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RESEARCH ARTICLE

STUDIES ON THE HYDRO-CHEMISTRY OF MUTHUPET ESTUARY SOUTH EAST COAST OF INDIA

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The seasonal variations of hydro-chemical parameters were studied during July 2011 to June 2012 in the Muthupet estuary (Lat.10° 46' N; Long.79° 51'E) south east coast of India. The rainfall ranged between 4.8 and 350 mm. The atmospheric and water temperature ranged from 28.8°C to 35.6°C and 25.4°C to 31.5°C respectively. The pH ranged between 7.1 and 8.2. Salinity fluctuated between 8.7‰ and 34.2‰. The dissolved oxygen was ranged from 3.5 to 7.2 ml/l. The nutrients such as total phosphorus, nitrate and silicate ranged from 0.29 to 1.95 µg/l, 1.27 to 4.45 µg/l and 28.25 to 98.74 µg/l respectively. The dissolved oxygen and nutrients were found to be low in summer and high during monsoon season. Similarly temperature, pH and salinity were low during monsoon and high during summer season.

Key words: Hydro-chemical parameters, Nutrients, Muthupet estuary, Correlation analysis.

INTRODUCTION

Estuary is the river mouth where there is mixing up of seawater and freshwater. Due to the turbulence of freshwater and seawater, there is a marked seasonal variation of hydrographical features such as temperature, light penetration, salinity, pH, dissolved oxygen and inorganic nutrients. Estuary is an ecologically important biotope for the simple reason that estuary forms the nursery grounds of many of the commercial fishes and prawns. Estuary thus naturally plays an important role in the production of food resources. In recent years considerable work has been done on the hydrochemistry of the south east Indian estuarine environment viz., Uppanar estuary (Nedumaran *et al*., 2011), Muthupet mangroves (Paramasivam and Kannan, 2005), Pichavaram mangroves (Ashok Prabu, 2008), Vellar estuary (Rajasegar, 2003), Kaduviyar estuary (Vengadesh Perumal *et al*., 2009), Mulki estuary (Vijayakumar, 2000) and Pennar estuary (Ravaniah *et al*., 2010). The present study is one among such attempts and intended to provide a better knowledge of the various hydro-chemical events happening in the Muthupet estuary.

MATERIALS AND METHODS

Muthupet estuary is situated at Muthupet (Lat.10° 46' N Long.79° 51'E) of Bay of Bengal, southeast coast of India. In the present investigation, monthly samplings were made during forenoon in a plastic container from July 2011 to June 2012. The physico-chemical parameters, temperature, pH, salinity, dissolved oxygen, nutrients such as total phosphorus, nitrate, and silicate were estimated by adopting standard procedures (Strickland and Parsons, 1972).

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RESULTS

Monthly variations in meteorological and physico- chemical parameters viz., rainfall, air and surface water temperature, pH, salinity, dissolved oxygen, phosphate, nitrate and silicate contents in Muthupet estuarine waters were recorded for a period of one year from July 2011 to June 2012.

Rain fall

The northeast monsoon in Tamilnadu brings very heavy rain during the months of October, November and December. The pattern of rainfall facilitates the divisions of the year into post monsoon (January – March), summer (April – June), Pre monsoon (July – September) and monsoon (October – December). Total rainfall of 999.4 mm was recorded from July 2011 to June 2012 and the monthly rainfall (mm) varied from 4.8 to 350 during the study period. No rainfall was recorded during January, Febuary, March and May 2012. The maximum rainfall (350 mm) was recorded during the north-east monsoon (November 2011) and minimum (4.8 mm) during the month of June 2012 (Table 1 and Fig.1).

Temperature

During the study period air temperature varied from 28.8 to 35.6°C. The minimum was recorded during monsoon season (December, 2011) and maximum during the summer season (May 2012). The atmospheric temperature showed a positive correlation with water temperature (r= 0.633) of Muthupet estuary. The surface water temperature ranged from 25.4°C to 31.5°C. The minimum surface water temperature (25.4°C) was recorded during monsoon season (November, 2011) and maximum (31.5°C) was recorded during the summer season

Table 1. Physico-chemical characteristics of water of the Muthupet estuary during July 2011 to June 2012

Month	Rainfall (mm)	Atmospheric °C	Water °C	pH	Salinity (‰)	Dissolved Oxygen (ml/l)
July 2011	27.6	31.6	28.2	7.8	30.5	4.7
August	60.2	32.5	28.2	7.4	14.5	6.5
September	128.2	31.1	27.4	7.3	14.7	5.5
October	323.2	30.2	28.3	7.2	9.5	6.8
November	350.0	30.2	25.4	7.2	8.7	7.2
December	85.2	28.8	27.6	7.1	9.2	6.1
January 2012	-	30.4	29.5	7.3	10.5	5.8
February	-	30.2	30.2	7.8	17.5	4.5
March	-	33.4	28.4	7.5	20.8	4.3
April	20.2	34.5	30.5	7.7	31	4.5
May	-	35.6	31.5	8.2	34.2	4.9
June	4.8	33.4	31.3	7.8	28.5	3.5

Fig. 1: Rainfall recorded during 2011 to 2012 in the study area

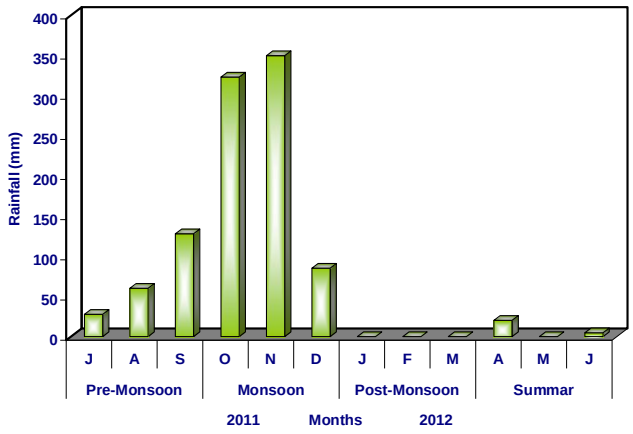


Fig.2: Monthly changes in atmospheric temperature duing 2011 to 2012 in the study area

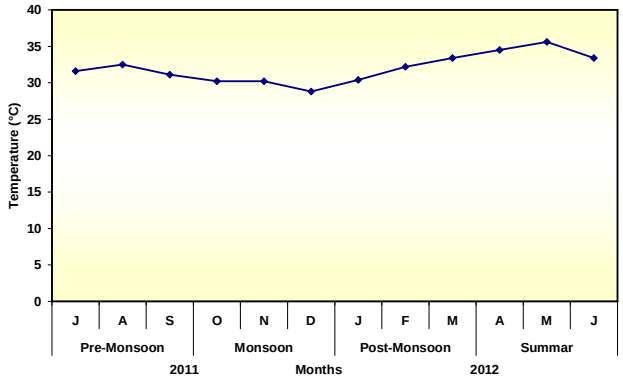
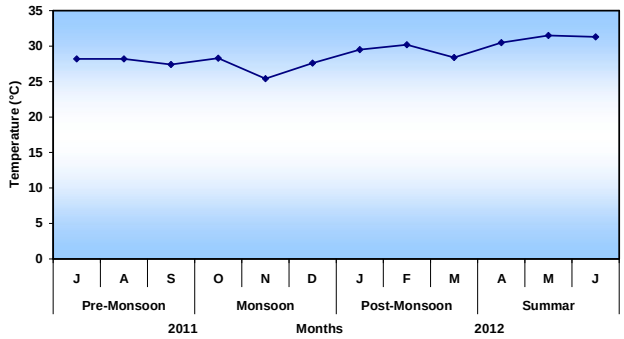


Fig. 3: Monthly changes in water temperature during 2011 to 2012 in the study area

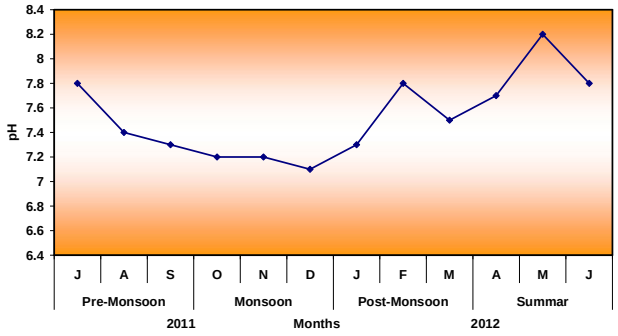


(May, 2012). (Table.1 and Fig.2). Water temperature of the Muthupet estuary showed a positive correlation with salinity (r=0.692) and pH (r=0.773) and a negative correlation with dissolved oxygen (r=-0.726) (Table1 and Fig.3).

pH

The monthly mean values of hydrogen ion concentration of water varied from 7.1 to 8.2 (Table.1 and Fig.4). Maximum values of pH were observed in the summer season (May, 2012) and minimum values were recorded in the monsoon seasons (December 2011). Statistical analysis showed that the pH had positive correlation with water temperature (r=0.7173) and salinity (r=0.904) whereas dissolved oxygen had an inverse relationship (r= - 0.723) (Table.3).

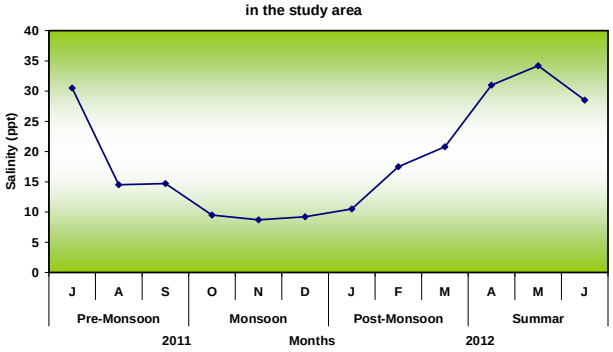
Fig.4: Monthly changes in the pH during 2011 to 2012 in the study area



Salinity

The seasonal variation of salinity in Muthupet estuary are graphically represented in Figure 5.

Fig.5: Monthly changes in salinity during 2011 to 2012 in the study area



A marked seasonal changes in salinity was observed throughout the study period. Minimum salinity (8.7‰) was recorded during monsoon (November 2011) and was slowly increased during post monsoon and attained maximum (34.2%) during summer season (May 2012). Salinity of the Muthupet estuary showed positive correlation between temperature (r=0.692) and pH (r=0.904) while it showed negative correlation with dissolved oxygen (r = - 0.773) (Table.3).

Dissolved Oxygen

Dissolved Oxygen (DO) in Muthupet estuary was varied between 3.5 and 7.2 ml/l. Minimum DO was recorded during the month of June, 2012 and maximum in November, 2011 (Table.1 and Fig.6). Statistical analysis showed that dissolved oxygen had a negative correlation with water temperature (r= -0.726), salinity (r= -0.773) and pH (r= -0.723) (Table.3).

Fig.6: Monthly changes in dissolved oxygen during 2011 to 2012 in the study area

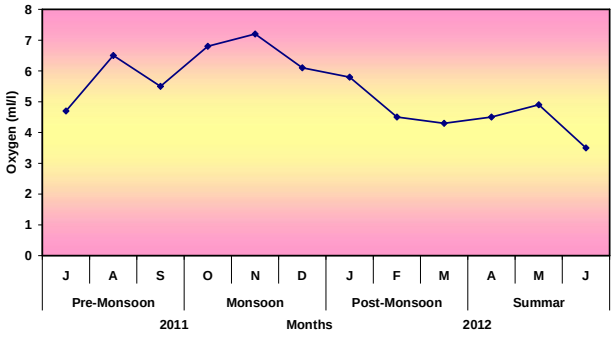


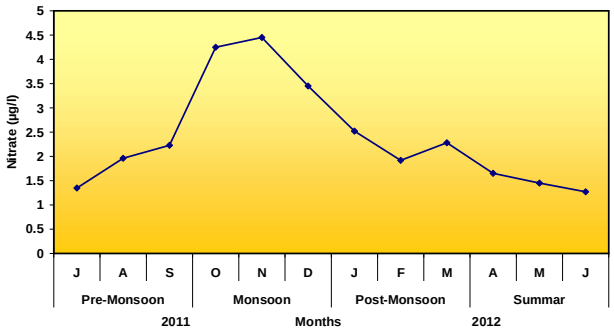
Table 2. Seasonal variation of Dissolved Nutrients in Muthupet estuary (µg / l)

Month	Nitrate	Phosphate	Silicate
July 2011	1.35	0.44	33.75
August	1.96	1.15	65.25
September	2.23	1.30	54.24
October	4.25	1.45	80.15
November	4.45	1.15	98.74
December	3.45	1.63	81.17
January 2012	2.52	1.95	69.25
February	1.92	1.23	49.15
March	2.28	0.88	38.64
April	1.65	0.77	30.15
May	1.45	0.58	28.25
June	1.27	0.29	35.15

Nitrate

The nitrate was varied from 1.27 to 4.45 µg/l. Minimum was recorded during the month of June, 2012 whereas maximum during the month of November, 2011 (Table.2 and Fig.7). Statistical analysis showed that the nitrate had positive correlation with DO (r=0.819) and negative correlation with pH (r=-0.738) and salinity (r=-0.812) (Table. 3).

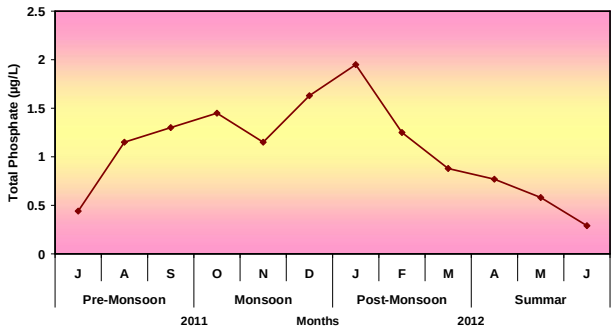
Fig. 7: Monthly changes in the nitrate content during 2011 to 2012 in the study



Total phosphorus

The monthly variations of dissolved phosphate recorded in Muthupet estuary are shown in the Fig.8. The total phosphorus was minimum (0.29 µg/l) in the month of June, 2012 and maximum (1.95 µg/l) in the month of October 2011.(Table 2 and Fig.8). Total phosphorus showed positive correlation with dissolved oxygen (r=0.651) and negative correlation with pH (r= -0.754) and salinity (r= -0.865). (Table.3)

Fig.8: Monthly changes in the total phosphate content during 2011 to 2012 in the study area



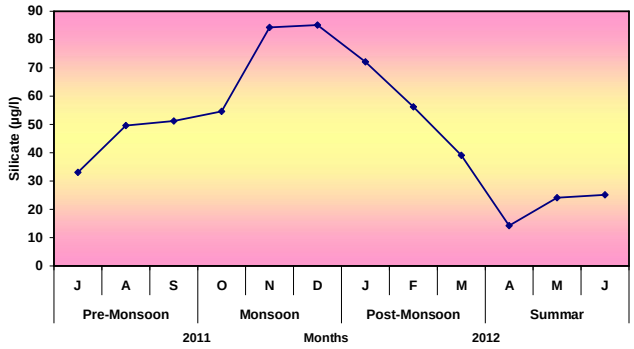
Silicate

The monthly variations of silicate of the water observed in Muthupet estuary during the study period (July 2011- June 2012) are graphically represented in Fig.9. The silicate content showed a minimum value of 28.25µg/l (May 2012) and a maximum value of 98.74µg/l (November 2012). Throughout the study period, mean seasonal temperature, pH, salinity, dissolved oxygen, phosphorus, nitrate, and silicate contents were not uniform in Muthupet estuary.

Table 3. Correlation coefficient (r) values between the environmental parameters

	Atmos °C	Water °C	pH	Salinity	Oxygen	Nitrate	Phosphate	Silicate
Atmos °C	1.000							
Water °C	0.633	1.000						
pH	0.748	0.773	1.000					
Salinity	0.837	0.692	0.904	1.000				
Oxygen	-0.568	-0.726	-0.723	-0.773	1.000			
Nitrate	-0.666	-0.713	-0.788	-0.812	0.819	1.000		
Phosphate	-0.724	-0.412	-0.754	-0.865	0.651	0.618	1.000	
Silicate	-0.662	-0.602	-0.812	-0.912	0.825	0.878	0.752	1.000

Fig. 9: Monthly changes in the silicate content during 2011 to 2012



DISCUSSION

The physico-chemical parameters such as temperature, pH, salinity, dissolved oxygen and nutrients showed seasonal variations. The seasonal variations of the environmental features in the estuarine system is chiefly controlled by the spectacular regime of the rainfall during monsoon. In the present study area, the peak values of rainfall were recorded during the northeast monsoon periods (October-December). The rainfall was scanty during post monsoon and summer months. Commendable works are available on Vellar estuary (Nedumaran *et al*., 2001); Point Calimere costal water (Damothaeran *et al*., 2010); Parangipettai coast (Santhanam and Perumal, 2003; Sundaramanickam *et al*., 2008) and Muttukadu backwaters (Prema and Subramaniam, 2003). Temperature is an universal factor in the aquatic ecosystem, which influences the physico-chemical characteristics and also influences the life of organisms. The highest value of surface water temperature was recorded in summer season and lowest in monsoon periods. The seasonal variations in the water temperature may be associated with the wind force, freshwater discharge influx of the inshore water and atmospheric temperature. The reduction in the water temperature mainly depend upon the intensity of rainfall during monsoon and the low air temperature existed at the time. Similar observations have been reported by Thangaraj (1984) in Vellar estuary; Senthilnathan (1990) in Vellar, Uppanar and Kaduviar river estuary; Bikash Saha *et al*. (2001) in Sundarbans brackish water; Soundarapandian *et al*. (2009) in Uppanar estuary; Palpandi (2011) Vellar estuary.

Thus the present findings favour the earlier reports on the fluctuations of water temperature on the estuaries. Generally low pH values were recorded during the monsoon period and slightly higher values during summer period. Similar seasonal pattern was recorded earlier by Thangaraj (1984), Palpandi (2011), Santhanam and Perumal (2003) in Vellar estuary; Murugan and Ayyakkannu (1991) and Soundarapandian *et al*. (2009) in Uppanar backwaters. Minimum values of pH during monsoon in the study area may be controlled by the influence of freshwater discharge, rainfall and also due the decomposition of organic matter as stated by Ragothaman and Patil (1995) and Upandhayay (1998). Dissolved Oxygen (DO) contents showed well marked seasonal variations in the Muthupet estuary. It is seemed to be controlled by various factors such as rainfall, temperature, phytoplankton photosynthesis and salinity. Dissolved oxygen content was high during monsoon period in the study area could be due to the influx of fresh water during the monsoon, higher solubility and low salinity. Similar observations in DO values have also been reported from the Vellar estuary (Vijayalakshmi and Venugopalan, 1973, Brinda *et al*., 2010; Nedumaran *et al*., 2001); Pichavaram mangroves (Govindasamy and Kannan, 1991); Mandovi and Zuari estuaries (Dwivedi *et al*., 1974); Point Calimere coastal water (Damotharan *et al*., 2010); Mutthkadu backwaters (Prema and Subramanian, 2003). The salinity act as a prime factor among the most important environmental parameters in the distributions of living organisms (Chandra Mohan and Sreevanivas, 1998).

The intrusion of neritic water and low river discharge may be responsible for high salinity, the monsoonal rain and continuous flow of the freshwater of the rivers may be responsible for low salinity in the present study in conformity with the earlier reports from Vellar estuary (Chandran and Ramamoorthi, 1984; Palpandi, 2011; Singbal, 1976); Uppanar backwaters (Murugan and Ayyakannu, 1991; Soundarapandian, *et al*., 2009). In the present study, nitrate concentration was high during the monsoon and low during summer season. The high nitrate content observed during monsoon periods is mainly due to the river water discharge from agricultural fields containing nitrogenous particles of various origins. Low values of nitrate observed during summer seasons might be due to the lesser amount of freshwater inflow and higher salinity. Similar maximum value in monsoon and minimum in summer season were also recorded by Qasim *et al*. (1969) from Cochin backwaters, De Souza (1977) from Mandovi and Zuariestuaries, Sivakumar (1982) in Vellar estuary, Hari Muraleedharan *et al*. (2010) in Thondi coastal waters, Sundaramanikam *et al*. (2008) in Parangipettai and Cuddalore coast. The presence of total phosphorus in an estuary can be taken as an index of total fertility in the ecosystem (Redfield, 1934). In the present study, the total phosphorus were found to be increased during monsoon periods and decreased slowly from summer onwards.

High concentration of total phosphorus during monsoon season due to heavy rainfall, decomposition of particular organic matter, industrial effluents and from the agricultural discharges from the adjacent lands. Such monsoonal maximum and summer minimum in the total phosphorus concentration was also reported from Vellar estuary (Sivakumar, 1982; Chandran and Ramamoorthi, 1984; Nedumaran *et al*. (2001); Periyar river estuary (Sarala Devi *et al*., 1991), Coleroon estuary (Prabha Devi, 1986) and Mandovi estuary (Dehadrai, 1970 and Dwivedi *et al*., 1974). The seasonal average silicate content in the study area showed maximum values during monsoon and minimum during summer seasons. The peak values of silicate observed during monsoon may attributed to the heavy fresh water influx and land run off which carries slit and other silicon deposits from upper reaches of the river. Observations similar to present study were reported earlier by Qasim *et al*. (1969) and Ansari and Rajagopal (1974) in Cochin back waters. Nair *et al*. (1983) in Ashtamudi estuary, Praba Devi (1986) in Coleroon estuary. The silicate concentration also showed negative relationship (r=-0.912) with salinity, which was also noted earlier in Vellar estuary (Chandran and Ramamoorthi, 1984 and Thangaraj, 1984) Kerala backwaters (Sarala Devi *et al*., 1983).

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