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Investigation of Water Quality Assessment and Ecological Status in the Thamirabarani River Using Diatom Diversity

A. Rajeshkanna[1,*], R. Venkatachalapathy[1]

[1]Micropalaeontology laboratory, Department of Geology, Periyar University, Salem-636 011, Tamil Nadu, India

[*]Corresponding author: **A. Rajeshkanna**

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KEYWORDS

ThamirabaraniRiver, Macrophyts, OMNIDIA, Biological Diatom Index, Water Quality Index

ABSTRACT:

In the present study was investigated the water quality assessment in Thamirabarani river. A total of 44 macrophyts samples and water samples were collected from 22 different locations during the winter (December 2022) and summer (March 2023) seasons. In the presence study total of 135 diatom taxa belongs to 43 genera were recorded. The most abundant genera namely *Aulacoseira, Bacillaria, Cocconeis, Cymbella, Cyclotella, Diadesmis, Discostella, Gomphonema, Navicula, Nitzschia, Staurosirella, Seminavis, Tryblionella* and *Ulnaria* were recorded. The National Sanitation Foundation Water Quality Index was used to calculate the water quality and OMNIDIA's software version 6.1 were used for biological diatom index (IBD). The lowest to highest biological diatom index values of 6.6 to 12.5 and water quality index values of 37 to 61 were recorded during winter and summer seasons. Based on the IBD and WQI analysis values result reveal the Oligotrophic, mesotrophic and eutrophic water quality condition during winter and summer seasons in the study area.

1. Introduction

Diatoms (unicellular siliceous algae) are beneficial creatures to research; since they are a group of algae with a large number of species, disperse widely, and have many growth morphologies to make the most use of resources and to withstand physical shocks [1]. Diatoms are common in many water-based systems, making them important indicators of changes in environmental indicators, land use and trophic indices for monitoring water quality [2, 3, 4]. They are significant biological indicators and are present in all aquatic settings. Each taxon of diatoms has unique requirements for the quality of the water it grows in reacts swiftly to environmental and human-caused changes [5, 6,]. In recent years, rural community growth has been spurred by population increase. Furthermore, disregarding environmental issues has caused an increase in urban, rural, and agricultural contaminants water supplies [7]. The most significant, renewable, and necessary sources of freshwater for domestic, industrial, and agricultural purposes are rivers. It is crucial to take into account the significant impact that human activity has on water quality, environmental rules pertaining to water pollution, and the quality of available water resources. As a result, the provision of safe, high-quality water for a variety of uses depends on the sustainable management of water resources [8]. Many nations exclusively consider diatoms when evaluating the quality of the water [9]. Diatoms have two key characteristics that make them the best bioindicators for detecting early pollution: a quick response to environmental changes and a narrow ecological valence towards particular environmental conditions [10]. The general indices of water quality results from this study, which were determined using the national sanitation foundation water quality index (NSF-WQI), showed that the mean concentration of the following physico-chemical factors, including pH, Nitrates (NO_3), Phosphates (PO_4^{3-}), Turbidity, Total Dissolved Solids (TDS), Temperature, Coli forms Biochemical Oxygen Demand (BOD) and Dissolved Oxygen (DO) [11]. This study uses the NSF-WQI method which assessing river

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water quality and it is simple and easy to implement. NSF-WQI can be the basis for environmental analysis and river management. The NSF-WQI, which has undergone extensive field testing and is used to assess and calculate the WQI of various water bodies [12] was employed in this current study. As a result, it is possible to evaluate the water quality of water bodies by examining changes in chemical, physical, and biological features caused by anthropogenic or natural processes [13]. The Nine parameters including dissolved oxygen, faecal coliform forming units (CFU), pH, biological oxygen demand, temperature, total phosphate (PO4), nitrate (NO3), turbidity (NTU), and total dissolved solids - are used to estimate the water. These parameters or variables are all within the standard range [11]. It is one of the best ways to represent water quality because it condenses a lot of data into a single number between 0 and 100 [11]. The aim of the present study are, to record the diatom taxa present in the study area, distribution of diatoms taxa, determine the water quality index (WQI), diatom indices and understand the environmental conditions and their correlation.

2. Materials and Methods

2.1. Study area

The Thamirabarani, one of Tamil Nadu perennial rivers, raises at an elevation of 1,725 metres (5659 feet) above sea level from the crest of the Pothigai hills on the eastern slopes of the Western Ghats. It flows eastward for about 128 kilometres before its confluence with the Bay of Bengal at Punnakayal [14]. The main sources of drinkable water for Tamil Nadu Tirunelveli and Thoothukudi districts are the Thamirabarani River's numerous reservoirs, aqueducts, and dams. For irrigation, energy production, and industrial processes, they supply a sizable amount of water (Figure 1). The only sources of drinking water for the entire area is this river, and paddy cultivation is the predominant type of agriculture practised here [15]. The Chittar, Gadananathi, Karaiyar, Manimuthar, Pachaiyar, Ramanathi and Servalar rivers are the main tributaries of the river. The river's bed is composed of volcanic and metamorphic rocks in the upper parts, and is sandy in the middle and lower reaches. The river basin features a lot of alluvium deposits that are used for farming. Red and mixed red and black clay soils are the two main types of soil found in the basin [16, 17]. In the basin, there are three significant reservoirs. The Papanasam reservoir, the oldest one that has been constructed across the Thamirabarani River, is the main reservoir. For the purpose of to stabilize the irrigation water supply, the Thamirabarani River's two most significant tributaries, the Manimuthar and Servalar reservoirs, were had been constructed. In order to control water flow through canals for irrigation in the main river, the eight anaicut (diversion weirs) are also present (IWS, 1988) [18].

2.2. Sample collections and processing

In the present study each locations 44 macrophyte and water samples were collected during the winter (December 2022) and summer (March 2023) seasons from the Thamirabarani River between Papanasam and Punnakayal. The sampling sites were covered for 128 kilometers, from Papanasam to Punnakayal and every sampling site situated approximately 3-5 kilometers apart. The samples were analyzed using altered method

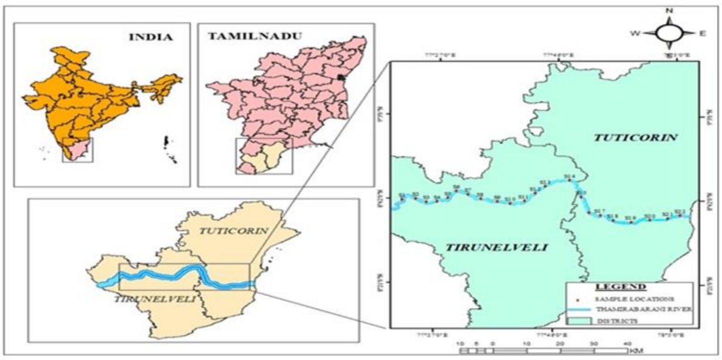

Fig.1. Map showing the study area.

Of [19]. In plastic zip-lock bags, samples were taken from every conceivable habitat, including plants (epiphytic) and rocks (epilithic). At least five (5) plant leaves and roots were used to collect epiphytic samples by gently brushing the undersides and petioles. Formaldehyde (4% concentration) was used to preserve diatom samples, and equal amounts of (10–15 ml) concentrated hydrogen peroxide (H_2O_2) and nitric acid (NHO_3) were added to each beaker at 90ºC for three hours to remove all organic materials. The oxized samples were centrifuged for five times at 3000 rpm for 10 minutes with distilled water. The samples were labelled and kept in glass tube after centrifuged.To prepare permanent slides for the study of diatoms were made using the coverslip and mounted them with Naphrax (Resin like substances). Under a 40X magnification of light microscope, the samples' at least 15-7 valves were counted and identified.

2.3. Observation and Identification

For permanent slides, the cleaned material was mounted using Naphrax® mounting media after being spread out on the cover slips to air dry. Photomicrographs were created using an Olympus DP 73 digital camera and cell Sense standard 1.16 imaging software, and microscopic examinations were carried out using an Olympus BX 53 (Tokyo, Japan) microscope outfitted with Differential Interference Contrast optics and a 100X 1.4 oil immersion objective. Light microscopic plates (Scale bars = 10m) were produced using GIMP (version 2.8.14, GNU Image Manipulation Programme) and Inscape (version 0.91). Using pertinent monographs and studies indicated under each taxon in the description and bibliography, each processed diatom taxon was recognised. Benthic diatoms used in identification of the river sites affected/influenced by urban pollution in Cauvery river parts of Tamil Nadu [20, 21]. This section's descriptions and measurements are all based on earlier research [19, 21, 22, 23, and 24].

3. Result and Discussion

A total of 135 diatom taxa belonging to 43 genera were found in diatom samples collected during season's winter (December 2022) and summer (March 2023) from 22 different locations in the areas of Thamirabarani River (Table 1). The most common diatom genera at each locations were recorded such as *Achnanthes, Achnanthidium, Amphora, Aulacoseira, Bacillaria, Caloneis, Campylodiscus, Cocconeis, Craticula, Cyclotella, Cymbella, Cymbopleura, Diadesmis, Diplonesis, Discostella, Encyonema, Encyonopsis, Eunotia, Fragilaria, Frustularia, Gomphonema, Gyrosigma, Hantzschia, Luticola, Mastogloia, Melosira, Navicula, Navicymbula, Neidium, Nitzschia, Oricymba, Pinnularia, Plagiotropisc, Planothidium, Pleurosigma, Rhopalodia, Sellaphora, Seminavis, Staurosira, Staurosirella, Surirella, Tryblionella* and *Ulnaria.*

3.1. National Sanitation Foundation-Water Quality Index (NSF-WQI)

The NSF-QWI is a useful management and standard administrative tool for disseminating information about changes in water quality. This index has undergone thorough field testing, and it has been used to calculate the Water Quality Index (WQI) for a variety of water bodies while taking important pollution characteristics into account. The results of this study's NSF-QWI indicate that the mean concentrations of the variables (Dissolved Oxygen (DO), Fecal Coliform (CFU), pH, Temperature, Biological Oxygen Demand (BOD), Total Phosphates, Nitrate (NO_3), Turbidity (NTU), and Total Dissolved Solids (TDS)) are all within the normal range [11]. The analysed winter and summer seasons water sample results show in (Table 2 and Table 3)

Table 1. The diatom taxa were recorded in the Thamirabarani River during winter and summer seasons (December 2022 – March 2023)

Diatom taxa	Code
Achnanthes inflata (Kützing) Grunow	AINF
Achnanthidium exiguum (Grunow) Czarnecki	AEXI

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Achnanthidium lanceolatum (Kützing) Brébisson	ALCT
Achnanthidium minutissimum (Kützing) Czarnecki	ADMI
Amphora coffeaeformis (Sarode & Kamat)	ACBH
Amphora copulate (Kützing) Schoeman et Archibald	ACOP
Amphora ovalis (Grunow in Van Heurck)	AOMI
Aulacoseira ambigua (Grunow) Simonsen	AAMB
Aulacoseira granulata (Ehrenberg) Simonsen	AGVG
Bacillaria paxillifera (O.F. Müller)	BPAX
Caloneis amphisbaena (Bory de Saint Vincent)	CAMB
Caloneis bacillum (Grunow) Cleve	CBAC
Caloneis schumanniana (Grunow in Van Heurck) Cleve	CSHU
Caloneis silicula Krammer & Lange-Bertalot	CSIA
Campylodiscus hibernicus Ehrenberg	CHIB
Cocconeis pediculus (Ehrenberg)	CPED
Cocconeis placentula (Ehrenberg)	CPVP
*Craticula accommodate (*Hustedt) D.G. Mann	CRAC
Craticula halophila (Hustedt) Czarnecki	CHTE
Craticula vixnegligenda (Lange-Bertalot)	CVIX
Cyclotella meneghiniana (Kützing)	CMPS
Cymbella kappi (Cholnoky)	CKPP
Cymbella subleptoceros (Krammer)	CSLP
Cymbella turgidula (Grunow)	CTGL
Cymbella tumida (Grunow) Cleve	CTBO
Cymbopleura sublanceolata (Krammer)	CSLN
Diadesmis confervacea (Krasske) Metzeltin et Lange-Bertalot	DCRS
Diplonesis oblongella (Chromista)	DOBL
Diplonesis smithii (Mereschkowsky)	DSFR
Discostella stelligera (Cleve et Grun.) Houk et Klee	DSTE
Encyonema hustedtii (Krammer)	EHUS
Encyonema minutum (Hilse in Rbdh.)D.G. Mann	ENMI
Encyonema mesianum (Cholnoky) D.G. Mann	ENME
Encyonema neogracile (Krammer)	ENN1
Encyonema Perminutum (Krammer)	ENPM
Encyonema Silesiacum (Bleisch in Rabh.) D.G. Mann	ESLE
Encyonema vulgare (Krammer)	EVUL
Encyonopsis subminuta (Krammer & Reichardt)	ESUM
Eunotia bilunaris (Ehrenberg)	EBIL
Eunotia incisa (Krammer & Lange-Bertalot)	EINC
Eunotia minor (Kützing) Grunow in Van Heurck	EMIN
Eunotia rhomboidea (Hustedt)	ERHO
Fragilaria biceps (Kützing) Lange-Bertalot	FBCP
Fragilaria capucina (Desmazières Bremerton)	FCAG
Fragilaria gracilis (Hustedt)	FGRT
Fragilaria tenera (Lavigne et Robert)	FTLE
Fragilaria ulna ippen angustissima (Grunow)Lange-Bertalot	FUAN
Fragilaria Pararumpens (Lange-Bertalot)	FPRU
Frustularia crassinervia (Brebisson) Lange-Bertalot et Krammer	FCRS

Frustularia rostrata (Hustedt)	FROS
Gomphonema affine (Kützing)	GAFF
Gomphonema augur (Ehrenberg)	GAUC
Gomphonema exillissimum (Grunow) Lange- Bertalot & Reichardt	GETG
Gomphonema gracile (Ehrenberg sensu)	GGRA
Gomphonema graciledictum (E.Reichardt)	GGDI
Gomphonema lacusrankaloides (Gandhi) Karthick & Kociolek	GLKO
Gomphonema lagenula (Kützing)	GLGN
Gomphonema parvulum (Kützing)	GPAR
Gomphonema pseudoaugur (Lange- Bertalot)	GPSA
Gomphonema spiculoides (Gandhi)	GSPI
Gomphonema tamilensis (Karthick & Kociolek)	GTAM
Gyrosigma acuminatum (Kützing) Rabenhorst	GYAA
Hantzschia amphioxus (Ehrenberg) Grunow in Cleve & Grunow	HAMP
Hantzschia calcifuges (Reichardt et Lange-Bertalot)	HCAL
Luticola geoppertiana (Bleisch) D.G.Mann	LGOP
Luticola nivalis (Hustedt) E.Y. Haworth & M.G.Kelly	LNDI
Mastogloia elliptica (Thwaites) Cleve	MEDA
Mastogloia baltica (Grunow)	MBAL
Melosira varians (Agardh)	MVAR
Navicula cryptotenella (Lange-Bertalot)	NCTE
Navicula crytocephala (Kützing)	NCRY
Navicula elginensis (Gregory)	NELG
Navicula erifuga (Krammer & Lange-Bertalot)	NERI
Navicula heimansioides (Lange-Bertalot)	NHMD
Navicula notha (Wallace)	NNOT
Navicula placentula ((Ehrenberg))	NPLA
Navicula radiosa (Lange-Bertalot)	NRFA
Navicula rostellata (Kützing)	NROS
Navicula stroemii (Hustedt)	NSTR
Navicula veneta (Kützing)	NVEN
Navicymbula pusilla (Grunow) Krammer	NCPU
Neidium gracile (Hustedt)	NEGR
Nitzschia agnita (Hustedt)	NAGN
Nitzschia amphibian (Grunow) Lange-Bertalot	NAFR
Nitzschia clausii (Hustedt)	NCLA
Nitzschia dissipata (Kützing) Grunow	NDIS
Nitzschia fossilis (Grunow) Grunow in Van Heurck	NIFS
Nitzschia gracilis (Hantzsch)	NIGR
Nitzschia hantzschia (Rabenhorst)	NHAN
Nitzschia linearis (Hustedt) Lange-Bertalot	NLIP
Nitzschia nana (Grunow)	NNAN
Nitzschia obtuse (Hohn)	NOMU
Nitzschia palea (Kutzing)W.Smith	NPAL
Nitzschia scalpelliformis(Grunow)	NOSG
Nitzschia sigma (Grunow in Van Heurck)	NSLG
Nitzschia subacicularis (Hustedt) in A.Schmidt et al.	NSUA

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Nitzschia umbonata (Ehrenberg)Lange-Bertalot	NUMB
Pinnularia amabilis (Krammer)	PAML
Pinnularia divergens (Krammer)	PDPE
Pinnularia gibba (Ehrenberg)	PGFP
Pinnularia joculata (Manguin) Krammer	PJOC
Pinnularia nobilis (Skvortzow) Krammer	PNBI
Pinnularia rhombarea (Krammer)	PRHM
Pinnularia subcapita (Gregory)	PSCA
Placoneis clementis (Lange-Bertalot) in Kelly	PEGC
Placoneis clementispronina (Lange-Bertalot & Wojtal)	PDMT
Placoneis constans (Hustedt) E.J. Cox var. constans	PCTA
Placoneis molestissima (D. M etzeltin)	PMLT
Placoneis nanoclementis (Lange-Bertalot & Wojtal)	PNCL
Plagiotropisc Lepidoptera (Gregory) Kuntze	PLLE
Planothidium frequentissimum (Lange-Bertalot)	PLFR
Planothidium lanceolatum (Brebisson ex Kutzing)Lange -Bertalot	PTLA
Planothidium peragali (Brun & Hérib)	PTPE
Pleurosigma salinarum (Keeley) Reimer in Patrick & Reimer	PSBY
Rhopalodia gibba (Ehr.) O.Müller	RGIB
Rhopalodia gibberula (Hustedt)	RGGL
Sellaphora bacillum (Ehrenberg) D.G.Mann	SEBA
Sellaphora pupula (Kutzing) Mereschkowksy	SPUP
Seminavis strigosa (Hustedt)	SMST
*Staurosira construens (*Grunow in Van Heurck) Kingston	SCPM
Staurosirella pinnata (Ehrenberg)Williams et Round	SPIN
Surirella helvetica (Brun)	SHEL
Surirella leyana (Bramburger & Hamilton)	SLEY
Surirella pinnigera (Bramburger & Hamilton)	SUPI
Tryblionella apiculata (Gregory)	TAPI
Tryblionella constricta (Gregory)	TRCO
Tryblionella calida (Grunow in Cl. & Grun.) D.G. Mann	TCAL
Tryblionella debilis (Arnott ex O'Meara)	TDEB
Tryblionella hungarica (Wisl. & Por.) Bukhtiyarova	THPA
Tryblionella levidensis (W.Smith)	TLEV
Ulnaria acuscypriacus (Lange-Bertalot)	UACY
Ulnaria ulna (Lange-Bertalot)	UUSL

Table 2. The water quality parameters of the Thamirabarani River during winter season (W) Of December 2022

S. No	Turbidity	TDS	pH	Temp	NO_3	OD	BOD	Total PO_4	Feacal Coliform
1	5	295	7.26	27.1	35	9.2	24	0	0
2	7	230	7.85	28.4	30	6.5	20	0	13
3	5	305	8.23	27.5	25	7.2	24	0	0
4	20	165	7.64	27.3	18	8.2	24	0	0
5	42	390	7.70	27.0	20	7.6	24	0	16

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6	30	370	8.13	27.9	14	7.2	20	0	0
7	85	224	7.25	27.6	22	7.4	32	0	58
8	32	220	7.95	27.5	12	8.3	36	0	120
9	35	826	7.98	27.5	27	6.1	06	0	0
10	21	238	7.34	25.9	13	6.4	16	2.24	0
11	73	238	7.29	28.1	30	8.3	40	0	0
12	56	230	7.56	26.9	10	7.5	28	0	0
13	20	396	7.95	27.2	25	7.4	20	0	14
14	35	299	7.62	26.7	10	6.9	24	1.17	0
15	32	200	8.19	26.7	20	8.2	16	0.65	0
16	10	209	7.29	27.6	30	7.2	40	0	0
17	30	225	7.26	26.4	24	7.7	24	0	0
18	35	697	7.43	27.1	31	7.5	28	0	16
19	15	364	8.04	28.3	20	7.8	20	0	16
20	10	510	8..04	26.5	25	7.7	16	0	0
21	22	1072	7.64	26.8	24	7.5	32	0	15
22	5	330	7.92	28.1	33	6.9	16	0	0

Table 3. The water quality parameters of the Thamirabarani River during summer season (SU) of March 2023

S. No	Turbidity	TDS	pH	Temp	NO_3	OD	BOD	Total PO_4	Feacal Coliform
1	0	220	8.10	28.0	7	8.4	16	0	0
2	0	250	7.94	27.0	8	7.5	11	0	0
3	0	205	8.18	27.2	6	9.1	13	0	0
4	0	240	7.95	28.3	6	8.6	12	0	0
5	0	290	8.17	27.5	10	9.1	10	0	0
6	0	356	8.05	27.3	12	8.7	16	0	0
7	0	320	8.09	28.7	8	7.6	16	0	13
8	0	264	7.69	28.4	7	7.3	20	0	10
9	0	300	8.07	27.6	7	8.3	12	0	0
10	0	235	8.21	27.3	5	7.4	16	2.24	25
11	0	290	8.27	28.4	7	5.8	28	0	9
12	0	340	7.84	27.9	9	5.4	24	0	0
13	0	273	8.12	26.9	8	6.9	28.0	0	12
14	0	350	8.13	27.7	8	6.4	24	1.17	5
15	3	304	8.07	27.5	7	7.5	20	0.65	15

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16	3	445	7.98	27.6	10	6.9	24	0	0
17	5	373	8.14	26.8	8	7.1	20	0	0
18	0	592	8.27	26.8	13	5.7	32	0	0
19	0	532	8.22	25.8	14	7.2	20	0	10
20	2	440	8.15	27.8	12	7.3	24	0	13
21	4	483	7.98	26.4	12	7.4	20	0	17
22	5	350	8.23	26.6	9	8.1	16	0	20

Each parameter was given a specific weight in the NFS-WQI index computation since each one contributes differently to the adjustment of the water quality. The Table 4 lists the weighting factors for each parameter. This NSF-WQI index was calculated based on the following formula

NSF-WQI $=\sum_{i=1}^{n} Q_i W_i$

Scientists had to first graph the raw data's pH values, which ranged from 2 to 12, on a scale from 0 (The Bad) to 100 (The Good), to evaluate the degree of water quality. The drawn curves were obtained by averaging a weighted curve for each parameter. The nine parameter findings are compared to the curves to determine the "Q-value," which is a numerical value.

The analysed body of water is divided into five groups, ranging from very good to very terrible, based on the WQI index values, as shown in Table 5.

Table 4. Weighting factor for each parameter in NSF-WQI Calculation [25]

Parameters	**Weight**
Dissolved Oxygen (DO)	0.17
Fecal Coliform (CFU)	0.16
pH	0.11
Biological Oxygen Demand (BOD)	0.11
Temperature	0.1
Total Phosphates	0.1
Nitrate (NO_3)	0.1
Turbidity (NTU)	0.08
Total Dissolved Solids (TDS)	0.07

Table 5. Water Quality Value (NFS-WQI) [25]

Value – NFS-WQI	**Water Quality**
90-100	Excellent
70-90	Good
50-70	Medium
25-50	Bad
0-25	Very bad

According to water sample analyses, the result of the Water quality index from 22 different locations ranged from 37 to 61 were recorded. In this present study revealed that water quality assessment, based on the water quality index following results had been obtained (Table 6). The WQI values (37-50) were recorded locations at Papanasam, Vickramasingapuram, Sivanthipuram, Aladiyur, Sunpapermill, Gopalasamudram, Kokkirakulam, Naranammalpuram, Karugulam, Athichanallur, Sernthamangalam, Mukkani, Thiruvaluli Nadar Vilai, Alwarthirunagari and Punnakayal indicated

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Table 6. Water Quality Index Value in Thamirabarani River (December 2022 and March 2023)

S. No	Study Area	Water Quality Index	
		Winter	Summer
1	Papanasam	49	49
2	Vickramasingapuram	40	46
3	Sivanthipuram	50	46
4	Aladiyur	48	49
5	Ambasamuthiram	54	56
6	Kallitaikurichi	55	61
7	Athananallur	54	51
8	Thirupudaimaruthur	59	56
9	Mukkudal	56	53
10	Sunpapermill	43	45
11	Gopalasamudram	47	46
12	Kokkirakulam	44	44
13	Naranammalpuram	50	47
14	Sevalaperi	52	45
15	Murappanadu	51	49
16	Karugulam	47	48
17	Athichanallur	50	49
18	Sernthamangalam	41	42
19	Mukkani	39	41
20	Thiruvaluli Nadar Vilai	44	40
21	Alwarthirunagari	37	41
22	Punnakayal	46	44

bad water (Polluted). It is observed that the main cause of untreated waste water from industries discharge on surface water and anthropogenic activities. Whereas locations Ambasamuthiram, Kallitaikurichi, Athananallur, Thirupudaimaruthur, Mukkudal, Sevalaperi and Murappanadu were recorded water quality index values of (50-61) indicate Medium water (moderate-meso eutrophic) in winter and summer seasons i.e. during December 2022 and March 2023 respectively.

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3.2. Biological diatom indices analyzed

The aquatic systems and water quality are identified according to the tropic status using the diatom indices. A standardized technique developed and used in France for assessment of river water quality is the IBD [26]. The IBD was determined in the current investigation using OMNIDIA software Version 6.1. The present's classification of diatom indices using standard values Table 7 [27].

Table 7. Standard values of IBD water quality classification [27]

Index score	Environmental Status	Trophic status
>17	High	Oligotrophic
15–17	Good	Oligo-mesotrophic
12–15	Moderate	Mesotrophic
9–12	Poor	Meso-eutrophic
<9	Bad	Eutrophic

In the present study during seasons December 2022 (W- winter) and March 2023 (SU- summer) the biological diatom index values ranges from highest and lowest (16.1- 6.6) were recorded such as given below. The location 1 and location 2 the most abundant diatom taxa presented such as *Aulacoseira ambigua, Aulacoseira granulata, Cocconeis placentula, Discostella stelligera* and *Cymbella tumida*. Papanasam and Vickramasingapuram locations were recorded the IBD values (W- 16.1, SU- 15.4 and W- 15.7, SU- 15.2) of winter and summer respectively. These areas indicate Oligo-mesotrophic water quality condition due to the rainy season and good flow of water as it starting point of the river. The abundant diatom taxa and IBD values were recorded such as *Cocconeis placentula, Cyclotella meneghiniana, Cymbella tumida, Cymbella kappi, Navicula cryptonella, Navicula notha, Navicula rostellata, Gomphonema lagenula, Gomphonema pseudoaugur, Seminavis strigosa, Staurosirella pinnata, Ulnaria ulna* and the locations Ambasamuthiram (W- 11.6, SU-9.1), Kallitaikurichi (W- 12.5, SU- 10.2), Athananallur (W- 9.7, SU- 10.4), Thirupudaimaruthur (W- 9, SU- 11.9), Mukkudal (W- 11.1, SU- 10.8), Naranammalpuram (W- 11.8, SU- 10.2), Sevalaperi (W- 11.5, SU- 10.9) and Murappanadu (W- 12.1, SU- 11.3) indicated meso eutrophic (Moderate-Poor) water conditions. In these locations winter season values of highest and lowest ranges IBD (9 to 12.5) and water quality index (50 to 59), whereas summer season values ranges of highest to lowest IBD (11.9 to 9.1) and WQI (61 to 44) were recorded in this areas. The both seasons slightly variation because of the urban untreated sewage waters and anthropogenic activities indicates meso eutrophic (Moderate) water quality respectively. According to IBD values locations at Sivanthipuram (W- 8.9, SU- 9.2), Aladiyur (W- 9.8, SU- 8.4), Sunpaper mill (W- 7, SU- 8.1), Gopalasamuthiram (W- 8.6, SU- 7.3), Kokkirakulam (W- 7.1, SU- 7.9), Naranammalpuram (W- 8.5, SU- 7.4), Karugulam (W- 8.7, SU- 9), Athichanallur (W- 8.4, SU- 8.9), Sernthamangalam (W- 8.1, SU-8.6), Mukkani (W- 8.9, SU- 7.6), Thiruvaluli Nadar Vilai (W- 7.4, SU- 6.6), Alwarthirunagari (W- 7.1, SU- 7), and Punnakayal (W- 8.6, SU- 7.8) and the abundant species *Bacillaria paxillifera, Diadesmis confervacea, Gomphonema lagenula, Gomphonema parvulum, Gomphonema pseudoaugur, Nitzschia palea and Tryblionella levidensis* indicated the Eutrophic (Bad) water quality. The showing localities around Sivanthipuram, Aladiyur, Kokkirakulam, and Sernthamangalam were polluted water due to result of anthropogenic waste outlets that were discharged into the river. The IBD and water qualities index values ranged from very lowest at Sunpaper mill and Gopalasamuthiram areas during winter and summer seasons showing highly polluted water qualities due to industrial activities in the areas. The locations of Kokkirakulam, Naranammalpuram, Karugulam, Athichanallur, Mukkani, Thiruvaluli Nadar Vilai and Alwarthirunagari illustrate the pollutants of water quality due to urban sewage dumping and runoff from agricultural fields. According to the IBD and WQI values that indicate water is polluted. In contrast, home waste, urbanisation, and recreational activities in the Punnakayal area are the sources of the water pollution.

4. Conclusion

The primary objective of this investigation was to assessment the seasonal variations in the IBD and WQI found in the Thamirabarani River basin in south India. A total of 135 diatom taxa belongs to 43 genera were recorded in the study area. The current study results were found water quality assessment in the biological diatom index and water quality index range of oligo-mesotrophic, meso- trophic and eutrophic water respectively. The water quality levels of oligo-mesotrophic were observed in locations Papanasam and Vickramasingapuram due to both seasons good flow of water. Whereas locations at Ambasamuthiram, Kallitaikurichi, Athananallur, Thirupudaimaruthur, Mukkudal, Naranammalpuram, Sevalaperi and Murappanadu areas were recorded the values ranges of IBD and WIQ results indicate that a water qualities in meso eutrophic (Moderate-Poor) water condition. The water qualities were affected by anthropogenic factors and urban untreated sewage waters. It has been observed that certain locations such as Sivanthipuram, Aladiyur, Sunpaper mill, Gopalasamuthiram, Kokkirakulam, Naranammalpuram, Karugulam, Athichanallur, Sernthamangalam, Mukkani, Thiruvaluli Nadar Vilai, Alwarthirunagari and Punnakayal were recorded in the indicate eutrophic (bad) water qualities due to anthropogenic waste outlets, industrial activities, urban sewage dumping and runoff from agricultural fields. The sources of pollution anthropogenic affect, industrial, and natural disturb in the Thamirabarani River basin throughout the both seasons respectively. It is suggest that reduce sewage discharge, an effective control proper urban wastages should be developed in the river basin.

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6. Disclosure statement

No conflict of interest was reported by the author(s).

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