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Seasonal changes in physico-chemical parameters of Thondi Coast waters, Palk Bay, South East coast, India.

Cambios estacionales en los parámetros físico-químicos de las aguas de la costa de Thondi, Palk Bay, costa sureste, India

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ABSTRACT.

The present study was carried out to determine the water quality in terms of physicochemical parameters in the coastal waters of Thondi , Palk Bay for a period of one year from Jan2015 to Dec 2015. The analysis of different parameters such as temperature, pH, salinity, TDS, nitrite, nitrate, silicate, inorganic phosphate and total phosphate were carried out using standard methods. Water temperature ranged from 26.0°C-30.0°C, Salinity ranged (30.1-34.55‰, pH(8.0 -8.2), EC value (45.20103mho- 50.49 103mho), Turbidity 28-59 NTU, TSS value (58.28-95 mg/l), DO (4.01 ml/l -5.61 ml/l), BOD (0.16 mg/- 2.19 mg/l), Chemical Oxygen Demand (0.87 ml/l -19.9mg/l), Chloride 17252 mg/l -17850 mg/l), Sulphate (1098.79 mg/l - 2637.41 mg/l),Nitrite (0.117 µm/l and 1.192 µm/l), nitrate (1.513 µm/l and 12.981 µm/l), Ammonia (0.017 µm/l and 0.11 µm/l), total nitrogen (16.531 µm/l and 35.616 µm/l), inorganic phosphate (0.523 µm/l and maximum 2.047 µm/l), Total phosphorus (0.81 µm/l and 4.386 µm/l)and silicate was recorded 41.676 µm/l and 61.149 µm/l.In sediment samples pH(7.7 -8.1), Total Phosphorus(1.40µg/g -2.58 µg/g), total nitrogen (4.14 µg/g -9.80 µg/g), total organic carbon (1.70 mg/g-5.84 mg/g).The studies revealed that the physico-chemical parameters of water and samples showed seasonal variations in Thondi coastal waters.

Key words: Physico-chemical Parameters, Nutrients, statistical analysis, Palk Bay.

RESUMEN

El presente estudio se llevó a cabo para determinar la calidad del agua en términos de parámetros fisicoquímicos en las aguas costeras de Thondi, Palk Bay por un período de un año

desde enero de 2015 hasta diciembre de 2015. El análisis de diferentes parámetros como temperatura, pH, salinidad, Se llevaron a cabo TDS, nitrito, nitrato, silicato, fosfato inorgánico y fosfato total utilizando métodos estándar. La temperatura del agua osciló entre 26,0 ° C-30,0 ° C, la salinidad osciló (30,1-34,55 ‰, pH (8,0 -8,2), valor de CE (45,20103mho- 50,49 103mho), turbidez 28-59 NTU, valor TSS (58,28-95 mg / l), OD (4,01 ml / l -5,61 ml / l), DBO (0,16 mg / - 2,19 mg / l), Demanda química de oxígeno (0,87 ml / l -19,9 mg / l), Cloruro 17252 mg / l - 17850 mg / l), sulfato (1098,79 mg / l - 2637,41 mg / l), nitrito (0,117 µm / ly 1,192 µm / l), nitrato (1,513 µm / ly 12,981 µm / l), amoniaco (0,017 µm / ly 0,11 µm / l), nitrógeno total (16,531 µm / ly 35,616 µm / l), fosfato inorgánico (0,523 µm / ly máximo 2,047 µm / l), fósforo total (0,81 µm / ly 4,386 µm / l) y silicato se registró 41,676 µm / ly 61,149 µm / l. En las muestras de sedimento pH (7,7 -8,1), fósforo total (1,40 µg / g -2,58 µg / g), nitrógeno total (4,14 µg / g -9,80 µg / g), carbono orgánico total (1,70 mg / g-5,84 mg / g). Los estudios revelaron que los parámetros físico-químicos del agua y las muestras mostraron variaciones estacionales en las aguas costeras de Thondi.

Palabras clave: Parámetros físico-químicos, Nutrientes, análisis estadístico, Palk Bay.

INTRODUCTION

In the tropical regions, coastal ecosystems are known for their richness in biological productivity. The physico-chemical characteristics of an aquatic ecosystem undergo changes due to the action of tides, inflow of domestic and industrial effluents and during rainfall consequently, the biological characteristics are also to change. The physico-chemical parameters such as temperature, salinity, dissolved oxygen, pH and nutrients showed seasonal variation brought about by monsoon cycles and tidal rhythms have been known to be responsible for natural variations in the coastal ecosystem (Keesing and Irvine, 2005). Several reports on hydrography have been done by (Varadarajulu and Tippu Abdul Khader, 1976), distribution of dissolved oxygen and nutrients (Bhavanarayana and Lafond, 1957; De Sousa et.al., 1981). The environmental parameters are well documented (Qasim and Gopinathan,1969; Vijayalakshmi and Venugopalan, 1973; Sarala Devi et.al 1983). Extensive studies have been made pertaining to the spatio-temporal distribution and behaviour of nitrate-nitrogen, phosphate-phosphorous and silicate-silicon in many estuaries of India (Reddy et.al., 1993; Gowda and Panigrahy, 1992; Das et.al., 1997). The hydrography of the inshore waters has been observed (Annigeri 1986; Dharmaraj et.al*.,* 1986; Jagadeesan 1986; Rama Raju et. al., 1989; Rivonker and Verlancar 1990). Arunabha et.al. (1990) and Karl Banse (1990) have observed the seasonal variations of some hydrographical parameters in a tidal creek opening into the Bay of Bengal. Relatively more

information is available on the plankton and hydrography of the Gulf of Mannar (Chacko and Malu Pilay. 1957; Chacko and Rajendran 1959; Chidambaram et.al., 1951; Prasad 1954,1956; and Marichamy and Pon. Siraimeetan. 1979).

MATERIAL AND METHODS

Description of the study area: During the Quaternary period the Palk Strait must have originated introducing a close connection to the Southern Gulf of Mannar and to the northern Bay of Bengal with in the latitude of 90° and 10° N and longitude of 79° and 80° E. Northern boundary of the strait is of Kodiyakkarai Map (Fig.1). The Palk Strait is influenced mainly by the North east monsoon. The Strait has strong potential of living and nonliving resources. Thondi is a small village situated in the Palk Bay region of Tamil Nadu. The study area lies in the latitude of 9º44'N and longitude of 79º19' E. The rainfalls in Thondi region are mainly due to North East and South West monsoons. Thondi coast has a very minimal wave action. Turbidity of the seawater is moderately low and rich in nutrients hence, it serves as a treasure house for valuable marine resources like sea grass, seaweeds and invertebrates like coelenterates, echinoderms and shell fishes. The present study was carried out at Thondi Coast, Palk Bay, South east coast of India

Fig 1. Map of studied site.

Methodology: The water samples were obtained from the study region for a period of one year from January 2015 to December.2015, split into post-monsoon (January-March), summer (April-June), pre-monsoon (July -September) and monsoon (October-December) seasons for convenience, over a period of 12 months. In the current research, surface water samples were

obtained by using clean plastic containers and the water samples were analysed using standard Strickland and Parsons (1972) methods; Grasshoff et al. (1983) and APHA (1998), Temperature was measured using a precision of 0.5 °C thermometer. Salinity, as defined by Strickland and Parsons (1972), was estimated by the silver nitrate titration method using potassium chromate as an indicator. Using an Elico model EL 10pH meter, the pH was calculated. By Winkler's titration process, the dissolved oxygen content was measured. Turbidity was calculated and expressed as NTU (Nephelometric Turbidity Unit) by means of a turbidity meter. Complete suspended solids (TSS) were estimated by weighing 100 ml of unfiltered and filtered water samples of the residue after evaporation(Sahu et al., 2013).The water samples were filtered through the Millipore filtering unit for nutrient analysis using the whatman GF/C filter and dissolved nutrients such as nitrate, nitrite, ammoniaNH4, total nitrogen, inorganic phosphate, total phosphrous, silicate were calorimetrically calculated using ECIL CE 303 Grating, Spectrophometer, as defined by Strickland and Parsons (1972), at acceptable wave lengths. The statistics analysis was conducted using Data Analysis Toolpakak with MS office Excel.

RESULTS AND DISCUSSION

The minimum 0.2mm rainfall was recorded during May and the maximum 398.6mm rainfall was recorded during November. In the study area the rainfall was mainly influenced due to Northeast monsoon. Water temperature varies in accordance with ambient air temperature. In Thondi Coastal waters the minimum and maximum water temperature was recorded 26ºC and 30ºC during monsoon and summer months respectively and the mean value of temperature was 28 ºC (Fig.1). The maximum and minimum values of surface temperature were attributed with peak solar radiation and the temperature of water essentially influenced by the atmosphere. In general summer and pre monsoon season recorded high water temperature when compared with other seasons, which agree with the observations of Kannan and Kannan (1996). Alvarez Borrego and Alvarez Borrego (1982) have suggested the temperature variations as a function of bathymetry, solar radiation, tidal currents, incidence of upwelling waters and atmospheric variations.

In the study area, the minimum and maximum salinity value was recorded 30.1‰ and 34.55‰ during monsoon and summer months, and the mean value of salinity was 31.5‰(Fig.2). Variations in salinity were observed due to rainfall and flow of freshwater into the sea during tidal changes.. The low salinity in the study area is probably due to the huge volume of fresh water inflow and the input of considerable freshwater flow could be considered as a pollutant (Saunders et.al 2007). Variations in pH value were very meager during the study period of Jan- Dec. The minimum and maximum value of pH was recorded 8.0 and 8.2 during monsoon seasons and

summer months and the mean value of pH was pH 8.1(Fig.3). Generally, higher pH values may be attributed to sea water mixing and redox variations in sediment and the water column, while lower pH values are observed during monsoon may due to influx of freshwater and tide action (Panigrahy et.al., 1999; Abu-Hilal & Adam 1995, Shriadah & Al-Ghais 1999). The maximum Ec (Electrical Conductivity -10^3mho) value was recorded 50.49 and minimum value was recorded 45.20 during Summer and monsoon months and the mean value of Electrical Conductivity was 47.49. The maximum turbidity value was recorded 59 NTU and minimum value was recorded 28 NTU during Summer and monsoon months and the mean value of turbidity was 42. The maximum and minimum value of total suspended solid was recorded 95 mg/l and 58.28mg/l during Summer and monsoon months and the mean value of total suspended solid was 79.13(Fig.4 -6). From the statistical analysis, the physical parameters were all positive correlation. Temperature was found highly significant between salinity, pH and EC and insignificant with turbidity and TSS. Salinity was highly significant with pH and EC and insignificant with turbidity and TSS. pH showed moderate significant with EC and insignificant with turbidity and TSS. Whereas, Turbidity was significant with TSS and EC and finally EC was insignificant with TSS. The result observed shows that high significant among the parameters are increase or decrease in temperature relatively increase or decrease in salinity and pH(Table.1).

In Thondi coastal waters the minimum and maximum DO value was recorded 4.01 ml/l and 5.61 ml/l during summer and monsoon seasons and the mean value of DO was 4.83 ml/l. The high oxygen content especially during monsoon could be attributed to low temperature and low salinity values which might help to enhance the level of dissolved oxygen content in water. In general, high values of dissolved oxygen are associated with high values of primary productivity (Krishnamurthy and Vishwanathan, 1968). It is assumed that high concentration of oxygen is met with before and after the outburst of phytoplankton (Subramanyan, 1959).The maximum and minimum value of Biological Oxygen Demand was recorded 2.19 mg/l and 0.16 mg/l during summer and monsoon months, with a mean value of Biological Oxygen Demand was 0.87 ml/l. The maximum value of Chemical Oxygen Demand was recorded 19.9mg/l and the minimum value of Chemical Oxygen Demand was recorded 3.2mg/l during summer and monsoon months and the mean value of chemical Oxygen Demand was 10.21 ml/l. The maximum and minimum value of Chloride was recorded 17850 mg/l and 17252 mg/l during Post monsoon and summer months and the mean value of Chloride was 17491.60 ml/l. The maximum and minimum value of Sulphate was recorded 2637.41 mg/l and 1098.79 mg/l during Pre monsoon and monsoon months and the mean value of Sulphate was 1851.33 ml/l(Fig.7-11). From the statistical analysis, the temperature showed highly significant with DO and BOD with negative and positive correlation respectively. Chloride showed moderate and positive correlation between temperature, salinity,

pH and EC. Whereas, Sulphate was negative correlation and moderately significant with temperature, salinity, EC and cl_2 and significant with pH, turbidity. Turbidity showed insignificant with DO, BOD, COD and Cl_2. Further, TSS was insignificant with DO, BOD, COD, Cl_2 and sulphate. DO was a moderately significant negative correlation with BOD and Cl_2. It shows the as the temperature, salinity or pH increase or decreases the DO value will decreases or increases and also reflects on BOD and COD values(Table.2)

Nitrite content varied in accordance with total nitrogen content of the seawater. In Thondi coastal waters the minimum and maximum nitrite value was recorded 0.117 µm/l and 1.192 µm/l during summer and monsoon months, respectively, and the mean value of nitrite was 0.568 µM/L.In Thondi Coastal waters the minimum and maximum nitrate value was recorded 1.513 µm/l and 12.981 µm/l during summer and monsoon season. During the study period the mean nitrate value was 8.238µm/l. coastal waters. The minimum and maximum concentration of Ammonia was recorded 0.017 µm/l and 0.11 µm/l during summer and monsoon season and the mean ammonia value was 0.063 µm/l. The minimum and maximum concentration of total nitrogen was recorded 16.531 µm/l and 35.616 µm/l during summer and monsoon season and the mean ammonia value was27.481 µm/l .There was a great fluctuation observed in inorganic phosphate content of Thondi Coastal waters during different seasons of the study period. The minimum 0.523 µm/l and maximum 2.047 µm/l value of inorganic phosphate were observed during summer and monsoon seasons respectively with a mean value of 1.168 µm/l. There was a great fluctuation observed in Total phosphorus content of Thondi Coastal waters during different seasons of the study period. The minimum and maximum content of Total phosphorus was recorded 0.81 µm/l and 4.386 µm/l during summer and monsoon seasons with a mean value of 2.153 µm/l. In Thondi Coastal waters the minimum and maximum value of silicate was recorded 41.676 µm/l and 61.149 µm/l during post-monsoon and monsoon months with a mean value of 48.735 µm/l (Fig.12- 19).Large scale upwelling and turbulent mixing in the upper water column keeps the nutrients high in all seasons. But in summer it has been observed that silicate and nitrogen concentrations show significant decrease Vandana Prasad et.al. (2007).From the statistical analysis, the temperature showed a negative correlation and highly significant with NO_2, NO_3, NH_4, TN and moderately significant with IP and TP and significant with SiO_3. Salinity showed a negative correlation and highly significant with NO_2, NO_3 and NH_4 and moderately significant with TN and IP and significant with TP and SiO_3. Similarly, pH also showed overall negative correlation and highly significant with NO_3, NH_4 and TN and insignificant with TP and SiO_3. Whereas, Turbidity and TSS found to be insignificant with all nutrient parameters. SiO_3 showed insignificant with pH, turbidity, TSS, DO, COD, Cl2, sulphate, NO_2, NO_3, NH_4, TN and IP

(Table.3). From this it is well understood that physiochemical parameters plays a major role in determination of nutrient value in the environment.

Nutrients analysis – Sediments: Variations of pH in sediment were very meager during the study period. The minimum (7.7) pH was recorded during summer and maximum (8.1) was recorded during Monsoon. In Thondi Total Phosphorus content in sediment showed the minimum value of 1.40µg/g was recorded during pre-monsoon and a maximum value of total Phosphorus 2.58 µg/g was recorded during monsoon. The total nitrogen content in sediment showed the minimum value of 4.14 µg/g was recorded during pre-monsoon and a maximum value of total nitrogen 9.80 µg/g was recorded during monsoon. The total organic carbon content in sediment showed the minimum value of 1.70 mg/g was recorded during pre-monsoon and maximum value of total organic carbon 5.84 mg/g was recorded during monsoon (Fig.20). In the present study the statistical analysis of nutrient in sediment samples in Thondi revealed both positive and negative correlation (Table.4). The moderate positive correlation was observed in between Total Nitrogen and Total Phosphorus. Weak positive correlation was observed in all the three parameters with pH. 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 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). Nutrients levels have been recorded to increase as a result of monsoon season. This increase may be attributed to (i) large-scale discharge from land runoff, and (ii) release of sediment-entrapped nutrients due to monsoon turbulences and wave action (Satpathy, 1996; Prasad and Ramanathan, 2008). All the physico-chemical parameters (transparency, temperature, salinity, pH, dissolved oxygen) and nutrients (nitrate, phosphate and silicate) showed significant spatial and temporal variations. Knowledge of nutrients relating to their contributory sources, utilization levels and their availability will be of great value to assess the productivity potential of marine ecosystem.From the statistical analysis, the sediment parameters showed insignificant with both positive and negative correlation except between TN and TP with significant positive correlation.

Fig.1 Fig.2

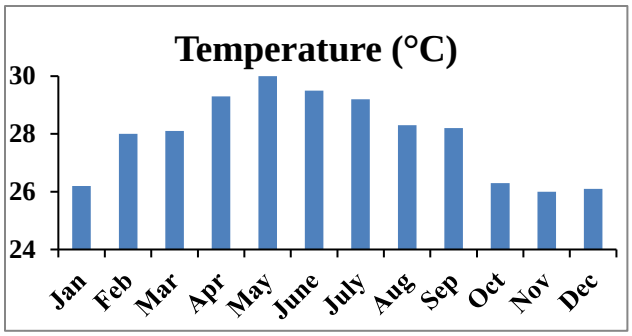
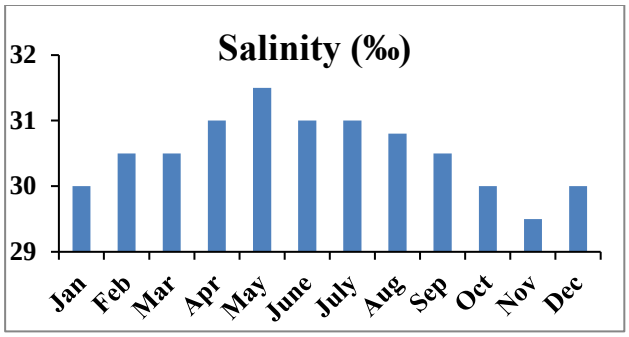


Fig.3



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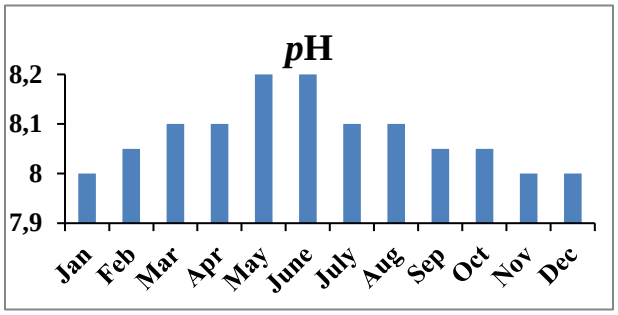
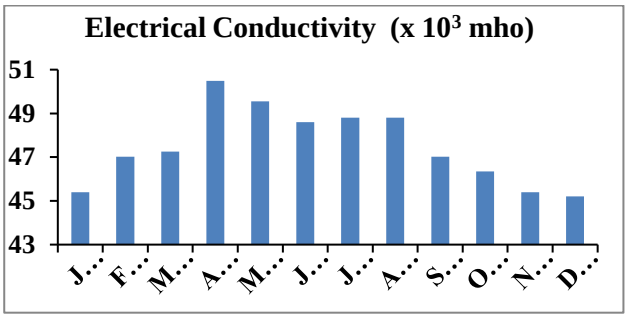


Fig.5



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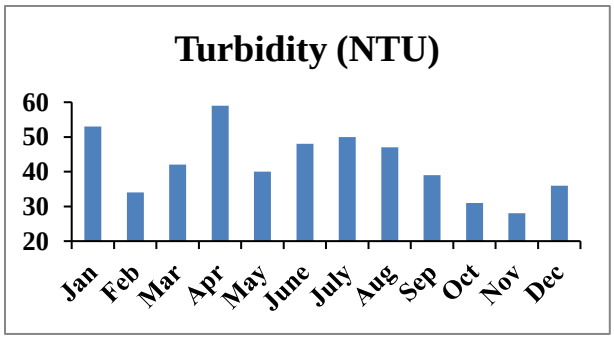
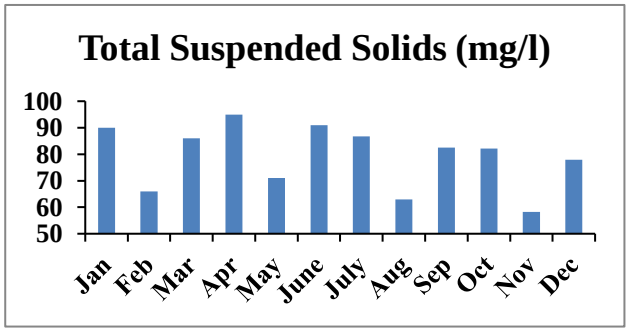


Fig.7



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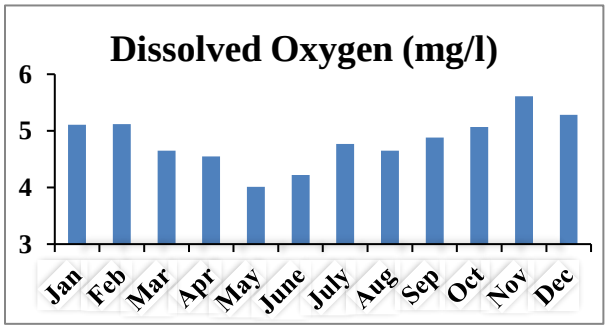


Fig.9

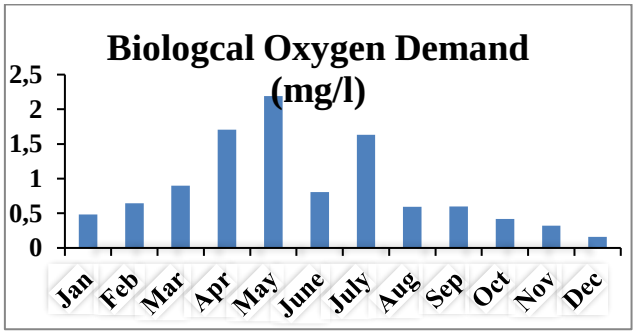
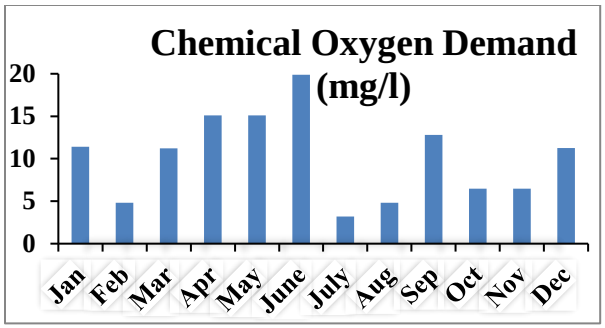


Fig.10



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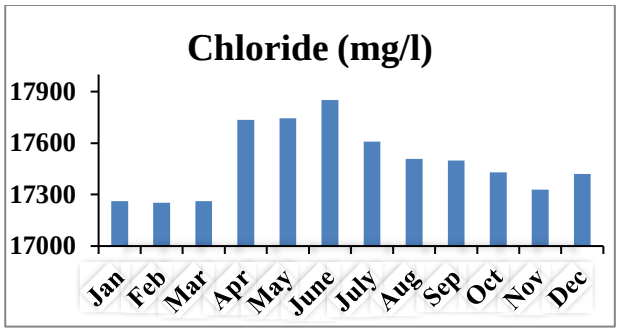
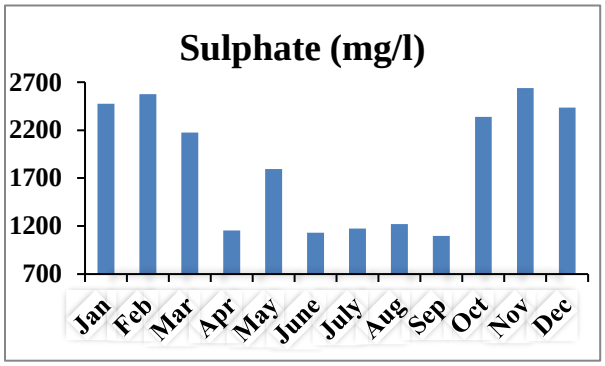


Fig .12



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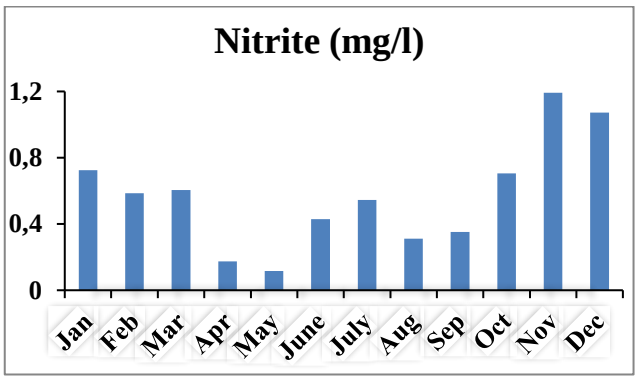


Fig.14

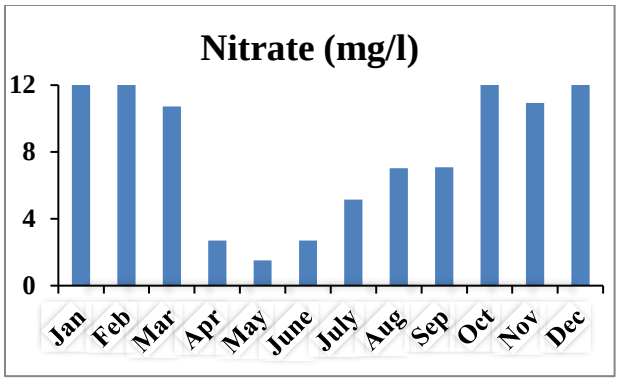


Fig.15

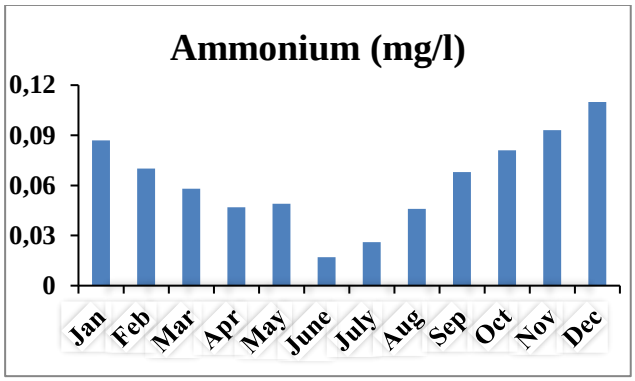
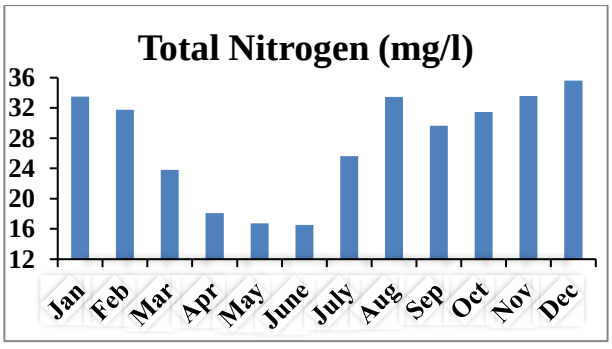
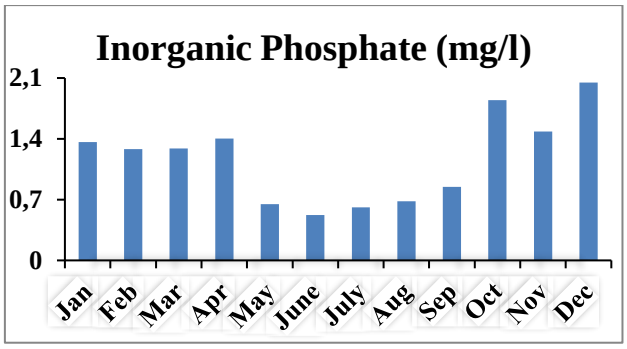


Fig.16





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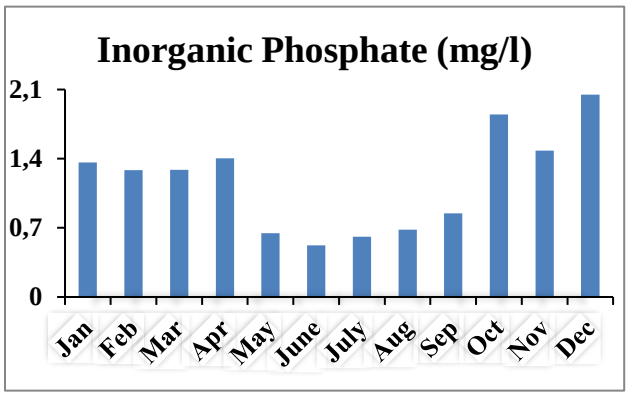


Fig.17

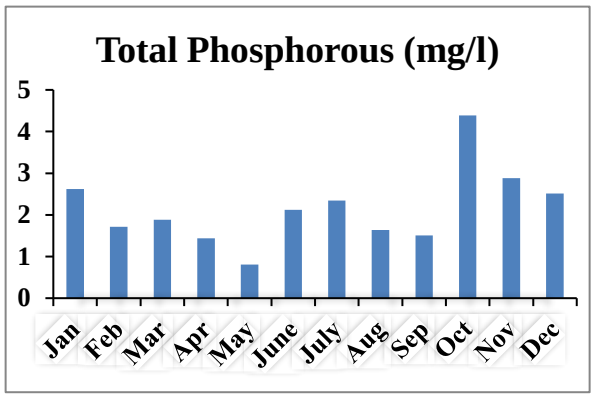
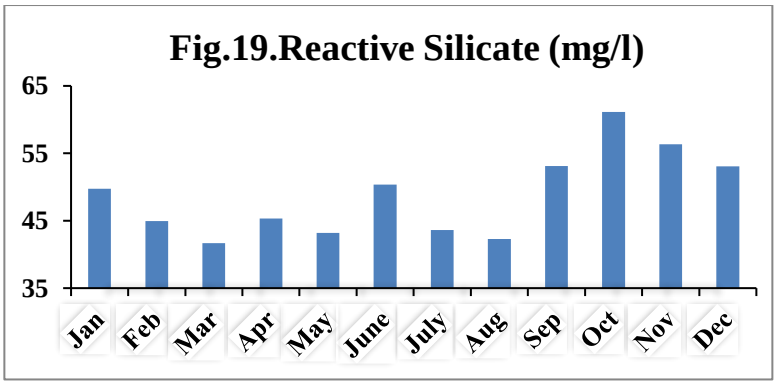


Fig.18



Variation of nutrient analysis in sediment samples of Thondi: Fig.20

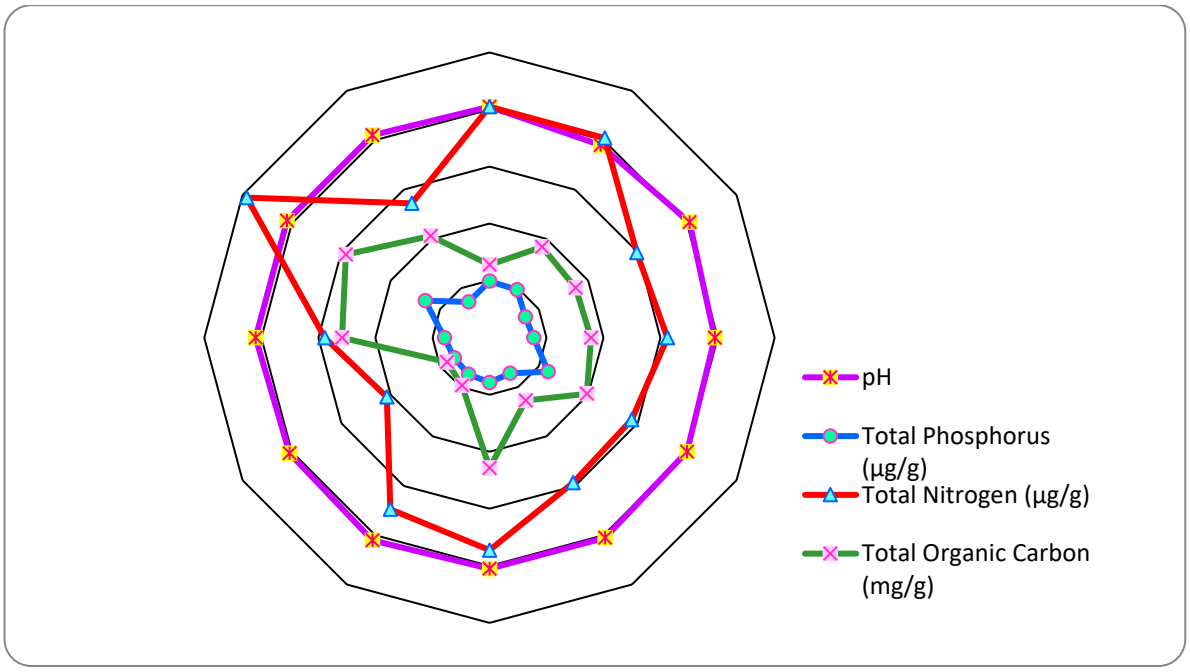


Table 1. Statistical analysis of Physical Parameters

	Temperature (°C)	Salinity (‰)	pH	EC (x 10^3 mho)	Turbidity (NTU)	TSS (mg/l)
Temperature (°C)	1					
Salinity (‰)	0.966***	1				
pH	0.888***	0.881***	1			
EC (x10^3 mho)	0.921***	0.912***	0.805***	1		
Turbidity (NTU)	0.509*	0.543*	0.347NS	0.601*	1	
TSS (mg/l)	0.248NS	0.257NS	0.202 NS	0.243NS	0.665**	1

NS – Not Significant, * - Significant, ** - Moderately Significant, *** - Highly Significant

Table 2. Statistical analysis of Chemical Parameters

	Temperature (°C)	Salinity (‰)	pH	EC (x 10^3 mho)	Turbidity (NTU)	TSS (mg/l)	DO mg/l	BOD mg/l	COD (mg/l)	Cl_2 (mg/l)	Sulphate (mg/l)
DO (mg/l)	-0.888***	-0.926***	-0.949***	-0.827***	-0.514*	-0.347NS	1				
BOD (mg/l)	0.825***	0.839***	0.706**	0.831***	0.479NS	0.253NS	-0.743**	1			
COD (mg/l)	0.379NS	0.360NS	0.499*	0.278NS	0.350NS	0.524*	-0.574	0.258NS	1		

							*				
Cl_2 (mg/l)	0.751 **	0.746 **	0.784 **	0.769 **	0.451 NS	0.335 NS	-0.758 **	0.631 *	0.569 *	1	
Sulphate (mg/l)	-0.756 **	-0.717 **	-0.609 *	-0.770 **	-0.615 *	-0.384 NS	0.658 **	-0.488 NS	-0.314 NS	-0.769 **	1

NS – Not Significant, * - Significant, ** - Moderately Significant, *** - Highly Significant

Table.4. Statistical analysis of Nutrients in Sediment

	pH	Total Phosphorus (µg/g)	Total Nitrogen (µg/g)	Total Organic Carbon (mg/g)
pH	1			
Total Phosphorus (µg/g)	-0.12823 NS	1		
Total Nitrogen (µg/g)	-0.05706 NS	0.653956 *	1	
Total Organic Carbon (mg/g)	0.121568 NS	0.493099 NS	0.44084	1

NS – Not Significant, * - Significant, ** - Moderately Significant, *** - Highly Significant

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Table 3. Statistical analysis of Nutrients -Water

	Temperature (°C)	Salinity (‰)	pH	EC (x 10^3 mho)	Turbidity (NTU)	TSS (mg/l)	DO (mg/l)	BOD (mg/l)	COD (mg/l)	Cl_2 (mg/l)	Sulphate (mg/l)	NO_2 (µ mol/l)	NO_3 (µ mol/l)	NH_4 (µ mol/l)	TN (µ mol/l)	IP (µ mol/l)	TP (µ mol/l)
NO_2 (µ mol/l)	-0.857 ***	-0.889 ***	-0.743 **	-0.870 ***	-0.567 *	-0.290 NS	0.858 ***	-0.716 **	-0.363 NS	-0.625 *	0.732 **	1					
NO_3 (µ mol/l)	-0.897 ***	-0.858 ***	-0.838 ***	-0.888 ***	-0.531 *	-0.251 NS	0.833 ***	-0.795 ***	-0.507 *	-0.915 ***	0.817 ***	0.766 **	1				
NH_4 (µ mol/l)	-0.887 ***	-0.828 ***	-0.847 ***	-0.839 ***	-0.567 *	-0.324 NS	0.794 **	-0.641 *	-0.241 NS	-0.706 **	0.789 **	0.723 **	0.807 ***	1			
TN (µ mol/l)	-0.844 ***	-0.790 **	-0.876 ***	-0.787 **	-0.467 NS	-0.467 NS	0.861 ***	-0.797 ***	-0.669 **	-0.774 **	0.553 *	0.682 **	0.843 ***	0.750 **	1		
IP (µ mol/l)	-0.792 **	-0.740 **	-0.730 **	-0.643 *	-0.399 NS	-0.021 NS	0.694 **	-0.529 *	-0.177 NS	-0.559 *	0.719 **	0.666 **	0.744 **	0.842 ***	0.531 *	1	
TP (µ mol/l)	-0.721 **	-0.704 **	-0.505 *	-0.606 *	-0.393 NS	0.057 NS	0.595 *	-0.576 *	-0.362 NS	-0.358 NS	0.465 NS	0.656 *	0.614 *	0.429 NS	0.488 NS	0.588 *	1
SiO_3 (µ mol/l)	-0.676 **	-0.700 **	-0.493 NS	-0.631 *	-0.546 *	-0.029 NS	0.567 *	-0.604 *	-0.004 NS	-0.165 NS	0.356 NS	0.575 *	0.440 NS	0.565 *	0.413 NS	0.555 *	0.770 **

NS – Not Significant, * - Significant, ** - Moderately Significant, *** - Highly Significant

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