Uttar Pradesh Journal of Zoology

Volume 45, Issue 18, Page 71-82, 2024; Article no.UPJOZ.3893
ISSN: 0256-971X (P)

Seasonal Variations in Physico-chemical Parameters of the Sediment of Thengapatnam Estuary, South-coastal Region of India

P.R. Abisha [a*]

[a] *Department of Zoology and Research Centre, Scott Christian College (Autonomous), Nagercoil, India.*

Author's contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

Article Information

DOI: https://doi.org/10.56557/upjoz/2024/v45i184425

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://prh.mbimph.com/review-history/3893

Original Research Article

Received: 27/06/2024
Accepted: 29/08/2024
Published: 02/09/2024

ABSTRACT

The tremendous biodiversity and ecological processes that depend on freshwater and marine environments are essential to human survival. The physicochemical parameters in both surface waters and sediments are important to understand estuarine dynamics. The present study was carried out to determine how the seasonal variation will affect the physicochemical parameters of sediments of five stations in Thengapatnam estuary. Sediment samples were collected for a period of one year from June 2014-May 2015 from five different sampling stations. The parameters such as pH, temperature, Nitrogen, Phosphorous, Potassium, Copper, Zinc, Iron and Manganese were analysed using standard procedures. The result expose that, soil sediment have high amount of potassium in all five stations. Sediment temperature varied from 25.7- 30.1°C. Hydrogen ion concentration ranged between 6.9 to 8.3, concentrations of nutrients viz. nitrate (2.4 – 6.4

**Corresponding author: Email: abishaprince1985@gmail.com;*

Cite as: *Abisha, P.R. 2024. "Seasonal Variations in Physico- Chemical Parameters of the Sediment of Thengapatnam Estuary, South-Coastal Region of India". UTTAR PRADESH JOURNAL OF ZOOLOGY 45 (18):71-82. https://doi.org/10.56557/upjoz/2024/v45i184425.*

mg/100g), phosphate (1.5 - 15.25 mg/100g) potassium (138 – 560 ppm) and concentration of metals like iron, zinc and manganese were found to be higher during monsoon season and lower during premonsoon seasons The overall findings highlight the need for a scientific solution to reduce the use of harmful chemicals and heavy metal contamination from the river system in order to preserve the biodiversity of freshwater and marine ecosystems.

Keywords: Water contamination; industrial chemicals; heavy metals; pollution; marine ecosystem.

1. INTRODUCTION

Everything that is alive, including humans, plants, animals, and even microbes, needs water to survive [1]. There is severe pollution in freshwater river streams and the ocean as a result of the growing global population and the effects of climate change on the ecosystem. Due to inadequate waste water treatment systems, modern industrial production and agriculture practices that use a variety of fertilisers, pesticides, and synthetic chemicals seep into rivers, killing aquatic life and creating eutrophication [2,3,4]. Marine ecosystems are crucial components of the global environment and offer many advantages to humankind, including recreational opportunities, drinking and irrigation water, and habitat for commercially important fisheries [5,6]. According to recent studies, rising greenhouse gas levels directly contribute to global warming, which causes erratic rainfall and floods [7,8]. Hazardous industrial chemical and heavy metals pollutants that leak into rivers and oceans also pose a threat to aquatic ecosystems [5,9]. The aquatic ecosystems are affected by some health stressors that extensively deplete biodiversity, the loss of biodiversity and its effects are predicted to be greater for aquatic ecosystems than for terrestrial ecosystems [10]. The biodiversity of freshwater habitats is at risk due to human activity and environmental change. Freshwater ecosystems are essential to human life and the maintenance of the enormous biodiversity, natural cycles, and processes found in nature [11,12].

Life on Earth is made possible by the ocean, which makes up 71% of the planet's surface and still has a significant influence over climate change. India has a coastline spanning 7516.6 km, with the Arabian Sea and Indian Ocean to the west and the Bay of Bengal to the east [13]. More than 16 million fishermen in India depend on the fishing industry for their livelihood, according to figures published by the Department of Fisheries, Government of India, 2020, and the National Fisheries Policy 2020 Draft. The primary food and nutrition source in India is the fisheries industry, which includes fish from brackish, inland, and marine waters [14,15]. In 2017–2018, it made up 5% of all exports from the nation and contributed a sizeable 1.03% of the GDP [16]. Estuarine and coastal areas are complex and dynamic aquatic environment [17]. The growing reliance on the ocean for these purposes has raised concerns and posed a serious threat to the preservation of the biological diversity of the ocean and its coastal regions [18,19,20]. In the southern region of India, the Thamiraparani River is the primary source of water for drinking and agriculture. Rising to a height of 1,645.2 metres from the Mahenthragiri hills of the Western Ghats, it passes by the Kothiyar Dam in the Tamilnadu district of Kanyakumari, South India, and then joins the Arabian Sea at the Thengapatnam estuary of the district with polluted sediments [21]. In the Kanyakuamri district of Tamilnadu, south India, industrial and agricultural pollutants have raised serious concerns about the river's water quality. Pollution is a major issue in India, where organic, inorganic, and biological pollutants have contaminated 70% of the country's groundwater reserves and surface water resources [22]. Sediment quality monitoring befits a very important process in the restitution and protection of the aquatic ecosystems. Sediments contained very high values of the physico chemical parameters [23]. Elevated nutrient levels and heavy metal pollution in water have an impact on the aquatic environment's ecology [24]. The main nutrients polluted due to improper management of agricultural fertilisers are potassium, phosphorous, and nitrogen. Industrial pollution contaminates aquatic ecosystems with heavy metals such as copper, zinc, manganese, iron, and lead. As a result, in recent years, management of the aquatic environment in particular has gained significant attention [25]. The major objective of the current work is to examine how seasonal variations in river sediment quality, as well as the farming industrial chemicals and metal pollutants associated with them, may impact the general health of aquatic ecosystems.

Description of the study area: In Tamil Nadu's Kanyakumari District, the Thengapatnam Estuary (latitude 7o 53' N and longitude 77o 07'), a portion of the Thamiraparani River is one of the most significant estuaries. The river flows through a 60-kilometer stretch and meets the Arabian Sea in the Kanyakumari district's Thengapatnam estuary southwest coastal region (Fig. 1). The estuary connects to the AVM canal (Ananda Victoria Marthandavarma Canal). Five stations were chosen for the current investigation. Station II was located approximately 1.2 km from Station I, signifying the gradient zone; Station III was located at the head of the estuary, one kilometre from Station II; Station IV was chosen at the AVM Canal; and Station V was chosen in the freshwater zone at Ganapathy Kadavu (Figs. 2-6).

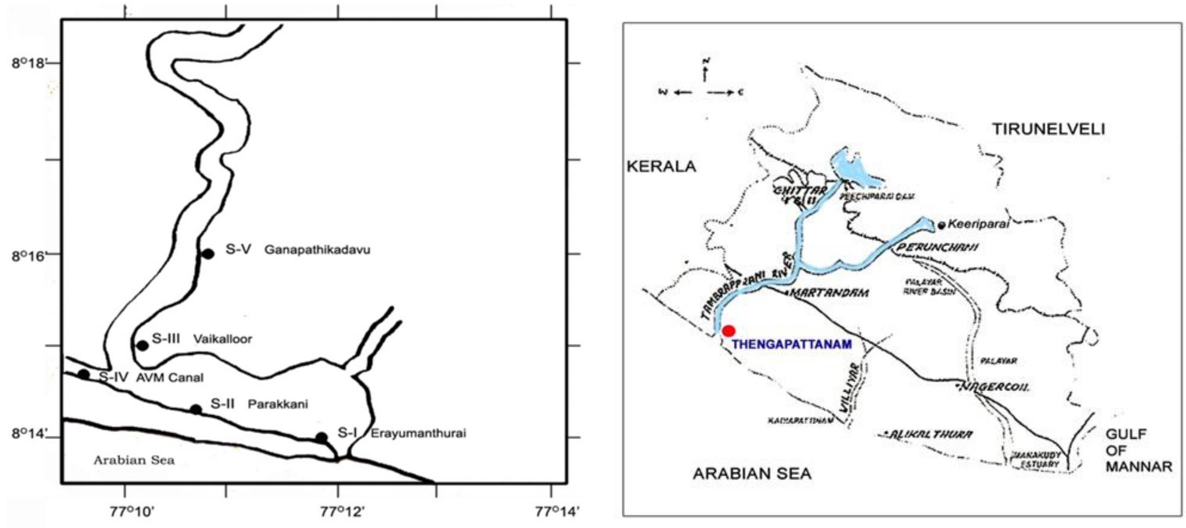

Fig. 1. Map showing the study area of Thengapatnam Estuary

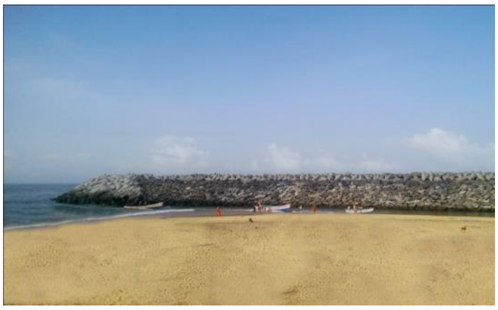

Fig. 2. Thengapatnam estuary showing station I

Fig. 3. Thengapatnam estuary showing station II

Fig. 4. Thengapatnam estuary showing station III

Fig. 5. Thengapatnam estuary showing station IV

Fig. 6. Thengapatnam estuary showing station V

2. MATERIALS AND METHODS

The sediment samples were taken from five stations using Peterson's Grab (0.04 m^2), for 12 months and quickly packed in air tight polythene bags. After sampling, precautions were taken to avoid contamination during drying, grinding, sieving and storage. Temperature of the sediment samples were measured using centigrade mercury thermometer of 0.1℃ accuracy. Sediment pH and EC were measured in a suspension of 1:2.5 sediment to water ratio using calibrated pH meter (Elico) and conductivity meter (Systronics) described by Pearson and Stanly [26]. The nutrients like nitrogen, phosphrous and potassium and trace metals in the sediment such as copper, zinc, manganese and iron were estimated using standard methods [27].

Data Analysis: The Simple correlation coefficient (r) was made for describing physico-chemical characteristics and two-way analysis (ANOVA) was also employed.

3. RESULTS

3.1 Sediment Temperature

The Thengapatnam estuary sediment temperature did not show wide spatial variations. Throughout the study period the sediment temperature showed minimum values (27.45 ℃), 27℃). 38,27℃). 40, 27.38, 27.67) in monsoon season and maximum during premonsoon season (29.55,29.04,28.85,29.20,28.85) (Table 1). T The statistical studies (two-way ANOVA) carried out in sediment temperature showed significant variation between seasons only ($p<0.001$) (Table 2).

Sediment pH: The data on the seasonal variations of pH in sediments recorded in the five stations during the study period was presented in Table 3. Sediment pH showed higher values during the pre-monsoon season (7.9, 7.8, 7.9, 7.6, 7.7) and lower during monsoon season (7.2,7.2,7.2,7.1,7.3) respectively. The data on two- way ANOVA test carried out for sediment pH showed significant variation between seasons only ($p<0.001$) (Table 4).

3.2 Nutrients

Nitrogen: The data on the seasonal variations of nitrate content in sediments recorded in the five stations during the study period was being presented in Table 5. The highest values were recorded during the monsoon period in all the five stations (47.0 mg/100 g, 57.0 mg/100 g, 45.5 mg/100 g, 53.5 mg/100 g and 45.0 mg/100 g for stations I – V respectively). The lowest values were recorded during the pre-monsoon period in all the five stations (25.25 mg/100 g, 40.00 mg/100 g, 29.50 mg/100 g, 35.50 mg/100 g and 26.75 mg/100 g respectively). The data on two way ANOVA test carried out for nitrogen in the sediment sample showed significant variations between stations and seasons ($p<0.001$) (Table 6).

Phosphorous: The data on the seasonal variations in the sediment phosphate concentration are shown in (Table 7). The maximum values noticed were 10.20 mg/100 g, 13.57 mg/100 g, 10.90 mg/100 g, 12.63 mg/100 g and 10.57 mg/100 g at the stations I to V respectively during monsoon season. The minimum values were 3.40 mg/100 g, 8.09 mg/100 g, 5.10 mg/100 g, 6.73 mg/100 g and 3.90 g/100 mg during pre-monsoon season at the stations I – V respectively. The data on two way ANOVA test for the season station interaction revealed significant variations in sediment phosphate between seasons ($p<0.001$) (Table 8).

Potassium: The seasonal changes observed in the sediment potassium concentration are depicted in Table 9. The mean concentration of potassium was more during the monsoon season in all the five stations (403.5 ppm, 416.25 ppm, 371.5 ppm, 362.75 ppm and 350.75ppm) and less during the pre-monsoon season in all the five stations (164.5 ppm, 162.75 ppm, 155.5ppm, 151.75 ppm and 143.25 ppm). ANOVA test carried out for the sediment potassium showed significant variation between seasons and stations (p<0.001) (Table 10).

3.3 Trace Metals

Copper: Seasonal comparison indicated (Table 11) higher values during the monsoon months in all the five stations (1.51ppm, 1.32ppm, 1.39ppm, 1.37ppm and 1.40ppm at the station I to V respectively). Lower values were observed during pre-monsoon months (0.69 ppm, 0.82 ppm, 0.92 ppm, 0.97 ppm and 1.02 ppm at the stations I, II, III, IV and V respectively). The data on two way ANOVA test carried out for copper in sediment showed significant variation between seasons only (p<0.001) (Table 12).

Zinc: Seasonal variation in concentration of zinc showed maximum values (1.21 ppm, 1.24 ppm, 1.26 ppm, 1.27 ppm and 1.26 ppm from the station I to V respectively) during monsoon months and minimum concentration (1.11 ppm, 1.12 ppm, 1.11 ppm, 1.19 ppm and 1.17 ppm from stations I to V respectively) was recorded during the pre-monsoon season in the five stations (Table 13). The data on two way ANOVA test carried out for zinc in sediment showed significant variation between seasons only (p<0.001) (Table 14).

Manganese: The manganese value of present study was varied from 5.20 ppm to 1.35 ppm I (Table 15) The maximum concentration of manganese 5.20 ppm was recorded in monsoon at station II and the minimum concentration 1.35 ppm was recorded in pre monsoon at station I. Using a two-way ANOVA test, manganese levels in sediment samples varied significantly between stations and seasons (p<0.001) (Table16).

Iron: The seasonal mean concentration of iron peaked during the monsoon season (15.07 ppm) and decreased during the pre-monsoon season (7.72 ppm). Significant differences (p<0.001) were found between stations and seasons in the results of the two-way ANOVA test conducted to determine the amount of iron in the sediment sample (Table 18).

Table 1. Mean seasonal variation of sediment temperature (°C) at station I – V

Sample	Monsoon	Post-monsoon	Pre-monsoon
Station I	27.45	27.69	29.55
Station II	27.38	27.68	29.04
Station III	27.40	27.56	28.85
Station IV	27.38	28.07	29.20
Station V	27.67	27.97	28.85

Table 2. Two way Analysis of Variance test for sediment temperature

Variation	SS	df	MS	F	P-value	F crit
Seasons	7.282543	2	3.641272	62.62668	1.29911E-05	4.45897
Stations	0.127947	4	0.031987	0.550146	0.704782366	3.837853
Error	0.46514	8	0.058143			
Total	7.875631	14				

Table 3. Mean seasonal variation of sediment pH at station I – V

Sample	Monsoon	Post-monsoon	Pre-monsoon
Station I	7.2	7.3	7.9
Station II	7.2	7.3	7.8
Station III	7.2	7.3	7.9
Station IV	7.1	7.2	7.6
Station V	7.3	7.4	7.7

Table 4. Two way analysis of variance test for sediment pH

Variation	SS	Df	MS	F	P- value	F crit
Seasons	0.886083	2	0.443042	78.47232	5.53359E-06	4.45897
Stations	0.040583	4	0.010146	1.797048	0.222689175	3.837853
Error	0.045167	8	0.005646			
Total	0.971833	14				

Table 5. Mean seasonal variation of nitrogen (mg/100g) in sediment at station I – V

Stations	Monsoon	Post-monsoon	Pre-monsoon
Station I	47.00	42.00	25.25
Station II	57.00	50.50	40.00
Station III	45.50	40.50	29.50
Station IV	53.50	51.50	35.50
Station V	45.00	42.25	26.75

Table 6. Two way analysis of Variance test for sediment nitrogen

Variation	SS	df	MS	F	P-value	F crit
Seasons	893.3333	2	446.6667	135.9113	6.68081E-07	4.45897
Stations	366.5583	4	91.63958	27.88399	9.49374E-05	3.837853
Error	26.29167	8	3.286458			
Total	1286.183	14				

Table 7. Mean seasonal variation of sediment phosphorus (mg/100g) at station I – V

Sample	Monsoon	Post-monsoon	Pre-monsoon
Station I	10.20	9.43	3.48
Station II	13.57	12.25	8.09
Station III	10.90	10.31	5.10
Station IV	12.63	10.95	6.73
Station V	10.57	10.00	3.90

Table 8. Two way Analysis of Variance test for sediment phosphorous

Variation	SS	df	MS	F	P-value	F crit
Seasons	112.4822	2	56.2411	161.9625	3.37443E-07	4.45897
Stations	24.98061	4	6.245153	17.98472	0.000461378	3.837853
Error	2.777982	8	0.347248			
Total	140.2408	14				

Table 9. Mean seasonal variation of sediment potassium (ppm) at station I – V (ppm)

Sample	Monsoon	Post-monsoon	Pre-monsoon
Station I	403.50	392.00	164.75
Station II	416.25	400.00	162.75
Station III	371.50	369.25	155.50
Station IV	362.75	353.00	151.75
Station V	350.75	336.75	143.25

Table 10. Two way Analysis of Variance test for sediment potassium

Variation	SS	df	MS	F	P-value	F crit
Seasons	155098.4	2	77549.21	615.2716	1.74067E-09	4.45897
Stations	3330.25	4	832.5625	6.605509	0.011875362	3.837853
Error	1008.325	8	126.0406			
Total	159437	14				

Table 11. Mean seasonal variation of sediment copper(ppm) at station I – V

Sample	Monsoon	Post-monsoon	Pre-monsoon
Station I	1.51	1.39	0.69
Station II	1.32	1.20	0.82
Station III	1.39	1.26	0.92
Station IV	1.37	1.35	0.97
Station V	1.40	1.36	1.02

Table 12. Two way Analysis of Variance test for sediment copper

Variation	SS	df	MS	F	P-value	F crit
Seasons	0.734203	2	0.367102	36.33508	9.67182E-05	4.45897
Stations	0.033564	4	0.008391	0.830531	0.541805121	3.837853
Error	0.080826	8	0.010103			
Total	0.848593	14				

Table 13. Mean seasonal variation of sediment zinc (ppm) at station I – V

Stations	Monsoon	Post-monsoon	Pre-monsoon
Station I	1.21	1.19	1.11
Station II	1.24	1.20	1.12
Station III	1.26	1.26	1.11
Station IV	1.27	1.24	1.19
Station V	1.26	1.25	1.17

Table 14. Two way analysis of variance test for sediment zinc

Variation	SS	df	MS	F	P-value	F crit
Seasons	0.030146	2	0.015073	23.4332	0.000451996	4.45897
Stations	0.011244	4	0.002811	4.370202	0.036379827	3.837853
Error	0.005146	8	0.000643			
Total	0.046536	14				

Table 15. Mean seasonal variation of sediment manganese (ppm) at station I -V

Stations	Monsoon	Post-monsoon	Pre-monsoon
Station I	1.76	1.62	1.35
Station II	5.20	4.80	4.07
Station III	4.70	4.50	3.83
Station IV	4.14	4.06	3.88
Station V	3.91	3.88	3.15

Table 16. Two way Analysis of Variance test for sediment manganese

Variation	SS	df	MS	F	P-value	F crit
Seasons	2.305773	2	1.152887	106.5822	1.71198E-06	4.45897
Stations	10.49064	4	2.62266	242.46	2.22539E-08	3.837853
Error	0.086535	8	0.010817			
Total	12.88295	14				

Table 17. Mean seasonal variation of sediment iron (ppm) at station I – V

Stations	Monsoon	Post-monsoon	Pre-monsoon
Station I	13.44	11.78	6.32
Station II	13.31	12.05	6.85
Station III	13.33	13.25	7.30
Station IV	14.27	13.50	7.50
Station V	15.07	14.45	7.72

Table 18. Two way analysis of variance test for sediment iron

Variation	SS	df	MS	F	P-value	F crit
Seasons	141.0627	2	70.53134	955.2454	3.02358E-10	4.45897
Stations	4.168456	4	1.042114	14.11393	0.001068729	3.837853
Error	0.590687	8	0.073836			
Total	145.8218	14				

4. DISCUSSION

In an aquatic environment, the sediment serves as a nutrient storage facility. According to Khan, 2018., the primary determinants of sedimentation nature and rate are watershed characteristics, water transport, and ecological stress. Sediments are increasingly recognized as both a carrier and a possible source of contaminants in aquatic systems and these materials may also affect ground water quality and agricultural product when disposed on land [28]. It is indisputable that maintaining ecological integrity through the preservation of ecosystem services is crucial [18]. Ecosystems found in freshwaters can be the most vulnerable worldwide. The most impacted terrestrial ecosystems have much lower levels of biodiversity than freshwater environments [19,20,29]. The biodiversity of India's freshwater and marine ecosystems is at risk due to pollution caused by a range of human activities, including as industrial processes, waste disposal, transportation, and inappropriate usage of fertilizer in agriculture [30,31]. Global research is being conducted to create systematic conservation planning to save freshwater biodiversity since the aquatic environment is facing major threats to ecosystem stability and diversity [32]

In the studies area Thengapatnam estuary, Kanyakumari district, Tamil Nadu, south costal region, India, Sediment temperature did not exhibit significant regional variability. Every station recorded a higher temperature during the pre-monsoon period. This could be caused by the comparatively high ambient and water temperatures. Because of the rain and the chilly temperatures, the sediment's temperature was low during the southwest monsoon months. The ocean absorbs solar energy and releases it into the atmosphere due to its substantial thermal inertia, causing temperature fluctuations [33]. The wintertime soil temperature dropped in tandem with the air temperature, partly due to the freshwater input during the monsoon season. Rajasegar et al. [34] from the Vellar estuary and Bragadeeswaran et al. from the Arasalar estuary all saw a similar pattern [35] [34].

Anything either highly acidic or alkaline would kill marine life. Aquatic organisms are sensitive to pH changes and biological treatment requires pH control or monitoring, Pravin Singare et al., 2011 [36]. Prior to the monsoon, soil pH readings were higher, and during the monsoon, they were lower. It might result from redox changes in the water column and sediments in addition to the effect of fresh water [37]. It is possibly due to redox changes in the sediments and water column a part from the influence of fresh water (Saravanakumar et al., 2008). Low value of pH recorded during monsoon may also be due to the increased rate of inflow of fresh water, decomposition of organic matter and conversion of releasing carbondioxide into carbonic acid [32] [38], Anitha and Sugirtha (2013) from the Thengapatnam estuary, and Bragadeeswaran et al. (2007) from the Arasalar estuary all reported comparable findings.

The current study point out that the pre-monsoon season had the lowest levels of sediment nitrogen while the monsoon season had the highest levels. It was reported that, high nitrogen content in finer substrates in Africa's Swartkops estuary it may due to the fine particles likely trapped detritus, increasing the number of bacteria which leads to high nitrogen levels concentration [37]. Such great and sudden elevated nitrogen concentrations will cause phytoplankton decomposing [39].

Under the right conditions, phosphorus releases into the surrounding water, acting as a reservoir for the mineral. In this study, the premonsoon season had the lowest phosphate content, while the monsoon season had the highest phosphate content in the sediment. The highest concentration of phosphorus is due to the agricultural waste discharge from water, sewage and coconut husk retting activities (Helen et al., 2016) [21,40]. Strong flooding may cause low levels by removing the top layer of sediments, while dead organic materials from the top layer may cause higher values [41]. Bhagan et al. (1998) noted that the monsoon season caused the sediment's phosphate concentration to rise [42]. Moreover, increased fertiliser application, detergent use, and home sewage largely also make impact in significant loading of phosphorus in the sediment [10].

In sediment, potassium is a naturally occurring element. The weathering of rocks is the primary source of potassium in fresh water; nevertheless, the discharge of household trash has increased the amount of potassium in contaminated water. Several scientific data cited that, the value of potassium was higher during the monsoon season and lower during the pre-monsoon period. Low levels of potassium may be likely due to its utilisation by biological activity and low fresh water flow [43]. The high concentration of potassium during monsoon is mainly caused by heavy river rain off leaching of potassium from the nearby coconut plantation, which use potash fertilizers [38]. Domestic sewage from human settlements near the selected stations and surface runoffs during Monsoon into the estuary could be the reason for this high levels of nutrients (Nandini and John, 2018)[23]. Adeola Alex et al., (2016) [44] have reported similar results from Nwaja Creek.

In developing countries like India, improper industrial wastewater management seriously contaminates the freshwater and marine ecosystems [45]. Heavy metal pollution of coastal water results from the mining, smelting, and burning of fossil fuels, as well as the discharge of trash from manufacturing and processing businesses and municipal sewage. The current study found that the premonsoon season had lower copper concentrations, while the monsoon period had higher concentrations. Land runoff and flooding from monsoon rains could introduce copper into the estuary, leading to its eventual accumulation in the sediment. Senthilnathan and Balasubramanian (1997) reported, higher copper contents in the Velar and Kaduviar estuaries during the monsoon season [46].

Pre-monsoon seasons shown lower concentrations of metals such as manganese, iron, and zinc, when compare to the monsoon seasons. A scientific data suggest that, the relative abundance of suspended matter, fixed during transportation, may contribute to the presence of more iron [47]. Iron may precipitate as an insoluble hydroxide in alkaline water conditions, as suggested by several study which assertion that sediments contain a higher iron content than river water [48]. It may be a correlation between the lower iron concentration during the premonsoon and the increase in phytoplankton uptake and decrease in rainfall. An anthropogenic activity leads to change in the natural availability of the heavy metals in the natural environment and that is the main cause of contamination.

Microorganisms, animals, and plants all require zinc as a micronutrient [49]. The current study's findings suggest that increased land drainage and flooding during the monsoon season are to blame for the elevated concentration of zinc in sediment. River runoff may be the primary cause of the elevated manganese levels in the current study.

5. CONCLUSION

This study monitored the sediments contaminated with industrial chemical and certain trace metals in the Thengapatnam estuary of Tamil Nadu, a south-coastal region of India, using both geochemical and ecological indices at the same time. The estimated indices revealed significant amounts of chemical pollutants and trace metals concentration in the studied areas. We noted the average concentrations of all the trace metal pollutants, including iron, zinc, and copper. These findings show that all of the study regions' soil sediments contain substantial levels of potassium. The study's conclusions recommend avoiding both direct and indirect discharge of raw wastewater in the study area and reducing the use of pesticides and fertilisers in agricultural activities to prevent negative effects on the aquatic ecosystems. Creating a management plan that limits the discharge of pollutants into aquatic ecosystems and the wetland watershed is generally necessary for the effective protection of the wetland. The present baseline information will be helpful and form a useful tool for future ecological monitoring and assessment along the coastal waters.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

ACKNOWLEDGEMENT

The author sincerely thankful to the Department of Zoology and Womens Cristian College for providing facility and co-operation carrying out this research work.

COMPETING INTERESTS

Author has declared that no competing interests exist.

REFERENCES

1. Padhy C, Pattanayak KP, Reddy MD, Raj RK. Biodiversity-an important element for human life. Indian Journal of Natural Sciences. 2022;13(72):42746-42750.
2. Zahoor I, Mushtaq A. Water pollution from agricultural activities: A critical global review. Int. J. Chem. Biochem. Sci. 2023;23(1):164-176.
3. Nadarajan S, Sukumaran S. Chemistry and toxicology behind chemical fertilizers. In Controlled Release fertilizers for sustainable agriculture. Academic Press. 2021;195-229.
4. Chakraborty SK, Chakraborty SK. River pollution and perturbation: Perspectives and processes. Riverine Ecology Volume 2: Biodiversity Conservation, Conflicts and Resolution. 2021;443-530.
5. Bănăduc D, Simić V, Cianfaglione K, Barinova S, Afanasyev S, Öktener A, Curtean-Bănăduc A. Freshwater as a sustainable resource and generator of secondary resources in the 21st century: Stressors, threats, risks, management and protection strategies, and conservation approaches. International Journal of Environmental Research and Public Health. 2022;19(24):16570.
6. Bashir I, Lone FA, Bhat RA, Mir SA, Dar ZA, Dar SA. Concerns and threats of contamination on aquatic ecosystems. Bioremediation and biotechnology: Sustainable approaches to pollution degradation. 2020;1-26.
7. Jogdand OK. Study on the effect of global warming and greenhouse gases on environmental system. In Green chemistry and sustainable technology. Apple Academic Press. 2020;275-306.
8. Rajkhowa S, Sarma J. Climate change and flood risk, global climate change. In Global climate change. Elsevier. 2021;321-339.
9. Mushtaq N, Singh DV, Bhat RA, Dervash MA, Hameed OB. Freshwater contamination: Sources and hazards to aquatic biota. Fresh water pollution dynamics and remediation. 2020;27-50.
10. Ramachandra TV, Asulabha KS, Sincy V. Phosphate loading and foam formation in urban lakes. GP Globalize Research Journal of Chemistry. 2021;5(1):33-52.
11. Apostolaki S, Akinsete E, Koundouri P, Samartzis P. Freshwater: The importance of freshwater for providing ecosystem services. Encyclopedia of the World's Biomes. 2020;71-79.
12. Hassan B, Qadri H, Ali MN, Khan NA, Yatoo AM. Impact of climate change on freshwater ecosystem and its sustainable management. Fresh Water Pollution Dynamics and Remediation. 2020;105-121.
13. Kalyan D, Pathan AI, Agnihotri PG, Azimi MY, Frozan D, Sebastian J, Prieto C. Effect of climate change on sea level rise with special reference to indian coastline. in intelligent computing & optimization: Proceedings of the 4th International Conference on Intelligent Computing and Optimization 2021 (ICO2021). Springer International Publishing. 2022;3:685-694.
14. Kundu SK, Santhanam H. All pain and no gain: Factors impacting local and regional sustainability due to COVID-19 pandemic with respect to the Indian marine fisheries. Current Research in Environmental Sustainability. 2021;3:100086.
15. Bobdey AD. A study of fish diversity in Bhandara District (MS) India, With Special Emphasis on Pollution and Human Interference in Aquatic Habitats. Online International Interdisciplinary Research Journal. 2013;147-153.
16. Rajeev M, Bhandarkar S. Unravelling supply chain networks of fisheries in India: The Transformation of Retail. Springer Nature; 2022.
17. Anitha G, Kumar SP. Seasonal variations in physico-chemical parameters of Thengapattanam estuary, South west coastal zone, Tamilnadu, India. International Journal of Environmental Sciences. 2013;3(4):1253-1262.
18. Arthington ÁH, Naiman RJ, Mcclain ME, Nilsson C. Preserving the biodiversity and ecological services of rivers: new challenges and research opportunities. Freshwater Biology. 2010;55(1):1-16.
19. Barbarossa V, Bosmans J, Wanders N, King H, Bierkens MF, Huijbregts MA, Schipper AM. Threats of global warming to the world's freshwater fishes. Nature Communications. 2021;12(1): 1701.
20. Bhat RA, Singh DV, Qadri H, Dar GH, Dervash MA, Bhat SA, Yousaf B. Vulnerability of municipal solid waste: An

emerging threat to aquatic ecosystems. Chemosphere. 2022;287:132223.

21. Helen D, Vaithyanathan C, Ramalingom Pillai A. Assessment of heavy metal contamination and sediment quality of Thengapattinam estuary in Kanyakumari District. IJCPS. 2016;5(1):8-17.
22. Chinchmalatpure AR, Gorain B, Kumar S, Camus DD, Vibhute SD. Groundwater pollution through different contaminants: Indian scenario. Research developments in saline agriculture. 2019;423-459.
23. Nandini S, John Milton MC. Assessment of the physico-chemical parameters of sediment of Adayar Estuary, Tamil Nadu, India**.** Internal. J. Research in Advent Technology. 2018;6(9):2474-2481.
24. Kong W, Xu Q, Lyu H, Kong J, Wang X, Shen B, Bi Y. Sediment and residual feed from aquaculture water bodies threaten aquatic environmental ecosystem: Interactions among algae, heavy metals, and nutrients. Journal of Environmental Management. 2023;326:116735.
25. Thakur R, Sarvade S, Dwivedi BS. Heavy metals: Soil contamination and its remediation. AATCC Review. 2022;10(02) :59-76.
26. Pearson TH, Stanley SO. Comparative measurement of the redox potential of marine sediments as a rapid means of assessing the effect of organic pollution. Marine Biology. 1979;53:371-379.
27. Dewis J, Freitas F. Physical and chemical methods of soil and water analysis. FAO soils Bulletin. 1970;(10).
28. Khan MN, Mobin M, Abbas ZK, Alamri SA. Fertilizers and their contaminants in soils, surface and groundwater. Encyclopedia of the Anthropocene. 2018;5:225-240.
29. Dudgeon D, Arthington AH, Gessner MO, Kawabata ZI, Knowler DJ et al. Freshwater biodiversity: Importance, threats, status and conservation challenges. Biological Reviews. 2006;81(2):163-182.
30. Bassi N, Kumar MD, Sharma A, Pardha-Saradhi P. Status of wetlands in India: A review of extent, ecosystem benefits, threats and management strategies. Journal of Hydrology: Regional Studies. 2014;2:1-19.
31. Gan W, Ge Y, Zhong Y, Yang X. The reactions of chlorine dioxide with inorganic and organic compounds in water treatment: Kinetics and mechanisms. Environmental Science: Water Research and Technology. 2020;6(9):2287-2312.
32. Harper M, Mejbel HS, Longert D, Abell R, Beard TD, Bennett JR, Cooke SJ. Twenty-five essential research questions to inform the protection and restoration of freshwater biodiversity. Aquatic Conservation: Marine and Freshwater Ecosystems. 2021;31(9):2632-2653.
33. Letcher TM. Global warming, greenhouse gases, renewable energy, and storing energy. In Storing Energy. Elsevier. 2022; 3-12.
34. Bragadeeswaran S, Rajasegar M, Srinivasan M, Rajan UK. Sediment texture and nutrients of Arasalar estuary, Karaikkal, south-east coast of India. Journal of Environmental Biology. 2007; 28(2):237-240.
35. Rajasegar M, Srinivasan M, Khan SA. Distribution of sediment nutrients of Vellar estuary in relation to shrimp farming; 2002.
36. Pravin U Singare, Manisha P Trivedi, Ravindra M Mishra. Assessing the physico-chemical parameters of sediment ecosystem of vasai creek at Mumbai, India. Marine Science. 2011;1(1):22-29.
37. Saravanakumar A, Rajkumar M, Serebiah JS, Thivakaran GA. Seasonal variations in physico-chemical characteristics of water, sediment and soil texture in arid zone mangroves of Kachchh-Gujarat. J. Environ. Biol. 2008;29(5):725-732.
38. Vasantha R. Studies on the distribution of sediment nutrients of Thengapatnam estuary along the west coast of India. J. Basic. App. Bio. 2009;3(1 & 2):124 -130.
39. Wang J, Zhang Z. Phytoplankton, dissolved oxygen and nutrient patterns along a eutrophic river-estuary continuum: Observation and modeling. Journal of Environmental Management. 2020;261: 110233.
40. Faulkner SP, Richardson CJ. Physical and chemical characteristics of freshwater wetland soils. Constructed wetlands for wastewater treatment. 2020;41-72.
41. Paulmurugan R, Sabu T, Sandhya C, Das MR. Impact of physico-chemical parameters on the microbial population and its nature in a major retting zone of Kerala. International Journal of Environmental Studies. 2004;61(5):571-578.
42. Bhagan V, Selvaraj V, Srirenganathan P. Physico-chemical studies of water and sediments of AVM Canal near peninsular India. Journal of Ecotoxicology &

Environmental Monitoring. 1998;8(3):263-268.
43. Ziblim IA, Timothy KA, Phillip A. Effects of season on the mineral (Potassium, Calcium, Phosphorus, Magnesium) levels of pennisetum pedicellatum in Northern Ghana. Greener Journal of Agricultural Sciences. 2012;2(7):329-333.
44. Adeola Alex Adesuyi1, Moses Okafor Ngwoke, Modupe Olatunde Akinola, Kelechi Longinus Njoku and Anuoluwapo Omosileola Jolaoso. Assessment of physicochemical characteristics of sediment from Nwaja Creek, Niger Delta, Nigeria. Journal of Geoscience and Environment Protection. 2016;4:16-27.
45. Sonone SS, Jadhav S, Sankhla MS, Kumar R. Water contamination by heavy metals and their toxic effect on aquaculture and human health through food Chain. Lett. Appl. Nano Bio Science. 2020; 10(2):2148-2166
46. Senthilnathan S, Balasubramanian T. Distribution of heavy metals in estuaries of southeast coast of India; 1997.
47. John DA, Leventhal JS. Bioavailability of metals. Preliminary compilation of descriptive geoenvironmental mineral deposit models. 1995;10-18.
48. Namieśnik J, Rabajczyk A. The speciation and physico-chemical forms of metals in surface waters and sediments. Chemical Speciation and Bioavailability. 2010; 22(1):1-24.
49. Khan ST, Malik A, Alwarthan A, Shaik MR. The enormity of the zinc deficiency problem and available solutions; An overview. Arabian Journal of Chemistry. 2022;15(3):103668.

Peer-review history:
The peer review history for this paper can be accessed here:
https://prh.mbimph.com/review-history/3893