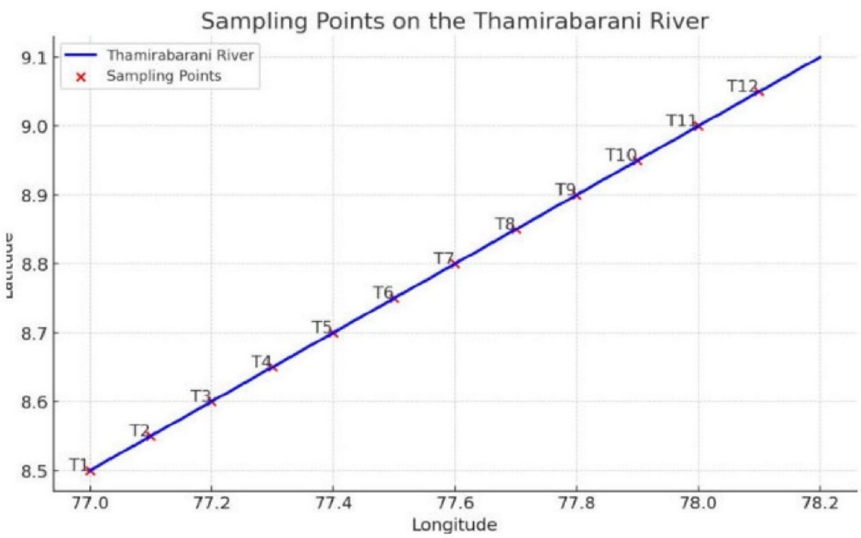
GRAPHICAL ABSTRACT





Abstract

Aquatic ecosystems in the Thamirabarani River Basin, Tamil Nadu, India, are facing increasingly complex challenges due to climate change, particularly concerning water temperature and dissolved oxygen levels. This study delves into the intricate relationship between these variables and their profound implications for freshwater biodiversity. The rising temperatures and declining dissolved oxygen levels pose escalating threats to the health of aquatic organisms and the stability of ecosystems. To tackle this issue, a hybrid methodology that integrates remote sensing and field data is proposed to calculate the Water Quality Index (WQI) and comprehensively assess ecosystem health. Remote sensing data offer valuable spatial insights, while field measurements ensure accuracy, resulting in robust findings. The study uncovers a significant negative correlation between water temperature and dissolved oxygen levels, highlighting the adverse effects of warming waters on aquatic habitats. Moreover, habitat fragmentation exacerbates climate

stressors, adding further challenges to freshwater biodiversity conservation. The findings underscore the urgent need for conservation and adaptive management strategies, including temperature regulation, riparian vegetation enhancement, nutrient pollution management, and habitat connectivity preservation. By implementing these measures, biodiversity loss in freshwater ecosystems can be minimized, ensuring their resilience in the face of ongoing climate change.

Keywords: Macro invertebrates, urban streams, water quality, trichoptera, plecoptera, monitoring, Ephemeroptera, Urbanization impacts and Biodiversity assessment

1. Introduction

Large mirrorless macroinvertebrates can be seen with the naked eye. They are essential to freshwater ecology, cycling nutrients, food webs, and ecosystem services. High species diversity in the aquarium includes insects, crustaceans, mollusks, and worms, which play different ecological roles in streams, rivers, lakes, and wetlands. Bioindicators of freshwater water quality and environment make macroinvertebrates one of the most important elements of the ecosystem. By variety and abundance, aquatic ecosystems' overall condition can be summarized. For instance, macroinvertebrates that are intolerant of pollution or habitat destruction are good indicators of water quality. Key macroinvertebrate community stages shifting over time may indicate higher pollutant levels or aquatic habitat disturbance.

In general, critical variables are pH (potential of hydrogen), BOD (biochemical oxygen demand), and COD (chemical oxygen demand). COD gauges the degree of pollution in water by measuring the quantity of oxygen needed to oxidize organic materials. The amount of oxygen used by microbes during the breakdown of organic waste is measured by BOD, which indicates the degree of organic contamination in water. The pH scale, which measures how acidic or alkaline water is, is important for both industrial and aquatic life. In many cases, a Water Quality Index (WQI) value would be a fairly useful index. It enables the study of enormous datasets of water quality that fluctuate across time and space to yield a single result. Water quality is the main subject, which should be fully comprehended for those who main the water of that particular place body. This index method will suffice for assessing the water supply hazard among societies.

The pressing need to comprehend the water quality of the Thamirabarani River Basin in the context of industry, urbanization, and climate change is the objective behind this study. Assessing water quality, determining important physicochemical characteristics, and investigating their influence on biotic indices are the goals. Its hybrid methodology, which combines field measurements with remote sensing to provide a thorough evaluation of water quality, is innovative. Important insights into ecological effects are provided by this research, supporting efficient water management and the preservation of biodiversity. This research is novel because it uses a hybrid methodology that integrates data from remote sensing and field measurements to provide a thorough assessment of water quality. The Thamirabarani River Basin was selected for the study because it is a crucial freshwater ecosystem that is experiencing a growing number of environmental problems, making it a perfect case study. This decision enables a comprehensive comprehension of the ecological effects of different stresses and the creation of efficient management plans for the sustainability of freshwater resources.

This study motivated by the urgent need to comprehend the intricate relationships that exist between the socio-environmental systems and geographical features of the Thamirabarani River Basin. It is critical to evaluate the condition of the water resources in the basin due to the mounting demands of industrialization, urbanization, and climate change.

The study offers a contribution as follows

- Utilising a hybrid methodology combines field measurements with data from remote sensing to provide an extensive assessment of the quality of the water.
- The study not only pinpoints important physicochemical factors influencing the quality of water, but it also emphasizes the complex relationships that exist between these factors and biotic indicators.
- This work helps develop efficient water management techniques by providing insights into the ecological effects of temperature fluctuations, dissolved oxygen levels, and fertilizer concentrations.

In the end, it is in favour of freshwater ecosystem sustainability and biodiversity preservation in the face of escalating environmental difficulties.

2. Review of literature

Sahoo & Saha (2023), has investigated industrial zone water quality in terms of WQI. Besides that, this research discusses environmental consequences of industrial activities and pollution mitigation. This study can assess water quality parameters such as aquatic life and biological diversity that are impacted by industrial discharges and runoff. This makes it possible for stakeholders to formulate strategies addressing pollution and to minimize the damage to ecology and so to protect water resources in the regions where industry is well developed.

Singh (2023), has applied a comparative approach to assessing existing WQI models. Refining our methodologies and improving the ability to detect development pressures is the research's contribution to determining the quality of river water. Employing a comparative approach in the study provides a basis to analyze the advantages and setbacks of different methods for the WQI calculation.

Rahmati & Alibi (2023), has proposed the hybridization of the WQI with the multivariate statistics in the parts dealing with agriculture rules, this study now opens the opportunity to watch for or watch any kinds of associations that exist between the farming practices and water quality that would lead to the sustainable management of the water resources. The research demonstrates the extreme vulnerability of water resources due to widespread agricultural activities and the grim consequences of poor water quality associated with land use patterns.

Mishra & Patel (2023), the study has concentrating on lakes' water quality of urban areas, Mishra and Patel take into account the approach that is built on the basis of water quality index calculations (WQI) and the advanced remote sensing techniques. Incorporating WQI data with spatial services like satellite imagery and remote sensing, the research delivers a detailed assessment of the condition of the urban lab and also indicates the locations of sources of pollution as well as other causes of ecological stress.

Wang & Li (2023), study shows that WQI is a useful instrument in the water quality index. This study also brings out the seasonal and long-term variation aspects of water quality in the coastal region. The literature reviews the seasonal/historical data and the complex relationships between anthropogenic and natural variabilities on coastal water quality are unraveled by their research.

Yang & Huang (2023), this study assesses how climate change defiles water quality using the WQI and the application of hydrological modeling methods. By working on the matter, the study provides an insight into the role of climate change and variability in controlling water quality parameters, critical info for the development of water resources management and climate change adaptation strategies.

Chen & Zhang (2023), Study has serves a comparison of various WQI models for assessing the state of lake water quality in the face of importance shift. This project examines the available WQI methodology, and is also a key source of understanding the proper water quality assessment methods in order to have effective environmental management in a dynamic environment. Such research may gain is to hone the WQI system, thus, increasing its relevance at a time when ecosystem conservation and management is required owing to global environmental changes.

Buçinca, A., (2024) suggests using macroinvertebrates and benthic diatoms as bioindicators to assess the water quality in Kosovo's Ibër Basin. This method examines the variety, abundance, and ecological indices of these creatures at 20 different sampling locations in order to evaluate the effects of different human pressures on freshwater ecosystems. The results help guide plans for managing water resources, enabling focused conservation and cleanup initiatives to enhance and maintain the basin's overall water quality.

Ni, L., (2024) examines the species, density, and biomass of benthic macroinvertebrates in Hongze Lake between 2016 and 2020, as well as physicochemical variables. The structure of macroinvertebrate communities is correlated with dissolved oxygen and pH by redundancy analysis (RDA). The study's objectives are to identify dominating species and regional variations and to evaluate the quality of the water using indices based on macroinvertebrates.

Zeybek Yünlü, M (2024) evaluate the pollution levels in Yalvaç Stream, which is an essential water supply for Lake Eğirdir in Turkey, and how they affect the lake's pollution load and water usability. It looks at the macrozoobenthic invertebrate fauna using biotic indices and diversity assessments, seasonal sampling, and invertebrate fauna analysis to assess water quality. The results emphasize the decline in water quality that is linked to pollution from homes, businesses, and animals.

Dügel, M., (2024) is to evaluate the distribution and ecological state of macroinvertebrates at 44 locations in the Ceyhan River Basin throughout various seasons. Its objectives are to ascertain how environmental factors affect the composition of macroinvertebrates and assess ecological quality by applying the Multimetric Index. The distribution of species and variables such as temperature, pH, and altitude are found to be significantly correlated in the results.

3. Materials and Methods

3.1. Study area description

The complex interaction of physical characteristics and the socio-environmental system makes Thamirabarani River Basin, a big natural area in southern Tamil Nadu, a fascinating research area. This basin borders the districts of Tirunelveli and Thoothukudi, giving scientists considerable room to research plants and animals. From the rich Agasthyamalai Mountains in the Western Ghats, Thamirabarani River flows east through a variety of habitats, from rocky mountains to broad plains. The river merges into the Bay of Bengal near its end, highlighting its importance in maintaining the regional hydrological system. Visitors love the basin's natural beauty and intricate human-environment interactions. In my country, land is essential for survival, supporting organ and agricultural production. Urbanization exacerbates urban-rural conflicts. An added element presents challenges and opportunities. It is pursued while preserving water supplies that degrade with urbanization.

Sampling points along the Thamirabarani River were strategically selected to cover diverse ecological and anthropogenic influences. **Papanasam (T1)** and **Agasthiyar Falls (T2)** represent upstream, pristine conditions. **Servalar Reservoir (T3)** assesses the impact of water retention. **Manimuthar (T4)** examines confluence effects, while **Tirunelveli (T5)** provides insights into urban influences. **Cheranmahadevi (T6)** and **Veeravanallur (T7)** study mid-stream impacts of agriculture and urban runoff. **Alwarthirunagari (T8)** looks at cumulative downstream effects, and **Srivaikuntam (T9)** investigates the impact of water regulation. **Arumuganeri (T10)** and **Punnaikayal (T11)** focus on estuarine transitions, while **Tuticorin (T12)** explores coastal influences. This diverse selection ensures a comprehensive assessment of macroinvertebrate diversity and water quality.

3.2. Data collection

1. Remote Sensing Data: Videos of high spatial resolution satellite imaging and remote sensing data were requested from trustworthy sources ranging from ISRO and other institutions.

2. Field Measurements: The monitoring process had the measurements on five fundamental water quality indicators such as pH, dissolved oxygen, biochemical oxygen demand, and total suspended solids.

3. Historical Data: Tables would be built from extensive historical datasets obtained from governments, research organizations and past studies over a period of several years.

3.3. WQI calculation and hybrid modeling

The hybrid computing of the Water Quality Index (WQI) study for the Thamirabarani River Basin study reflects a wise methodology which features the strengths of both remote sensing based data maturity as well as field performance verified data. This approach is the critical component of getting a more precise and comprehensive water quality assessment, which is done jointly by direct, on-the-ground inspections and positional data provided by the remote sensing technologies. The WQI was established to data these four parameters- pH (Potential of Hydrogen), dissolved oxygen (DO), biochemical oxygen demand (BOD) and total suspended solids (TSS)- that were obtained either through measurements or derivations. From field measurements and remote sensing data analysis, these values were realized.

Firstly, laboratory investigations carried out in the Tamirabarani basin began with water sample collection from different portions of the river thereby enabling actual determination of these physical parameters.

After collection of all data points for every parameter, we compared them against professional standards or regulatory agency thresholds for permissible levels of environmental variables. Water parameters weightage then represented the score of each parameter depending on its individual importance to water quality. The formula for calculating the Water Quality Index (WQI) typically involves assigning weights to individual water quality parameters based on their importance, then summing these weighted values to obtain a composite index score. It can be represented as:

$$WQI = \sum_{k=1}^{n} W_k \times R_k$$

Where, W_k and R_k denotes the weight and value of each WQ parameter $k \epsilon n$. Usually, each water quality parameter R_k is converted from its measured value to a dimensionless rating by comparing it to reference or standard values. The total WQI score is then calculated by multiplying these ratings by the corresponding weights and adding them together. Stronger parameters which are more important ecologically or greatly affect the health of humans were given larger weighting systems in the computation of WQI.

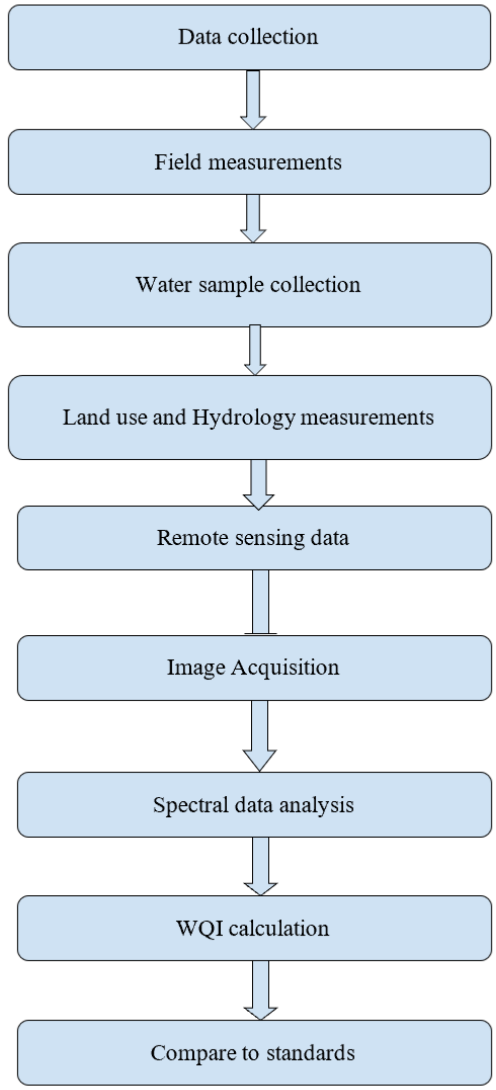


Figure1. Working model of this study

The study's methodology is presented in Figure 1, which shows a thorough procedure for evaluating the water quality in the Thamirabarani River Basin. It includes field measurements and the collecting of water samples, as well as the integration of data analysis from remote sensing. This graphic depiction provides a concise synopsis of the study's methodology, improving comprehension of the research technique and its implications for the evaluation of water quality.

3.4. Hybrid modeling

For the Thamirabarani River Basin WQI study, hybrid approach is a significant and comprehensive water quality indicator since it uses remote sensing data and field data. Remote sensing-based continuous data supplies can take pictures of the catchment area and determine its spatial features. Such data provides unique insights into water clarity, vegetation cover, etc., and is essential for water quality research.

Our suggested hybrid technique calculates hydrologic parameters using remote sensing and field measurement data to merge both datasets. For example, remote sensing data can detect water clarity trends and areas with good vegetation. By directly monitoring nutrient concentrations, dissolved oxygen levels, and other essential water quality indicators, laboratory experiments validate findings. Water quality factors are weighted differently in the hybrid methodology to reflect their relative importance in water quality assessment. Ecological significance, regulatory norms, and human health implications are considered before weighting goods. To avoid this, the WQI calculation's higher-weighted criteria evaluate Pahoa’s impact on water quality and ecosystem health, leading in a more accurate and meaningful study. The Pahoa's impact illustrates how multiple factors affect ecosystem health and water quality. Ecological importance, legal needs, and health implications are included.

4. Results and discussion

4.1. Physicochemical properties

The study's physicochemical features cover a range of factors that are essential for evaluating the quality of water. These variables include turbidity, electrical conductivity, pH, temperature, dissolved oxygen, and concentrations of nutrients. Every metric offers an information on several facets of water quality, including pollution, nutrient levels, and appropriateness for aquatic life. This table 1, physicochemical variables help us to depict the rich and diverse features of humans and other forms of life in this case study of Thamirabarani River Basin. The parameters to be considered are represented in the table given below.

Table 1. Physicochemical properties

Variable	**Range**	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**	**Variance**
Temperature	48˚C	8.80˚C	23.20˚C	32˚C	27.796˚C	4.838˚C^2
Velocity	48 m/s	1.38 m/s	0.00 m/s	1.38 m/s	0.373 m/s	0.066 m^2/s^2
Discharge	48 m^3/s	40.77	0.00 m^2/s	40.77 m^3/s	21.112	141.036 m^2/s^2

		m^3/s			m^3/s	
pH	48	7.10	8.38	7.775	0.34	0.118
EC	48 µS/cm	496.73 µS/cm	38.63 µS/cm	535.36 µS/cm	193.449 µS/cm	16848.235 µS^3/cm^2
DO	48 mg/l	3.30 mg/l	4.80 mg/l	8.10 mg/l	6.357 mg/l	0.705 mg^2/l^2
Turbidity	48 NTU	13.07 NTU	0.30 NTU	13.37 NTU	3.150 NTU	9.550 NTU^2
NH4N	48 mg/l	0.22 mg/l	0.00 mg/l	0.22 mg/l	0.064 mg/l	0.005 mg^2/l^2
NO2	48 mg/l	0.30 mg/l	0.00 mg/l	0.30 mg/l	0.015 mg/l	0.002 mg^2/l^2
NO3	48 mg/l	0.79 mg/l	0.02 mg/l	0.81 mg/l	0.346 mg/l	0.046 mg^2/l^2
PO4	48 mg/l	3.29 mg/l	0.00 mg/l	3.29 mg/l	1.122 mg/l	0.862 mg^2/l^2
COD	48 mg/l	12 mg/l	2 mg/l	14 mg/l	5.854 mg/l	10.766 mg^2/l^2
BOD	48 mg/l	6.70 mg/l	0.20 mg/l	6.90 mg/l	2.166 mg/l	1.641 mg^2/l^2
TKN	48 mg/l	0.78 mg/l	0.06 mg/l	0.84 mg/l	0.443 mg/l	0.046 mg^2/l^2
SO4	48 mg/l	17.59 mg/l	0.99 mg/l	18.58 mg/l	6.104 mg/l	7.573 mg^2/l^2
TC	48 MPN Count/100 ml	896 MPN Count/100 ml	4 MPN Count/100 ml	900 MPN Count/100 ml	80.458 MPN Count/100 ml	18651.445 MPN^2Count^2/100 ml^2
FC	48 MPN	108 MPN	2 MPN	110 MPN	16 MPN	0.155 MPN^2

	Count/100 ml	Count/100 ml	Count/100 ml	Count/100 ml	Count/100 ml	$Count^2/100ml^2$

It regulates biochemical activity in water; the completion process of nutrients and the distribution of the species. These are the factors that define the measured temperatures: seasonal manifestation and river basin thermal balance. These values define the selection of water regarding aquatic life, irrigation, and other relevant uses. The presented pH levels differ, hence, the water quality is mildly alkaline, mainly beneficial to water dwellers. OD then becomes the oxygen with which all water organisms breathe. Thus, the obtained variation proves that oxygen concentration sustains various types of aquatic environments. Defined as the extent of light penetration through the water body, "Turbidity"(TDY) results from water sedimentation, organic matter, and human interferences. Therefore high wineries are needed for light, algae growth, and ecosystem production.

4.2. Correlation matrix between physicochemical variables

Correlation table 2 analyzes the causal relations rather than the effects between different physical chemistry with biotic indices in the Tamarabarani river basin area.

Table2. Correlation matrix between physicochemical variables

Variable	**FBI**	**EPT**	**EPTC**	**ASPT**	**BMWP**
Temp	507*	-.420*	-.294	-.305	-.337
Velo	-.202	.159	.031	160	334*
Disch	.002	-.100	.021	-.018	.156
pH	.263	-.316*	.005	-.272	-.192
EC	.475*	-.406*	-.176	-.538*	-.432*
DO	-.290*	332*	.067	.362*	.175
TDY	.162	-.123	-.140	-.239	-.192

NH4N	.528*	-.363*	-.244	-.403*	-.518*
NO2	115	-.093	-.113	-.091	-.013
NO3	.213	-.218	-.024	-.386*	-.195
PO4	.208	-.037	-.305*	-.327*	-.179
COD	299*	-.254	-.177	-.174	-.233
BOD	.352*	-.324*	-.169	-.514*	-.343*
TKN	.416*	-.361*	-.148	-.544*	-.372*
SO4	360*	.312*	-.140	-.495*	-.299*
TC	393*	-.209	-.295	-.224	-.389*
FC	.416*	-.185	-.387*	-.229	-.431*

The electrical conductivity shows the strongest positive correlation with Biochemical Oxygen Demand, Organic Material and Nitrate, which means that the levels of EC and water quality indicators are strongly related. However, there are incomplete and weak positive connections with IONC, Chironomides, Ephemeropterraelly Transfers (EPT), Average Score per Taxon (ASPT), and Danish Biological Index (DBI), meaning that the relationships between EC and biotic indices might be complicated by other variables and factors.

Nitrate (NO3) displays a moderately positive linear relationship with FBI and EC that is not high suggesting that NO3 levels can contribute to overall water quality and conductivity. Though NO3 shows a moderate inverse correlation with EPT, ASPT, and BMWP, evidence can be implied that it has the potential to cause ecological damage as a result of its variations with the environmental factors. In a similar way, there is a very close relationship between TKN readings and FBI index, EC index and Total Coliform (TC) values. This shows that the chances of high TKN levels translating to unhealthy water quality and also a high microbial contamination. Similarly, TKN shares the strongest negative correlations with EPT, ASPT, and BMWP. This highlights, perhaps, ecological problems that have been generated by higher density of TKN.

The TC and FC correlations with FBI, EC, and NH4N displays positive values thus suggesting potential correlations between microbial water contamination levels and water quality. Conductivity would also play a significant role in the equation. On the other hand, extremely poor turbidity index, algal poisoning toxicity index, and biotic measures index have been considerably decreased when coliform concentration is higher, which may be observed as ecological impacts of those biotic indices. Ultimately, the whole correlation matrix reveals the very existence of intricate communications between physicochemical things and the biotic indicators in the water system of Thamirabarani River Basin, shedding the light on the probably ecological sensibility of the river and possible water quality repercussions for the environment and human health.

4.3. Total number of organisms observed during this study

The results of diverse treatments are depicted in the figure 2 covering the period from June to August, which are presented regularly. The treatments, which are designated from T1 to T12, behave differently within the course of the three-month period and may suggest possible actions as well as changes connected to instrument application

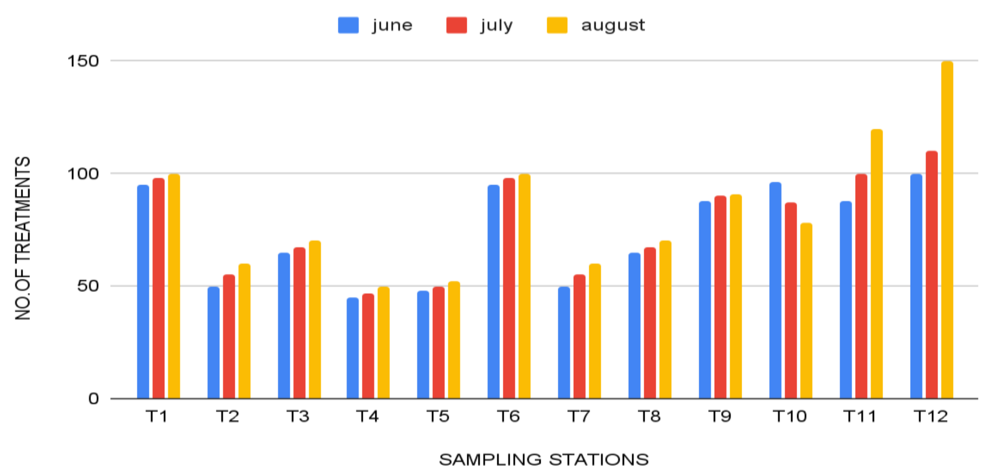


Figure 2: Total number of organisms during this study

When data exploratory analysis is made, some trends and phenomenon become visible. T1, T6, T7 and T8 treatments often record high values each of the 3 months. This indicates a long-term positive impacting or effectiveness, the scalability of the treatments. On the contrary T2, T4, and T5 treatment, the responses are lower than the other ones. This can be explained either by their minimal effectiveness or by their responses to the certain conditions in a specific social group. I found an interesting fact which is that these four treatments (T9, T10, T11, and T12) that we assessed had continually varied in value during the rime. Such treatments often present with the values ranging from one month to another month, thus, coming with higher and lower interim results. This uncertainty might be caused by a number of factors such as different environmental conditions, methods of applying the treatment, or the innate variability in the responses to the same treatment which often arises over time.

Treatment disparities show a poor rate at both levels in every month of comparison. However, June treatments like T1, T6, and T12 are more advanced than T2, T4, and T5. However, in August, the image may alter, which may indicate new medications or patient response to treatment. ANOVA and T-tests are used to compare groups, such as treatments given in different months. The F-ratio illustrates variability between and within groups in an ANOVA of three or more groups, such as treatments spanning several months. However, t-tests compare two groups' means, such as June versus August treatments. T-tests use sample sizes, variances, and means to calculate T-statistics to compare differences. If reported changes are statistically significant, these tests separate treatment responses from random variations. ANOVA and T-tests are needed to compare treatment results and draw inferences from experimental data.

4.4. Variations in the family biotic index level of river Tamirabarani

From the given information the figure 3 shows that, the treatments with values under 3 can be termed "Excellent," the others with value range from 4 to 5 are called "Good," treatments whose values oscillate in the range 5 to 6 can be referred to as "Fair," and the rest with the value more than 7 are considered as “Poor.”

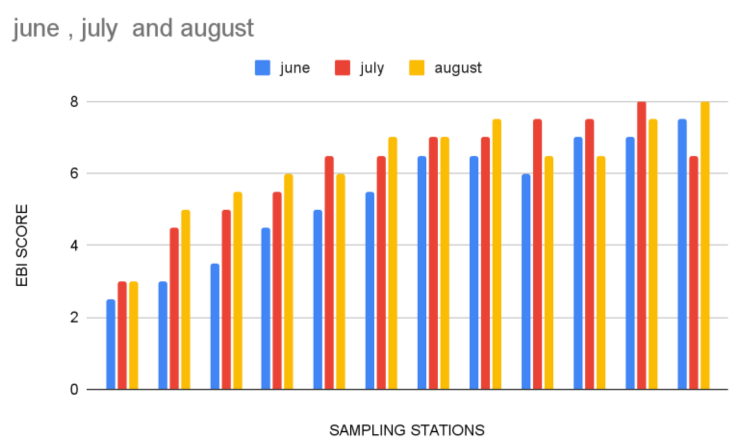


Fig. 3 Variations in the family biotic index level of river Thamirabarani

Illustratively, the treatments T1, T2, and T3 always fall within the “Excellent” square for all months, further demonstrating their consistent high performance. Treatment of regimes type 4, type 5, and type 6 fall generally in discretionary bucket exclusive of making the grade although nevertheless possessing potential of improvement. Plans, T7, T8, and T9 implement the share category, which signifies quite effective options but need some improvements. There are still three processes, T10, T11, and T12 whose returned grade is 'poor'. These processes require re-design or intervention since their performance is unsatisfying. The segregation of types of treatment to create clarity permits for a quick interpretation and a comparison between treatments which can further be deepened to assess performance levels. Which nuance as there may be additional studies or her text analysis to be checks to ensure total evaluation and decision-making.

4.5. Temperature and dissolved oxygen

The interaction of water temperature and dissolved oxygen levels constitutes the basis for drawing inferences concerning the water body's health. The research that demonstrates the strength of this relationship will generate a significant negative correlation, emphasizing the central role of temperature as a determining factor for the quantity of oxygenates in water bodies. With more warm water, the lesser oxygen dissolves which means that warmer water cannot contain the more Dissolved Oxygen. A rise of temperature decreases the amount of oxygen for aquatic organisms and can increase the odds of oxygen-deprived conditions, toxic to some of the aquatic organisms.

4.6. Habitat fragmentation

Climate change poses threats to freshwater ecosystems mainly because of the biodiversity and climate effects. Biotic measures such as EPT and ASPT demonstrate the quality of water, pollution and existence of physical modifications on aquatic live.

Heat has impact on the water species diversity. Said species as Ephemeroptera, Plecoptera, and Trichoptera, are Cold-Water organisms which are now endangered by climate change. Climate change can affect the migratory birds, reptiles, and insects from one region to another and they may face risks. Tourist transport ratings involving ecological and aquatic species could reduce. Global warming can have a positive impact on a certain organisms, modifying also the seasonal distribution of the freshwater communities. Climate change affects water precipitation (compresses another tori of downpour and drought) thus exerting pressure on water bodies. These circumstances hinder flow, foul water and also exterminate the aquatic life. Therefore, changes in the pattern of precipitation may impact species distribution either in leading ecologic systems disturbed by changes in the precipitation change regime stressors or biotic indices.

The levels of nutrients resulting from human influence significantly influence the rate at which the inhabitants of water bodies go extinct/thrive. The increase in nutrient concentration leads to more growth of algae and eutrophication that in turn help boost the welfare of some organism. Pollution by nutrients harms water quality and decreases biotic indicators responsive to the human nutrients in protected ecosystems. Hydrology as well as the rise in sea level acted as the separators of the habitats of aquatic animals. In broken environment, slow corresponding means that genetic link is lost and local gene pools go extinct. These signs are indicated by fragmentation, a typical climate stressor which may negatively impact biotic indices that are deemed to reflect ecosystem variety and connection, thus concurrently showing that climate change is unfavorably affecting the freshwater ecosystem biodiversity. Effects of climate change are evident on biologic indices caused by the factor such as temperature, precipitation, nutrient concentration, and fragmentation of habitats. This papers discusses many of the problems that are facing fresh water systems. Conservation promotes adaptive management in regards to the aquatic ecosystem and its mitigation/treatment. Thus, it would be possible to prevent the extinction of species and preserve such components of the natural environment as communities, ecosystems, ecosystems' elements, and other kinds of biological diversity.

Due to their environmental sensitivity macroinvertebrates can therefore be classified as good water quality bioindicators. Ecological sources on bodies of water are diverse and rich. Environmental problems such as heat as well as dissolved oxygen deficiency impacts on habitats of the macrofauntes. High temperatures affect the solubility of oxygen dissolved in water and consequently death macroinvertebrates occur. Increased amount of chemical fertilizer from human activities, causes algal blooms, which reduce the availability of oxygen. Such factors alter the population and quality of macroinvertebrates resulting in changes within ecosystems and food webs. For assessing water quality, measurement of temperature, dissolved oxygen and nutrients must be carried out. There is a tight coupling of macroinvertebrate populations and environmental variables detected when remote and actual measurements are taken. Conservation of freshwater ecosystem and its utilization is encouraged.

5. Conclusion

The Thamirabarani River Basin study highlights impact on aquatic biodiversity and sheds light on climate change and water quality. The Thamirabarani River Basin study found a negative association between water temperature and dissolved oxygen (DO) levels, with DO levels ranging from 3.30 mg/l to 8.10 mg/l at temperatures between 8.80˚C to 23.20˚C. Excessive precipitation increased pollutant flow, with phosphate and nitrogen levels ranging from 0.00 mg/l to 3.29 and 0.84 mg/l, respectively. These findings highlight the influence of climate change on water quality and the need for better data collection to assess long-term implications, which may cause hypoxic or anoxic conditions that endanger aquatic life. The main study reveals that excessive precipitation and nutrient influx affect aquatic environment health. High rainfall increases pollutant discharge into the water, causing nutritional changes and water discoloration that disrupt the aquatic ecology. Nutrient management was also necessary since too much phosphate and nitrogen can cause toxic algae and eutrophication, which harms water and biotic indicators. The study's data collection was limited, especially for land use fluctuation and climate change's long-term effects. Future research should focus on expanding the temporal and spatial scope of studies to include wider geographic areas and longer time periods to better understand how climate change affects freshwater ecosystems.

Nomenclature

WQI	Water Quality Index
pH	Potential of Hydrogen
DO	dissolved oxygen
BOD	biochemical oxygen demand
TSS	total suspended solids
EC	electrical conductivity
TDY	Turbidity
NH4N	ammonia nitrogen
NO2	NO2
NO3	nitrate-nitrogen
PO4	phosphate
COD	chemical oxygen demand
BOD	biochemical oxygen demand
NH\u004cN	ammonia nitrogen)
PO\u004c	phosphate
TC	total coliform
FC	fecal coliform
EPT	Ephemeroptera, Plecoptera, Trichoptera
ASPT	Average Score per Taxon
DBI	Danish Biological Index

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