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PHYSICO-CHEMICAL CHARACTERISTICS OF ARASALAR ESTUARY KARAIKAL SOUTHEAST COAT OF INDIA

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ABSTRACT

The seasonal variations of physico-chemical parameters were studied during April 2010 to March 2011 in the Arasalar estuary (Lat. 79° 52' E Long. 10° 55’ N) Karaikal southeast coast of India. The rain fall ranged between 0.33 - 551.8. The atmospheric and water temperature ranged from 26.1°C to 34.3°C and 25.1°C to 31.8°C respectively. The pH ranged between 7.5 and 8.4. The DO was ranged from 2.8 to 5.3 ml/l. Salinity fluctuated between 20.5 - 32.1‰. The nutrients such as silicate, total phosphorus and nitrate ranged from 14.2 to 85.1 µg/l, 0.32 to 1.21 µg/l and 2.47 to 8.69 µg/l respectively. The DO and nutrients was 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.

INTRODUCTION

Estuaries are highly productive and excellent nursery and feeding grounds for many commercially important fishes and shrimps(Ganapati,1975).The faunal distribution and productivity of estuary depend on various physico-chemical factors such as temperature, pH, salinity, DO and nutrients such as nitrate, phosphate and silicate. Several investigations have been carried out on the physico-chemical features of southeast Indian estuaries 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). No paper has been published on the physico-chemical characteristics in Arasalar estuary, Karaikal. Hence the present study was conducted to study the physico-chemcial parameters of water in the Arasalr estuary, southeast coast of India.

MATERIALS AND METHODS

Arasalar estuary is situated at Karaikal (Lat.79° 52' E Long.10° 55'N) of Bay of Bengal, southeast coast of India (fig.1). In the present investigation, monthly samplings were made during forenoon in a plastic container from April 2010 to March 2011. The physico-chemical parameters, temperature, pH, salinity, dissolved oxygen, nutrients such as total phosphorus, nitrate, silicate were estimated by adopting standard procedures (Strickland and Parsons, 1972).

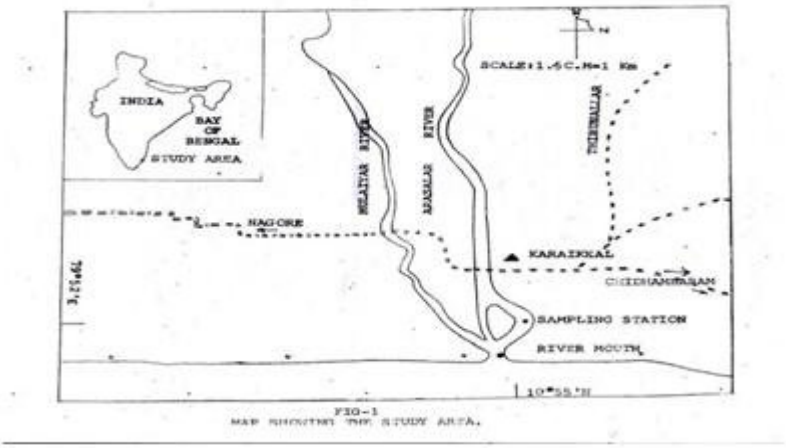


FIG-1
MAP SHOWING THE STUDY AREA.

RESULT

Physico-chemical parameters

Monthly variations in meteorological and physico- chemical parameters viz., rainfall, air and surface water temperature, pH , salinity, dissolved oxygen, phosphate, nitrate and silicate content in Arasalar estuarine waters were recorded for a period of one year from July 2010 to June 2011.

Rain fall

The north east monsoon in Karaikal brings very heavy rain during October, November and December months. 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 1632.36 mm was recorded from July 2010 to June 2011. Monthly rainfall (mm) varied from 0.33 to 551.8 during the study period. The maximum rainfall (551.8 mm) was recorded during the northeast monsoon (November 2010) and minimum (0.33 mm) during the month of April, 2011 (Table1 & fig. 2).

Temperature

During the study period air temperature varied from 26.1°C to 34.3°C. The minimum was recorded during monsoon season (November, 2010) and maximum during the summer season (June 2011) (fig.3). The atmospheric temperature showed a positive correlation with water temperature (r= 0.989) of Arasalar estuary. The surface water temperature varied from 25.1°C to 31.8°C. The minimum surface water temperature was recorded during monsoon season (December, 2010) and maximum was recorded during the summer season (June, 2011) (Table1 & fig.4). Water temperature of the Arasalar estuary showed a positive correlation with salinity (r=0.7787),pH(r=0.7175) and a negative correlation with dissolved oxygen (r=0.7362) (Table 3).

pH

The monthly mean values of hydrogen ion concentration of water varied from 7.5 to 8.4. Maximum values of pH were observed in the summer season (May, 2011) and minimum values were recorded in the monsoon seasons (December, 2010) (Table 1 & fig.5). Statistical analysis showed that the pH had positive correlation with water temperature(r=0.7175)salinity(r=0.8648) whereas with dissolved oxygen it had an inverse relationship (r=-0.8905) (Table 2).

Salinity

The seasonal variation of salinity in Arasalar estuary are graphically represented in fig . A marked seasonal change in salinity was observed throughout the study period. Minimum salinity (20.5‰) was recorded during monsoon (December 2010) and was slowly built up during post monsoon and attained maximum (32.1‰) during summer seasons (May 2011) (Table 1 & fig.6). Salinity of the Arasalar estuary showed positive correlation with temperature (r=0.7787) and pH (r=0.8648) while it showed negative correlation with dissolved oxygen (r=- 0.8905) (Table 2).

Dissolved oxygen

Dissolved oxygen in Arasalar estuary was varied from 2.8 to 5.3 ml/l. Minimum D0 was recorded during the month of May, 2011 and maximum during the month of November, 2010 (Table1 and fig.7). Statistical analysis showed that dissolved oxygen had a negative correlation with water temperature (r=-0.8063), salinity (r=0.91205) and pH (r=0.8905) (Table 2).

Silicate

The monthly variation of silicate of the water observed in Arasalar estuary during the study period (July 2010- June 2011) are graphically represented in fig.8. The silicate content showed a minimum value of 14.2µg/l (April 2011) and a maximum value of 85.1µg/l (December 2010) (Table1). Throughout the study period, mean seasonal temperature, pH, Salinity, DO, phosphorus, nitrate, and silicate content was not uniform in Arasalar estuary.

Total phosphorus

The monthly variations of dissolved phosphorus recorded in Arasalar estuary are shown in the fig 3. The total phosphorus was minimum (0.32 µg/l) in the month of April, 2011 and maximum (1.21 µg/l) in the month of November 2010(Table 1 & fig.9). Total phosphorus showed positive correlation with dissolved oxygen (r=0.6631) and negative correlation with pH (r= -0.7614) and salinity (r= -0.7427) (Table 2).

Nitrate

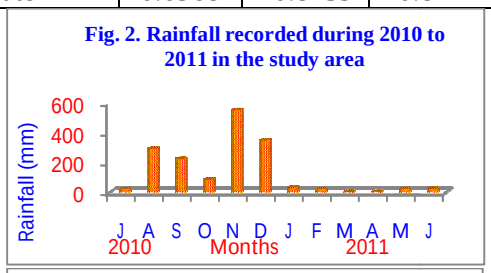
The nitrate was varied from 2.47 to 8.69 µg/l. Minimum was recorded during the month of April, 2011 and the maximum during the month of November, 2010 (Table1 & fig.10). Statistical analysis showed that the Nitrate had positive correlation with DO (r=0.7535) and negative correlation with pH (r=-0.7908) and salinity (r=-0.7908) (Table 2).

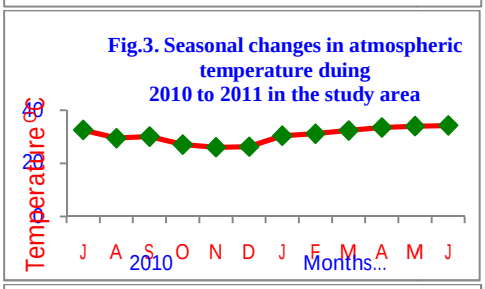
Table1. Physico-chemical parameters of Arasalar estuary

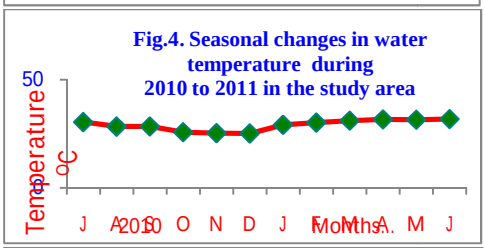
Parameters	July 2010	Aug. 2010	Sep. 2010	Oct. 2010	Nov. 2010	Dec. 2010	Jan. 2011	Feb. 2011	March 2011	April 2011	May 2011	June 2011
Rainfall mm	19.3	293.1	224.6	85.5	551.8	348.8	31.2	20.4	1.2	0.33	21.5	23.8
Atmosphere ^{o}C	32.6	29.5	30.1	27.1	26.1	26.3	30.4	31.2	32.4	33.5	34.0	34.3
Water ^{o}C	30.4	28.3	28.4	25.7	25.3	25.1	29.1	30.2	31.1	31.6	31.5	31.8
pH	8.1	7.9	7.8	7.6	7.6	7.5	7.7	7.8	7.8	8.1	8.4	8.2
Salinity ppt	26.1	26.8	23.1	24.6	21.4	20.5	23.1	23.6	26.1	28.6	32.1	31.1
Dissolved oxygen ml/l	3.1	3.9	4.9	4.6	5.3	5.1	4.6	4.7	4.4	3.9	2.8	2.9
Silicate µg/l	33.1	49.6	51.2	54.6	84.3	85.1	72.1	56.2	39.1	14.2	24.1	25.1
Total phosphorus µg/l	0.75	1.14	1.17	0.98	1.21	1.14	0.91	0.83	0.71	0.32	0.64	0.59
Nitrate µg/l	4.97	8.97	8.19	7.91	8.69	8.41	7.67	6.95	4.81	2.47	3.41	3.11

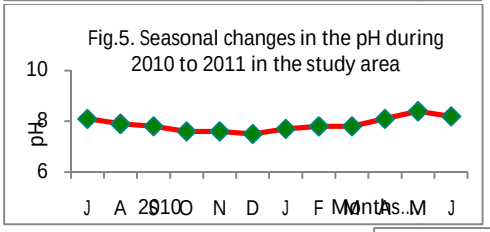
Table 2. Correlation coefficient (r) values between the environmental parameters

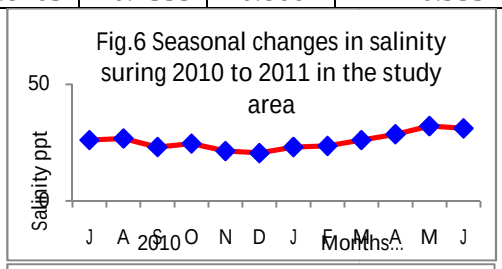
	Rainfall	*At.temp.*	*W.temp.*	*pH*	*Salinity*	*DO*	*Silicate*	*phosphorous*	*Nitrate*
Rainfall	1								
At.temp.	-0.7895	1							
W.temp.	-0.7902	0.989	1						
pH	-0.5311	0.7489	0.7175	1					
Salinity	-0.5881	0.8298	0.7787	0.8648	1				
DO	0.5829	-0.8063	-0.7362	-0.8905	-0.9120	1			
Silicate	0.7108	-0.8848	-0.8481	-0.7262	-0.8919	0.8172	1		
phosphorous	0.7897	-0.8444	-0.8359	-0.7611	-0.7427	0.6631	0.8344	1	
Nitrate	0.6968	-0.8759	-0.8412	-0.7908	-0.8165	0.7535	0.8667	0.9537	1

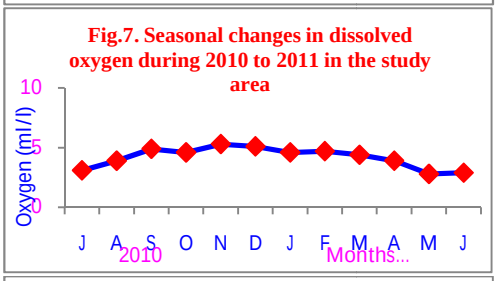


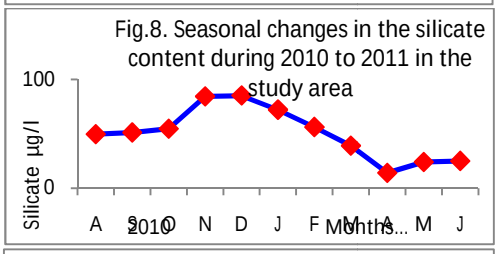


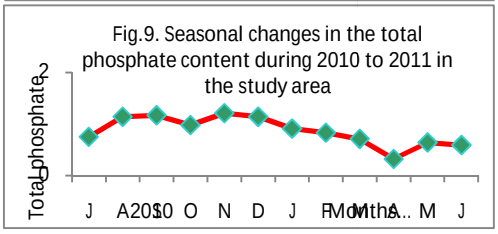


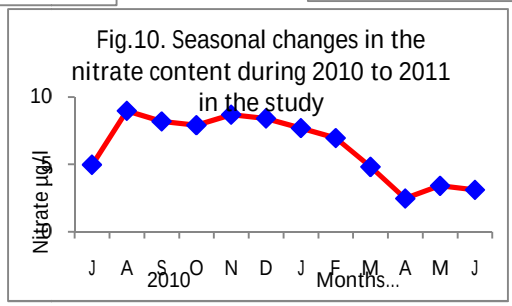












DISCUSSION

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 are 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 (Damotharan *et al*., 2010); Parangipettai coast (Santhanam and Perumal, 2003; Sundaramanickam *et al*., 2008); Muttukadu backwaters (Prema and Subramaniam, 2003).

Temperature is an universal factor in the aquatic ecosystem, which may influence the physico – chemical characteristics and also influence the of organisms. The highest value of surface water temperature was recorded in summer season and lowest in monsoon periods. The seasonal variation 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 depends 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 backwateres. 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 Upadhaya(1998).

The salinity act as a prime factor among the most important environmental parameters in the distribution of living organisms (Chandramohan and Sreevanivas,1998).The salinity

variation in the exchange of ions and nutrients because of the tidal flow and low during the monsoon season in the Arasalar estuary. 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); Zuari and Mandovi estuary (Singbal, 1973 & 76); Uppanar backwaters (Murugan and Ayyakannu, 1991; Soundarapandian *et al*., 2009).

Dissolved oxygen contents showed well marked seasonal variations in the Arasalar estuary. It seemed to be controlled by various factor 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) ; Muttukadu backwaters (Prema and Subramanian, 2003) ; Coleroon estuary (Jagadeesan, 1986).

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=-0.8919) with salinity, which was also noted earlier in Vellar estuary (Chandran and Ramamoorthi, 1984 and Thangaraj, 1984); Kerala backwaters (Sarala Devi *et al.*, 1983). 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 Ramamoorth, 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).

In the present study, nitrate concentration was higher during the monsoon and lower during summer season. The higher nitrate content observed during monsoon periods is mainly due to the river water discharge 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 Qasin *et al*.(1969) from Cochin backwaters, De Souza (1977) from Mandovi and Zuari estuaries, Sivakumar (1982) in Vellar estuary, Hari Muraleedharan *et al*. (2010) in Thondi costal waters, Sundaramanikam *et al*. (2008) in Parangipettai and Cuddalore coast.

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