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Seasonal Distribution of Nutrients in Water and Sediment of Three Coastal Region of Palk Bay Area, India

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Abstract: The present study was carried out to determine the seasonal distribution of nutrients in water and sediment of three coastal region of Thondi, Kottaiappattinum and Sethubhavachatirum for a period of one year from January 2018 to December 2018. The analysis of different parameters such as nitrite, nitrate, ammonia, total nitrogen, inorganic phosphate, total phosphate, silicate, pH sediment, total phosphate, total nitrogen and total organic carbon were carried out using standard methods in water as well as in sediment. The nitrite values varied between 0.214 to 0.892 $\mu\text{m/l}$, 0.128 to 0.848 $\mu\text{m/l}$ and 0.097 to 0.917 $\mu\text{m/l}$; nitrate values varied between 1.316 to 4.881 $\mu\text{m/l}$, 1.87 to 4.411 $\mu\text{m/l}$ and 7.029 to 12.045 $\mu\text{m/l}$; ammonia values varied between 1.316 to 4.881 $\mu\text{m/l}$, 1.87 to 4.411 $\mu\text{m/l}$ and 7.029 to 12.045 $\mu\text{m/l}$; total nitrogen values varied between 16.976 to 29.512 $\mu\text{m/l}$, 14.765 to 28.225 $\mu\text{m/l}$ and 12.776 to 23.541 $\mu\text{m/l}$; inorganic phosphate values varied between 0.354 to 1.98 $\mu\text{m/l}$, 0.292 to 1.967 $\mu\text{m/l}$ and 0.483 to 1.84 $\mu\text{m/l}$; total phosphorus values varied between 1.033 to 2.508 $\mu\text{m/l}$, 0.83 to 2.816 $\mu\text{m/l}$ and 1.418 to 2.953 $\mu\text{m/l}$; silicate content values varied between 25.217 to 54.074 $\mu\text{m/l}$, 30.883 to 59.872 $\mu\text{m/l}$ and 28.217 to 48.074 $\mu\text{m/l}$ at Thondi, Kottaiappattinum and Sethubhavachatirum, respectively.

In sediment, pH varied between 8.0 to 8.20, 7.9 to 8.20 and 8.0 to 8.10; total phosphorus 0.15 to 2.61, 2.31 to 3.31 and 0.91 to 2.17; Total nitrogen 6.50 to 12.95 $\mu\text{g/g}$, 4.85 to 11.96 $\mu\text{g/g}$ and 5.17 to 8.08 $\mu\text{g/g}$ and the total organic carbon 1.57 to 5.36, 2.21 to 3.59 and 1.48 to 4.15 at the three stations.

Keywords: Nutrient, Seasonal variation, Sediments, Coastal region, Palk Bay

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Introduction

Environmental conditions play an important role in promoting the occurrence and abundance of commercially exploitable marine resources (Ivelev, 1966). Nutrients are the necessary

parameters within the coastal waters that influence the growth, reproduction and metabolic activities of biotic components. Distribution of nutrients is principally supported by season, tidal

conditions, fresh water influx and land runoff, chemical effluents and flushing of chemical employed in the agricultural fields. In coastal waters, the nutrients regenerated from benthic sediments are a major source influencing primary production. Meiofauna and macrofauna are responsible for about 20% of regenerated nutrients (Mann, 1981). Nutrients like nitrate and phosphate influenced the productivity of the marine environment which is always higher during the monsoon season due to river run off and rapid oxidation of plankton detritus and decomposing matter (Sivakumar, 1982; Nedumaran *et al.*, 2001). Hence the present study was carried out to determine the seasonal distribution of Nutrients in water and sediment of three coastal regions of Thondi, Kottai pattinum and Sethubhavachatirum.

Materials and Methods

The water samples were collected from the study area of Thondi, Kottai pattinum and Sethubhavachatirum in Palk Bay area for a period of one year from January 2018 to December 2018. In the present investigation surface water samples were collected by using clean plastic containers. Water characteristics were estimated following standard methods (Strickland and Parsons, 1972; Grasshoff *et al.*, 1983; APHA, 1995). Samples of sediment were collected every month using a Vanveen grab. The samples were collected and packed in polythene bags and stored at -20°C. For estimation of the nutrients in the sediment samples, the frozen samples were thawed and dried at specified temperatures, before the samples can be used for analysis of nutrients. The amount of nutrients present in the sediment samples was expressed as µg/g. Nitrite was determined by the Azo Dye method described by Bend Schneider and Robinson (1952). Nitrate was estimated using cadmium reduction column as described by Solyom and Carlberg (1975). The inorganic phosphate was estimated using the method described by Murphy and Riley (1962). Silicate in the sample was estimated by the method of Strickland and Parsons (1972). The absorbance of

the blue complex was measured at 810 nm using a spectrophotometer.

Results and Discussion

Nitrite:

Nitrite content (Fig. 1) varied in accordance with total nitrogen content of the seawater. The nitrite values varied between 0.214 to 0.892 µm/l, 0.128 to 0.848 µm/l and 0.097 to 0.917 µm/l at Thondi, Kottai pattinum and Sethubhavachatirum, respectively. The maximum and minimum value of nitrite was recorded during pre-monsoon and monsoon months and the mean value of nitrite was recorded as 0.40 ml/l; 0.49 ml/l and 0.47 ml/l. The statistical analysis of nitrite content among Thondi, Kottai pattinum and Sethubhavachatirum showed that there is no difference between the three locations and the P value is 0.688044 (Table 1). The recorded high nitrite values could be due to the increased phytoplankton excretion, oxidation of ammonia and reduction of nitrate and by recycling of nitrogen and also due to bacterial decomposition of planktonic detritus present in the environment as reported by Govindasamy *et al.* (2000). The recorded low nitrite values during summer season may be due to less freshwater inflow and high salinity was reported by Mani and Krishnamurthy (1989).

Nitrate:

Nitrate content (Fig. 2) varied in accordance with total nitrogen content of the seawater. The nitrate values varied between 1.316 to 4.881 µm/l, 1.87 to 4.411 µm/l and 7.029 to 12.045 µm/l at Thondi, Kottai pattinum and Sethubhavachatirum, respectively. The maximum and minimum value of nitrate was recorded during pre-monsoon, monsoon and summer months and the mean values of nitrate was recorded as 2.95 µm/l, 3.00 µm/l and 9.00 µm/l, respectively. The statistical analysis of nitrate content among Thondi, Kottai pattinum and Sethubhavachatirum showed that there is no difference between the three location and the P value is 4.92 (Table1). The nitrate content fluctuated between the stations as

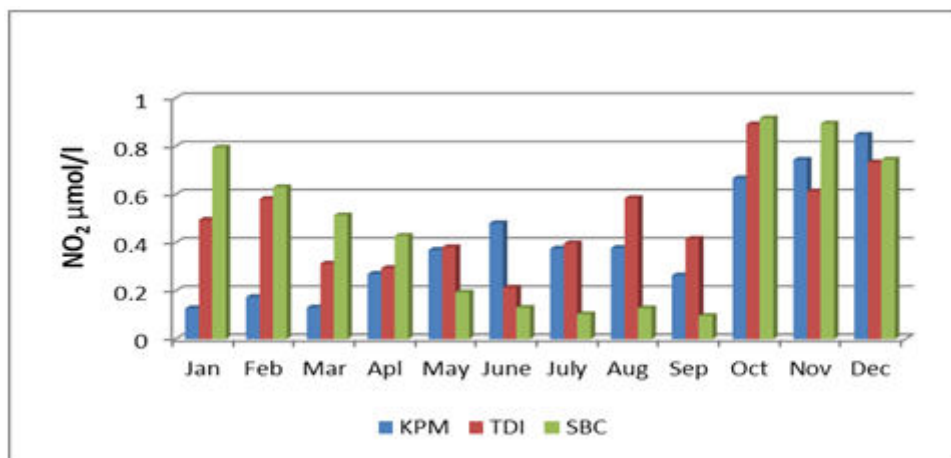


Fig. 1: Distribution of nitrite at Thondi (TDI), Kottai-pattinam (KPM) and Sethubhavachatirum (SBC) during 2018.

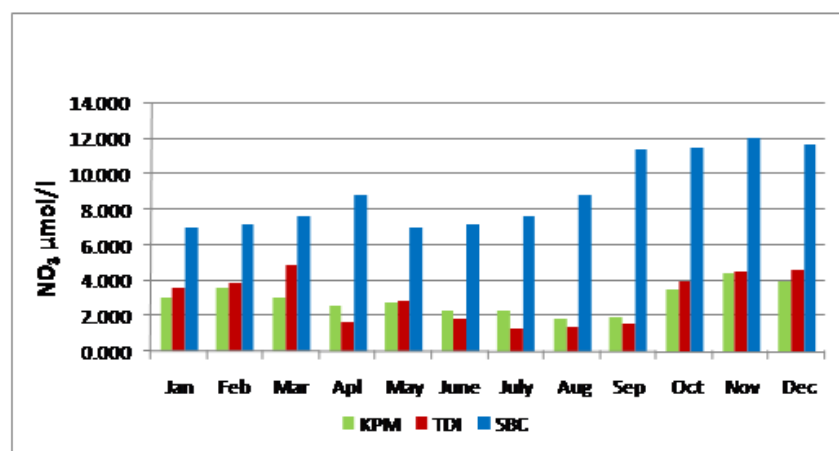


Fig. 2: Distribution of nitrate at Thondi (TDI), Kottai-pattinam (KPM) and Sethubhavachatirum (SBC) during 2018.

well as the months. The low nitrate content encountered may be due to the less usage of nitrogen fertilizers and less disposal of wastes around these stations. The present study derives support from earlier reports by Bragadeeswaran *et al.* (2007) in Arasalar estuary and Hari Muraleedharan *et al.* (2010) in Thondi coastal water.

Ammonia (NH₄):

The ammonia values (Fig. 3) varied between 1.316 to 4.881 µm/l, 1.87 to 4.411 µm/l and 7.029 to 12.045 µm/l at Thondi, Kottai-pattinam and Sethubhavachatirum, respectively. The maximum and minimum value of Ammonia was recorded during summer and monsoon and the mean values of ammonia was recorded as 0.49 µm/l 0.07 µm/l and 0.05 µm/l, respectively. The statistical analysis of ammonia among Thondi, Kottai-

pattinam and Sethubhavachatirum showed that there is no difference between the three location and the P value is 1.06 (Table1). Higher concentration of ammonia was observed during the monsoon season. A lower value of ammonia was found during the summer season. The recorded higher concentration could be partially due to the death and subsequent decomposition of phytoplankton and also due to the excretion of ammonia by planktonic organisms as reported by Segar and Hariharan (1989).

Total Nitrogen:

The total nitrogen (Fig.4) values varied between 16.976 to 29.512 µm/l, 14.765 to 28.225 µm/l and 12.776 to 23.541 µm/l at Thondi, Kottai-pattinam and Sethubhavachatirum, respectively. The maximum and minimum value of total nitrogen was recorded during monsoon and pre-monsoon

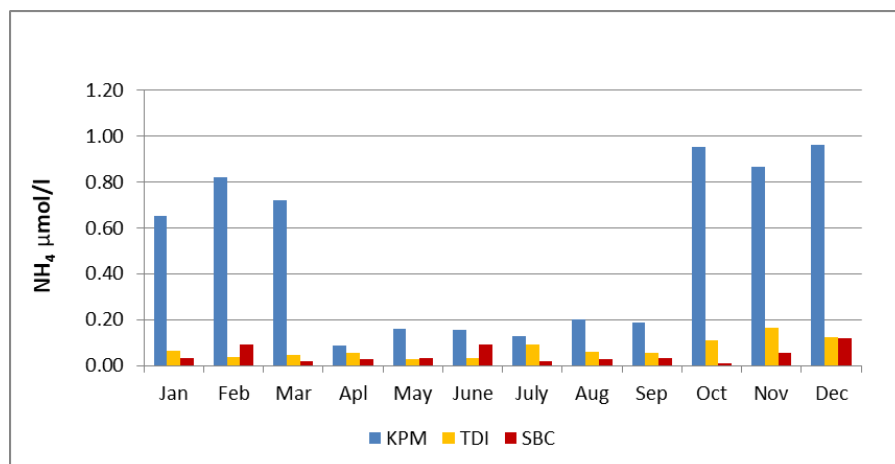


Fig. 3: Distribution of ammonia at Thondi (TDI), Kottaipattinam (KPM) and Sethubhavachatirum (SBC) during 2018.

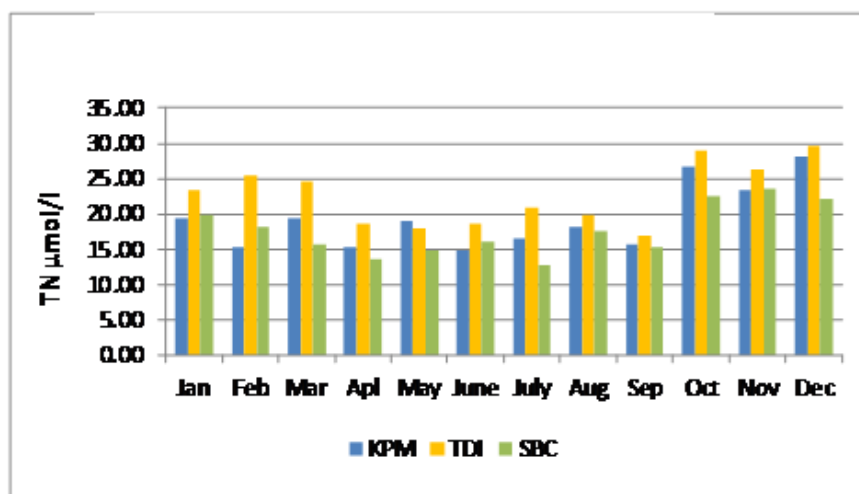


Fig. 4: Distribution of total nitrogen at Thondi (TDI), Kottaipattinam (KPM) and Sethubhavachatirum (SBC) during 2018.

months and the mean values of total nitrogen was recorded as 19.35 µmol/l, 22.57µmol/l and 17.67 µmol/l. The statistical analysis of total nitrogen among Thondi, Kottaipattinam and Sethubhavachatirum showed that there is no difference between the three locations and the P value is 0.022563 (Table 1).

Inorganic Phosphate:

The inorganic phosphate (Fig. 5) values varied between 0.354 to 1.98 µmol/l, 0.292 to 1.967 µmol/l and 0.483 to 1.84 µmol/l at Thondi, Kottaipattinam and Sethubhavachatirum, respectively. The maximum and minimum value of inorganic phosphate was recorded during monsoon and pre-monsoon months, respectively and the mean values of inorganic phosphate was recorded as

1.06 µmol/l, 1.17 µmol/l and 1.08 µmol/l. The statistical analysis of inorganic phosphate among Thondi, Kottaipattinam and Sethubhavachatirum showed that there is no difference between the three locations and the P value is 0.883262 (Table 1). The recorded high concentration of inorganic phosphates during monsoon season might possibly be due to intrusion of upwelling seawater into the creek, which in turn increased the level of phosphate as reported by Nair *et al.* (1984).

Total Phosphorus:

The Total phosphorus (Fig. 6) values varied between 1.033 to 2.508 µmol/l, 0.83 to 2.816 µmol/l and 1.418 to 2.953 µmol/l at Thondi, Kottaipattinam and Sethubhavachatirum, respectively. The maximum and minimum value of total phosphorus

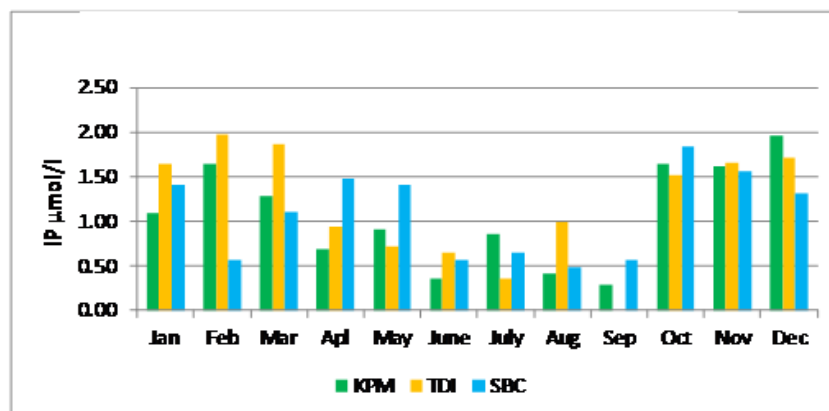


Fig. 5: Distribution of inorganic phosphate at Thondi (TDI), Kottaipattinum (KPM) and Sethubhavachatirum (SBC) during 2018.

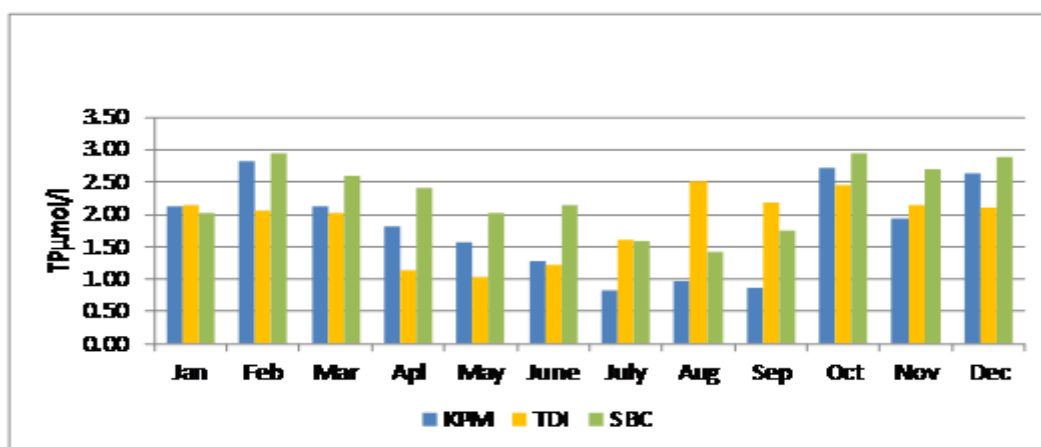


Fig. 6: Distribution of total phosphate at Thondi (TDI), Kottaipattinum (KPM) and Sethubhavachatirum (SBC) during 2018.

was recorded during monsoon and pre-monsoon months, respectively and the mean values was recorded at all the three stations as 1.81 $\mu\text{mol/l}$, 1.88 $\mu\text{mol/l}$ and 2.29 $\mu\text{mol/l}$, respectively. The statistical analysis of total phosphorus among Thondi, Kottaipattinum and Sethubhavachatirum showed that there is no difference between the three locations and the P value is 0.11757 (Table1). The maximum monsoonal phosphate value might be due to the regeneration and release of total phosphorus from bottom mud in to the water column by turbulence and mixing (Saravanakumar *et al.*, 2008). Low values of phosphate observed during post-monsoon season may be due to the reduction of land drainage, sewage and fertilizer disposal from the land drainage. Similarly maximum value in monsoon and minimum value in post-monsoon season were also reported from Tranquebar - Nagappattinam

coast (Sampathkumar, 1992) and Vellar estuary (Nedumaran *et al.*, 2001).

Silicate:

Variations in silicate content (Fig. 7) were very high during the study period. The silicate content values varied between 25.217 to 54.074 $\mu\text{mol/l}$, 30.883 to 59.872 $\mu\text{mol/l}$ and 28.217 to 48.074 $\mu\text{mol/l}$ at Thondi, Kottaipattinum and Sethubhavachatirum, respectively. The maximum and minimum value of silicate was recorded during monsoon and post-monsoon months, respectively and the mean values were recorded at all the three stations as 44.74 $\mu\text{mol/l}$, 37.93 $\mu\text{mol/l}$ and 39.68 $\mu\text{mol/l}$. The statistical analysis of silicate among Thondi, Kottaipattinum and Sethubhavachatirum showed that there is no difference between the three locations and the P value is 0.119585 (Table 1). Maximum value recorded in monsoon season

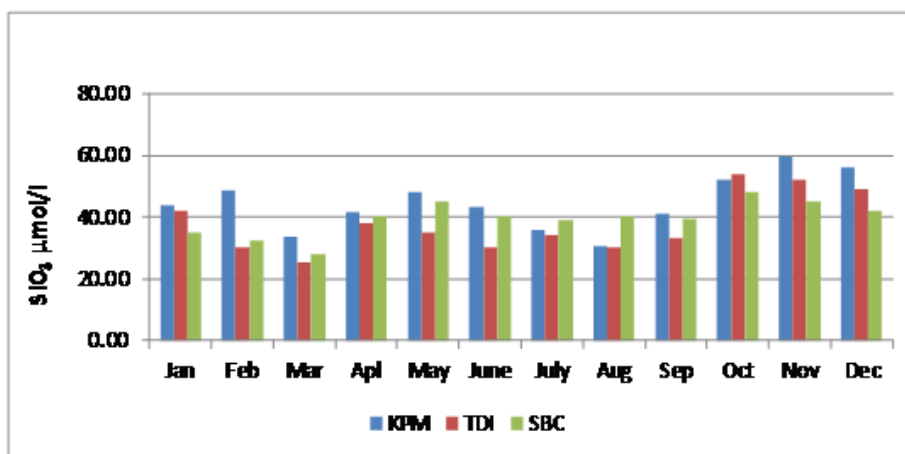


Fig. 7: Distribution of silicate at Thondi (TDI), Kottaipattinum (KPM) and Sethubhavachatirum (SBC) during 2018.

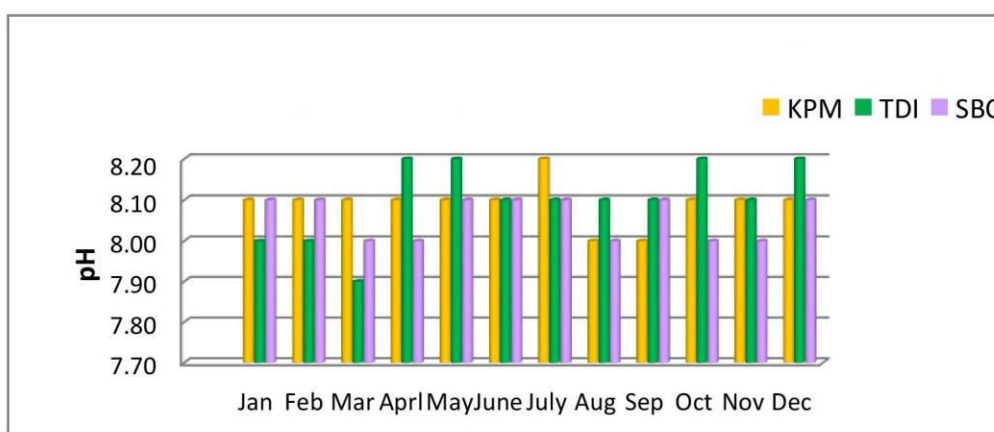


Fig. 8: Distribution of pH at Thondi (TDI), Kottaipattinum (KPM) and Sethubhavachatirum (SBC) during 2018.

could be due to significant flow of monsoonal fresh water derived from land drainage carrying silicate which leached out from rocks and sediment and exchanged with superimposed water within the coastal environment (Govindasamy *et al.*, 2000). The low value of silicate recorded during Post-monsoonal season could be attributed to uptake of silicates by phytoplankton for their biological activity (Saravanakumar *et al.*, 2008). Similar maximum value in monsoon and minimum in summer season has been reported by Nair *et al.* (1983) in Ashtamudi estuary.

Analysis of Sediments:

pH:

Variations in pH value (Fig. 8) were very meager during the study period of January- December

2018. Sediment pH was recorded more or less similar in all the three stations as well as months. The pH for sediment samples varied between 8.0 to 8.20, 7.9 to 8.20 and 8.0 to 8.10 at Thondi, Kottaipattinum and Sethubhavachatirum, respectively. The minimum pH was recorded during summer and maximum was recorded during monsoon and the mean values were recorded at all the three stations as 8.09, 8.10 and 8.06. The statistical analysis of sediment pH among Thondi, Kottaipattinum and Sethubhavachatirum showed that there is no difference between the three location and the P value is 0.309412 (Table 1).

Total phosphorus:

Total phosphorus ($\mu\text{g/g}$) (Fig. 9) content in sediment was recorded in all the three stations as well as months. The total phosphorus content in

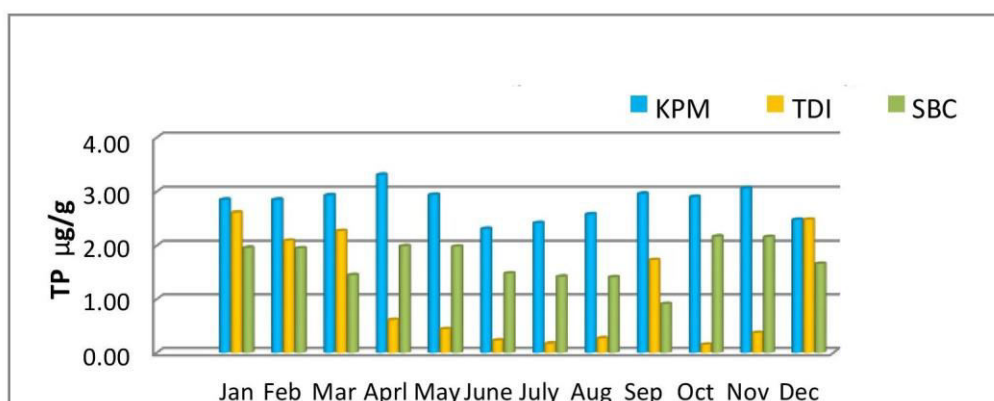


Fig. 9: Distribution of total phosphorus at Thondi (TDI), Kottaipattinum (KPM) and Sethubhavachatirum (SBC) during 2018.

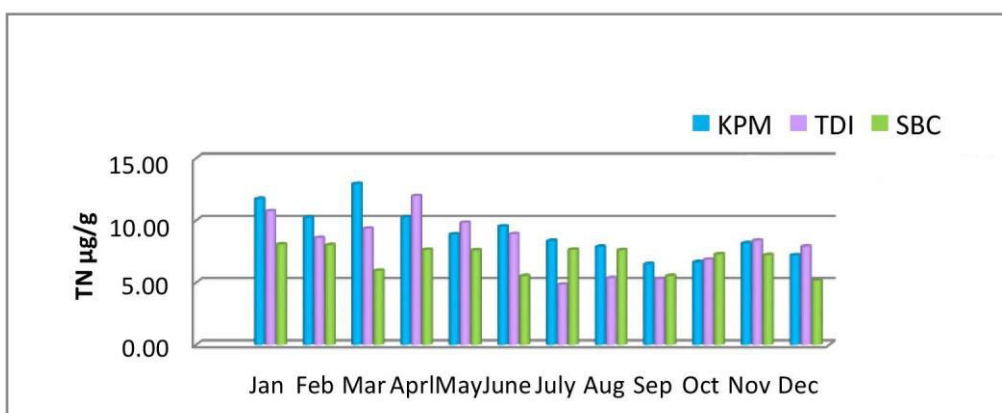


Fig. 10: Distribution of total nitrogen at Thondi (TDI), Kottaipattinum (KPM) and Sethubhavachatirum (SBC) during 2018.

sediment samples varied between 0.15 to 2.61, 2.31 to 3.31 and 0.91 to 2.17 at the three stations. Total phosphorus content in sediment showed minimum value during pre-monsoon and a maximum value of total phosphorus was recorded during monsoon and the mean values was recorded as 2.80 µg/g, 1.12 µg/g and 1.71 µg/g. The statistical analysis of total phosphorus among Thondi, Kottaipattinum and Sethubhavachatirum showed that there is no difference between the three locations and the P value is 1.52 (Table1).

Total nitrogen:

Total nitrogen content (µg/g) (Fig. 10) in sediment was recorded in all the three stations as well as months. The Total nitrogen content in sediment samples varied between 6.50 to 12.95 µg/g, 4.85 to 11.96 µg/g and 5.17 to 8.08 µg/g at the three

stations. Total nitrogen content in sediment showed minimum value during pre-monsoon and a maximum value of Total nitrogen was recorded during monsoon and the mean values recorded was 9.03 µg/g, 8.17 µg/g and 6.95 µg/g. The statistical analysis of total nitrogen among Thondi, Kottaipattinum and Sethubhavachatirum showed that there is no difference between the three locations and the P value is 0.029971 (Table 1).

Total organic carbon:

Total organic carbon content (mg/g) (Fig. 11) in sediment was recorded in all the three stations as well as months. The total organic carbon content in sediment samples varied between 1.57 to 5.36, 2.21 to 3.59 and 1.48 to 4.15 at the three stations. Total organic carbon content in sediment showed the minimum value during pre-monsoon and a

Table 1: Three stations : Thondi, Kottai pattinam and Sethubavachatrum

Variables	SS	DF	MS	F ratio	P value	F crit
Nitrite						
Between	0.051047	2	0.025524	0.378172	0.688044	3.284918
Within	2.227232	33	0.067492			
Nitrate						
Between	290.8597	2	145.4299	63.45187	4.92E-12	3.284918
Within	75.63505	33	2.291971			
Ammonia						
Between	1.495687	2	0.747843	16.54064	1.06E-05	3.284918
Within	1.492012	33	0.045212			
Total Nitrogen						
Between	148.7785	2	74.38924	4.262407	0.022563	3.284918
Within	575.9292	33	17.4524			
Inorganic Phosphate						
Between	0.081403	2	0.040701	0.124602	0.883262	3.284918
Within	10.7795	33	0.326652			
Total Phosphate						
Between	1.61789	2	0.808945	2.285792	0.11757	3.284918
Within	11.67875	33	0.353902			
Silicate						
Between	300.0897	2	150.0448	2.266461	0.119585	3.284918
Within	2184.675	33	66.20227			
pH sediment						
Between	0.011667	2	0.005833	1.215789	0.309412	3.284918
Within	0.158333	33	0.004798			
Total Phosphate sediment						
Between	17.423	2	8.7115	20.65768	1.52E-06	3.284918
Within	13.91635	33	0.421708			
Total Nitrogen sediment						
Between	26.33017	2	13.16509	3.908198	0.029971	3.284918
Within	111.1632	33	3.368582			
Total Organic Carbon sediment						
Between	3.096945	2	1.548472	1.976725	0.154587	3.284918
Within	25.85064	33	0.783353			

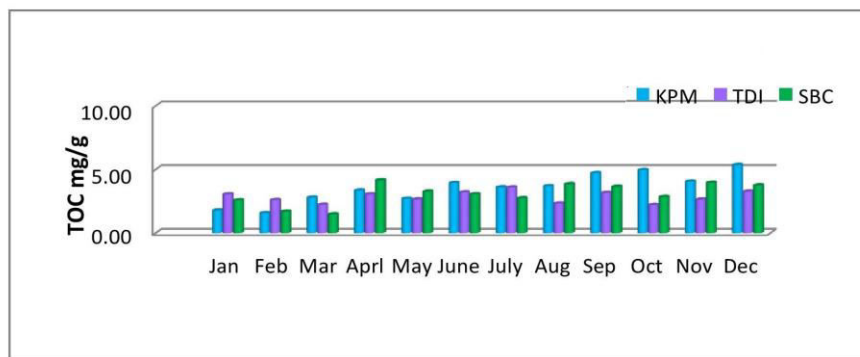


Fig. 11: Distribution of total organic carbon at Thondi (TDI), Kottaipattinum (KPM) and Sethubhavachatirum (SBC) during 2018.

maximum value of total organic carbon was recorded during monsoon and the mean values was recorded as 3.54 mg/g, 2.83 mg/g and 3.08 mg/g. The statistical analysis of total organic carbon showed that there is no difference between the three of locations Thondi, Kottaipattinum and Sethubhavachatirum and the P value is 0.154587 (Table 1). This study revealed that the minimum concentrations of nutrients were observed during March month and maximum concentrations of nutrients were observed during December month. Nutrient fluctuations were reported in Tranqubar – Nagapattinam coastal areas by Sampathkumar and Kannan (1998) and in Madras to Kovalam coastal zone by Rajendran (1992).

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