STUDIES ON THE PHYSICO-CHEMICAL CHARACTERISTICS OF MUTHUPET ESTUARY THIRUVARUR DISTRICT, TAMIL NADU, INDIA

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Abstract: Monthly variation in physico-chemical characteristics of water samples were studied in Muthupet estuary, Thiruvarur District, Tamil Nadu, India, for a period of twelve months (July 2012 to June 2013). By using standard methods ten different physico-chemical parameters were analyzed. Water temperature varied from 24.1 to 33.5ºC, Salinity varied from 9.03 to 31.42 ppt, pH ranged from 7.0 to 8.1. Dissolved Oxygen content varied from 3.5 to 6. 79 ml/L. Potassium was varied in between 3.86 to 7.01 m^{-1}, nitrate (1.16 to 4.37 mg/L), phosphate (0.48 to 1.97) and silicate (38.66 to 94.35 mg/L) were also studied.

Index Terms*: Physico-Chemical characteristics, Monthly Variations, Estuary, Water Quality.*

I. INTRODUCTION

Estuaries play a unique role in the functioning of life in this planet. They are also critical habitats to many species of fish, shellfish, birds etc. they are nurseries for many species of fish that are harvested in the open sea and are therefore, important to the food to many countries and regions. Estuaries therefore are popularly called as nurseries and play an important role in the generation of protein- rich fish and shellfish. In estuaries as in other aquatic systems the bulk of primary (plant) productivity is generated by microscope floating plants known as phytoplankton. Among the terrestrial and aquatic environments, the estuaries are among the most productive [1&2]. Estuaries have a high assimilative capacity that is the plants, animals and bacteria which are found there quickly break down and recycle organic matter, which leads to the very high productivity that is typical of estuaries. To some degree, the mixing and recycling of organic matter enables estuaries to absorb the toxic substances (effluents) which are released from the surrounding cities and town. Because of the high “assimilative capacity” estuaries and their associated wetland have been described as the kidneys of coastal ecosystems. Estuaries also serve as the buffer between the terrestrial and oceanic systems, capturing and processing the many substances that flow from the land to sea.

The estuarine environment is a complex blend of continuously changing habitats. Unlike fresh water bodies like lakes and rivers, estuaries can produce a wide range in the values of physical and chemical parameters that will be recorded and frequent changes occur in these values both with tidaland meteorological events. In streams, rivers and lakes, water quality parameters are more likely to fluctuate within a well-defined

range largely determined by rainfall and season and these values are often homogeneous throughout the water body[3]. In an estuary, in contrast these parameters can change abruptly in time and space are dependent on the study locations (sampling sites) and may or may not reflect general conditions throughout the estuary.

Estuaries act as natural laboratories studying the dynamics of physical and chemical parameters. Rivers carry into estuaries a variety of nutrients that are necessary for the growth of aquatic plants that in support aquatic animals such as finfishes and shellfishes. The nutrients most essential to plant productivity nitrogen, phosphorus and silica are called to the estuary by fresh water inflows. Freshwater inflows also contribute to the productivity of estuaries by bringing dissolved gases and food (detritus) to sessile animals namely mussels, clams and gastropods, which have developed filter feeding mechanism to trap nutrients and gases for their energy metabolism[4&5] hydrographic feature like temperature, salinity, dissolved oxygen, pH, and transparency constitute the important environmental requisites which govern the distribution, and abundance of flora and fauna in estuaries[6&7].

Biological processes such as primary production and decomposition can modify the physico-chemical conditions which the biological inter–relationship such as reproduction, recruitment and predator–prey cycles can modify the community structure. The latter in turn can have further consequences for the modification of physico-chemical characteristics of estuaries[8].

II. MATERIALS AND METHODS

Muthupet estuary (Lat. 11^0 42' N, long 79^0 39' E) is formed by the tributaries of Cauvery river southeast coast of India. Surface water samples were collected from Muthupet estuary covering two sampling sites (site 1. Mouth and 2. Estuary) at monthly interval for a periods of one year from July 2012 to June 2013, for the quantitative estimation of following hydrographical characteristic. Various physico-chemical parameters were analyzed by using standard methods[9]. Temperature: Water temperature of the tank water recorded by using Mercury field celcious thermometer. Salinity : Salinity were determined by Mohr's titration method. pH: The pH was determined by using Elico, model LI. 120 Digital pH meter. Dissolved oxygen: The Dissolved oxygen was determined by the modified Winkler's method[10]. The other parameters like, Potassium was estimated by silver nitrate method while phosphate estimated stannous chloride method. The nitrate and silicate was determined by the Brucine method.

III. RESULTS

Monthly variations in meteorological and physico- chemical parameters viz., surface water temperature, pH, salinity, dissolved oxygen, potassium, nitrate, phosphate and silicate contents in Muthupet estuarine waters were recorded for a period of one year from July 2012 to June 2013 (Table 1 & 2 and Figures 1-8).

Temperature

During the study period surface water temperature varied from 24.1 to 32.7°C. The minimum was recorded during monsoon season (November, 2012) and maximum during the summer season (May, 2013) in station-I (Table 1 and Fig. 1). The surface water temperature showed a positive correlation with salinity (r= 0.749) and of Muthupet estuary (Table 3).

At station-II, the surface water temperature ranged from 25.8°C to 33.5°C. The minimum surface water temperature (25.8°C) was recorded during monsoon season (November, 2012) and maximum (33.5°C) was recorded during the summer season (May, 2013) (Table 2 and Fig.1). Water temperature of the Muthupet estuary showed a positive correlation with salinity (r=0.789) and pH (r=0.634) and a negative correlation with dissolved oxygen (r = -0.927) (Table 4).

Salinity

The seasonal variation of salinity in Muthupet estuary was observed throughout the study period. Minimum salinity (9.03 ‰) was recorded during monsoon (December, 2012) and was slowly increased during post monsoon and attained maximum (29.57‰) during summer seasons (May, 2013) (Table 1 and Fig. 2) Salinity of the Muthupet estuary showed positive correlation between water temperature (r=0.749) and pH (r=0.915) while it showed negative correlation with dissolved oxygen (r = - 0.714) (Table 3) at station-I.

At station-II the monthly values of salinity in water samples varied from 9.46 to 31.42 ‰. The minimum values were recorded in the monsoon seasons (December, 2012) and Maximum values of salinity were observed in the summer season (May, 2013) (Table 2 and Fig. 2). Statistical analysis showed that the pH had positive correlation with water temperature (r=0.634) and salinity (r=0.856) whereas dissolved oxygen had an inverse relationship (r = -0.787) (Table 4).

pH

Monthly values of hydrogen ion concentration of water varied from 7.0 to 7.9. Maximum values of pH were observed in the summer season (May, 2013) and minimum values were recorded in the monsoon seasons (December, 2012) (Table 1 and Fig. 3). Statistical analysis showed that the pH had positive correlation with water temperature (r=0.762) and salinity (r=0.749) whereas dissolved oxygen had an inverse relationship (r = -0.584) (Table 3) at station-I.

At station-II the monthly mean values of hydrogen ion concentration of water varied from 7.2 to 8.1. The minimum values were recorded in the monsoon seasons (December, 2012) and Maximum values of pH were observed in the summer season (May, 2013) (Table 2 and Fig. 3). Statistical analysis showed that the pH had

positive correlation with water temperature (r=0.634) and salinity (r=0.856) whereas dissolved oxygen had an inverse relationship (r = -0.787) (Table 4).

Dissolved oxygen

Dissolved oxygen (DO) in Muthupet estuary was varied between 3.50 and 6.97 ml/L. Minimum D0 was recorded during the month of June, 2013 and maximum in November, 2012 (Table 1 and Fig.4). Statistical analysis showed that dissolved oxygen had a negative correlation with water temperature (r=-0.849), salinity (r=-0.-714) and pH (r=-0.584) (Table 3) at station-I.

At station-II the dissolved oxygen (DO) in Muthupet estuary was varied between 3.66 and 6.82 ml/L. Minimum D0 was recorded during the month of May, 2013 and maximum in November, 2012 (Table 2 and Fig.4). Statistical analysis showed that dissolved oxygen had a negative correlation with water temperature (r=-0.927), salinity (r= -0.882) and pH (r=-0.787) (Table 4).

Potassium

Monthly variations of potassium content were recorded in Muthupet estuary are shown in the Table 1 & 2 and Fig.5. The potassium was minimum (3.86 µg/L) June, 2013 and maximum (7.01 µg/L) in the month of April, 2013(Table 1 and Fig. 5). Total potassium content showed positive correlation with water temperature (r=0.547) and negative correlation was not observed (Table 3) at station-I.

At station-II the potassium in Muthupet estuary was varied between 4.10 and 6.91 µg/L. Minimum potassium content was recorded during the month of June, 2013 and maximum in March, 2013 (Table 2 and Fig.5). Statistical analysis showed that potassium had a negative correlation with salinity, pH and positive correlation with water temperature (Table 4).

Nitrate

The nitrate was varied from 1.16 to 4.28 µg/L. Minimum was recorded during the month of June, 2013 whereas maximum during the month of November, 2012 (Table 1 and Fig. 6). Statistical analysis showed that the Nitrate had positive correlation with DO (r=0.710) and negative correlation with water temperature (r = -656), pH (r = -0.835) and salinity (r = -0.883) (Table 3) at station-I.

At station-II the nitrate values were varied from 1.37 to 4.37 µg/L. Minimum was recorded during the month of June, 2013 whereas maximum during the month of November, 2012 (Table 2 and Fig. 6). Statistical analysis showed that the Nitrate had positive correlation with DO (r=0.889) and negative correlation with water temperature (r = -0.725), pH (r = -0.894) and salinity (r = -0.856) (Table 4).

Phosphate

The total phosphate was minimum (0.48 µg/L) in the month of June, 2013 and maximum (1.83 µg/L) in the month of January, 2013 (Table 1 and Fig. 7). Total phosphate content showed positive correlation with dissolved oxygen (r=0.593) and negative correlation with water temperature (r = -0.501), pH (r = -0.732) and salinity (r = -0.872) (Table 3) at station-I.

At station-II the total phosphate was minimum (0.65 µg/L) in the month of June, 2013 and maximum (1.97 µg/L) in the month of January, 2013 (Table 2 and Fig. 7). Total phosphate content showed positive correlation with dissolved oxygen (r=0.709) and negative correlation with water temperature (r = -0.511), pH (r = -0.773) and salinity (r = -0.824) (Table 4)

Silicate

Monthly variations of silicate of the water observed in Muthupet estuary during the study period (July 2012- June 2013) are graphically represented in Table 1 & 2 and Fig. 8. The silicate content showed a minimum value of 38.66 µg/L (May, 2013) and a maximum value of 92.06 µg/L (November, 2012). Total silicate content showed positive correlation with dissolved oxygen (r=0.712) and negative correlation with water temperature (r = -0.786), pH (r = -0.853) and salinity (r = -0.894) (Table 3) at station-I.

At station-II the silicate content showed a minimum value of 39.48 µg/L (May, 2013) and a maximum value of 94.35 µg/L (November, 2012). Total silicate content showed positive correlation with dissolved oxygen (r=0.931) and negative correlation with water temperature (r = -0.839), pH (r = -0.847) and salinity (r = -0.863) (Table 4). Throughout the study period, seasonal water temperature, pH, salinity, Dissolved oxygen, phosphate, nitrate, and silicate contents were not uniform in Muthupet estuary.

Table 1. Monthly variations of physico-chemical characteristics in the mouth of Muthupet estuary (Station–I).

Month	Surface Water Temp.	Salinity (ppt)	pH	D.O (mg/L)	K (m^{-1})	No_3 (µgat/L)	Po_4 (µgat/L)	Sio_3 (µgat/L)
Jul. 2012	27.5	21.69	7.5	5.89	5.01	1.31	0.60	48.60
Aug. 2012	27.8	17.64	7.3	4.86	4.94	1.85	1.07	57.58
Sep. 2012	26.3	19.35	7.4	5.96	4.86	2.11	1.28	69.43
Oct. 2012	27.9	13.79	7.2	5.38	4.11	3.67	1.35	85.28

Nov. 2012	24.6	12.18	7.1	6.97	4.01	4.28	1.22	92.06
Dec. 2012	25.7	9.03	7	6.22	3.90	4.13	1.54	81.23
Jan. 2013	28.9	10.73	7.2	5.67	5.87	3.22	1.83	76.42
Feb. 2013	29.4	15.62	7.3	5.49	5.93	2.75	1.47	65.21
Mar. 2013	30.5	19.64	7.5	4.96	6.87	2.34	0.97	53.50
Apr. 2013	31.2	25.29	7.4	4.35	7.01	1.94	0.82	44.42
May.2013	32.7	29.57	7.9	4.65	5.30	1.33	0.65	38.66
Jun. 2013	31.1	25.31	7.5	3.50	3.86	1.16	0.48	53.08

Table 2. Monthly variations of physico-chemical characteristics in the mouth of Muthupet estuary (Station–II).

Month	**Surface Water Temp.**	**Salinity (ppt)**	**pH**	**D.O (mg/L)**	**K (m^{-1})**	**No_3 (µgat/L)**	**Po_4 (µgat/L)**	**Sio_3 (µgat/L)**
Jul. 2012	28.9	23.16	7.9	4.94	5.23	1.48	0.86	53.67
Aug. 2012	29.15	19.53	7.8	5.03	5.12	1.97	1.24	59.83
Sep. 2012	28.74	20.44	7.6	5.23	4.98	2.32	1.46	75.23
Oct. 2012	28.63	15.42	7.3	6.11	4.45	3.79	1.63	89.45
Nov. 2012	25.8	14.25	7.4	6.82	4.37	4.37	1.44	94.35
Dec. 2012	26.7	9.46	7.2	6.08	5.26	4.25	1.31	82.46
Jan. 2013	29.8	11.54	7.3	5.48	6.10	3.45	1.97	78.29
Feb. 2013	30.8	16.98	7.5	5.12	6.73	2.88	1.68	67.51

Mar. 2013	31.6	20.44	7.7	4.85	6.91	2.52	1.16	55.49
Apr. 2013	32.2	28.73	7.6	4.22	6.24	2.14	0.93	46.23
May.2013	33.5	31.42	8.1	3.63	5.33	1.65	0.72	39.48
Jun. 2013	32.6	27.83	7.8	3.77	4.10	1.37	0.65	55.36

Fig. 2. Monthly variations of temperature recorded in the mouth of Muthupet estuary (Station–I and station-II)

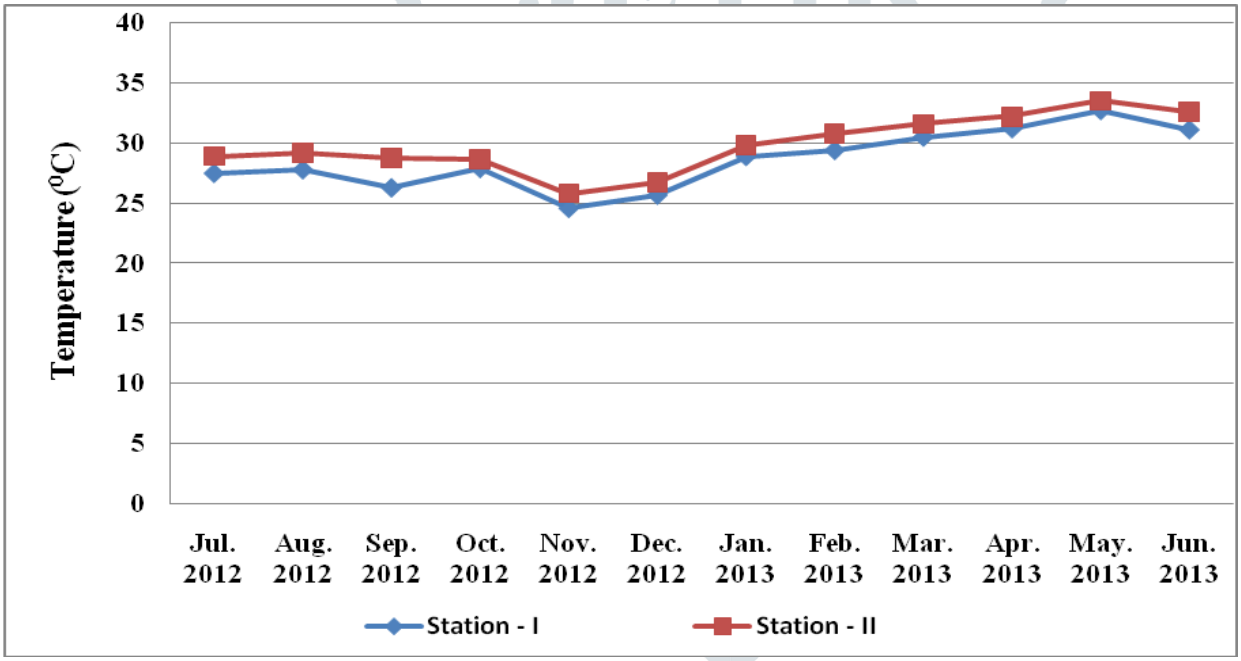

Fig. 3. Monthly variations of salinity in the mouth of Muthupet estuary (Station–I and station-II)

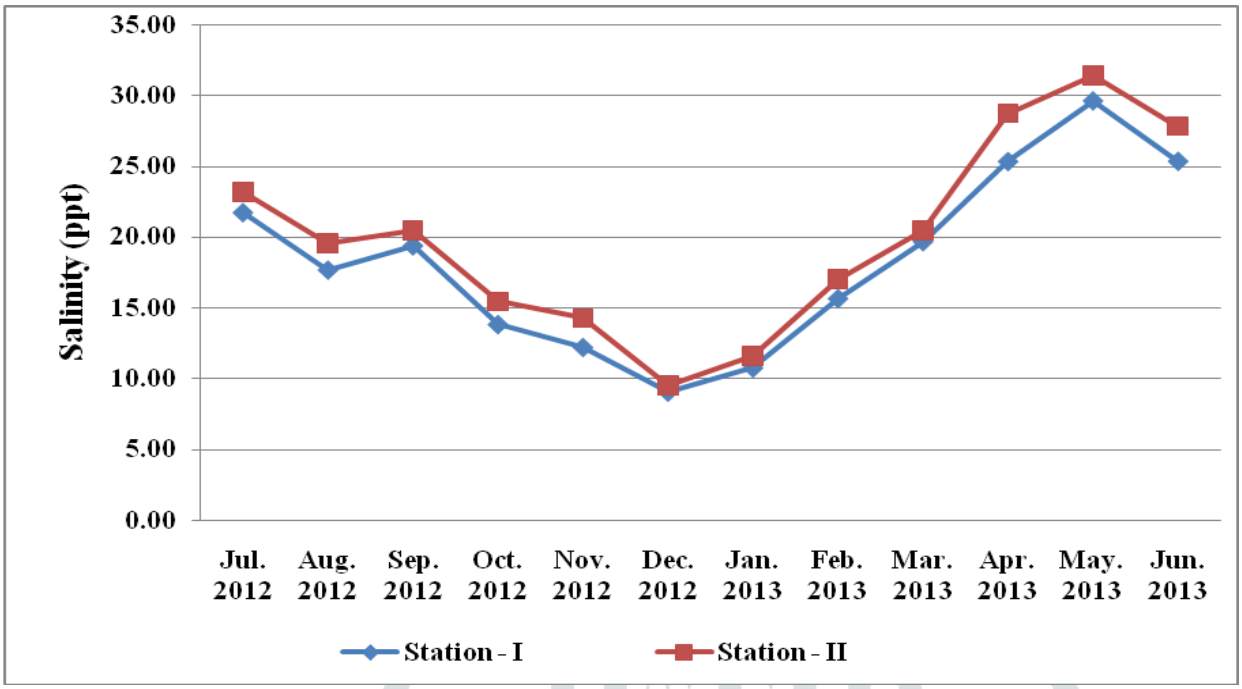

Fig. 4. Monthly variations of pH in the mouth of Muthupet estuary (Station–I and station-II)

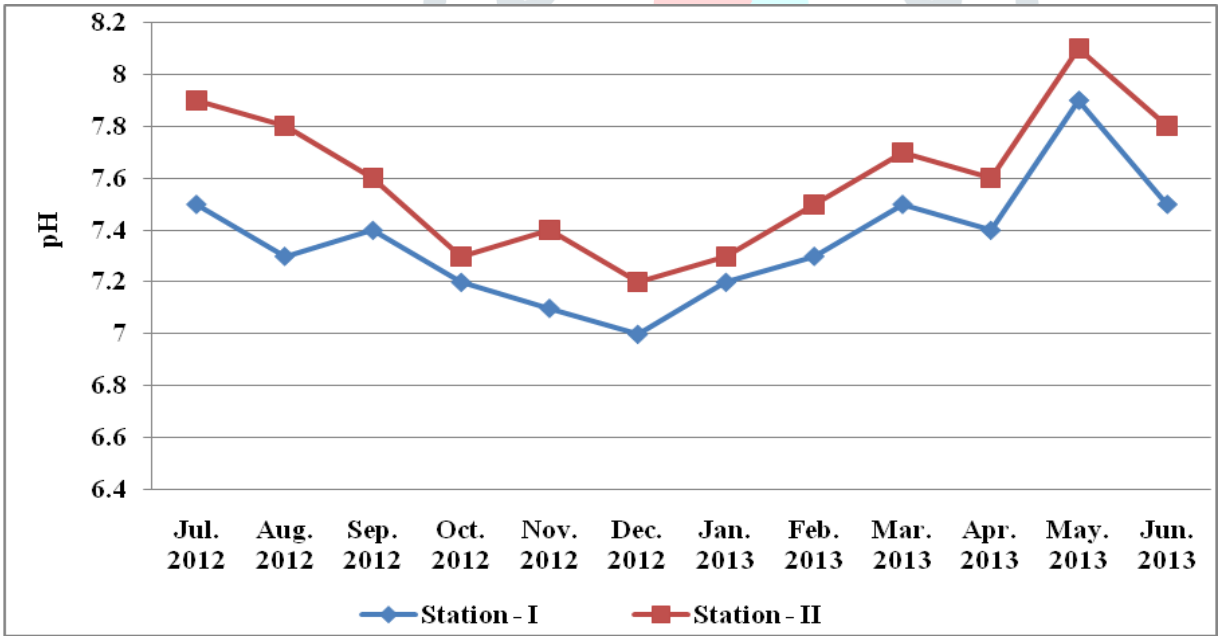

Fig.5. Monthly variations dissoloved.Oxygen (µg/l) in the mouth of Muthupet estuary (Station–I and station-II)

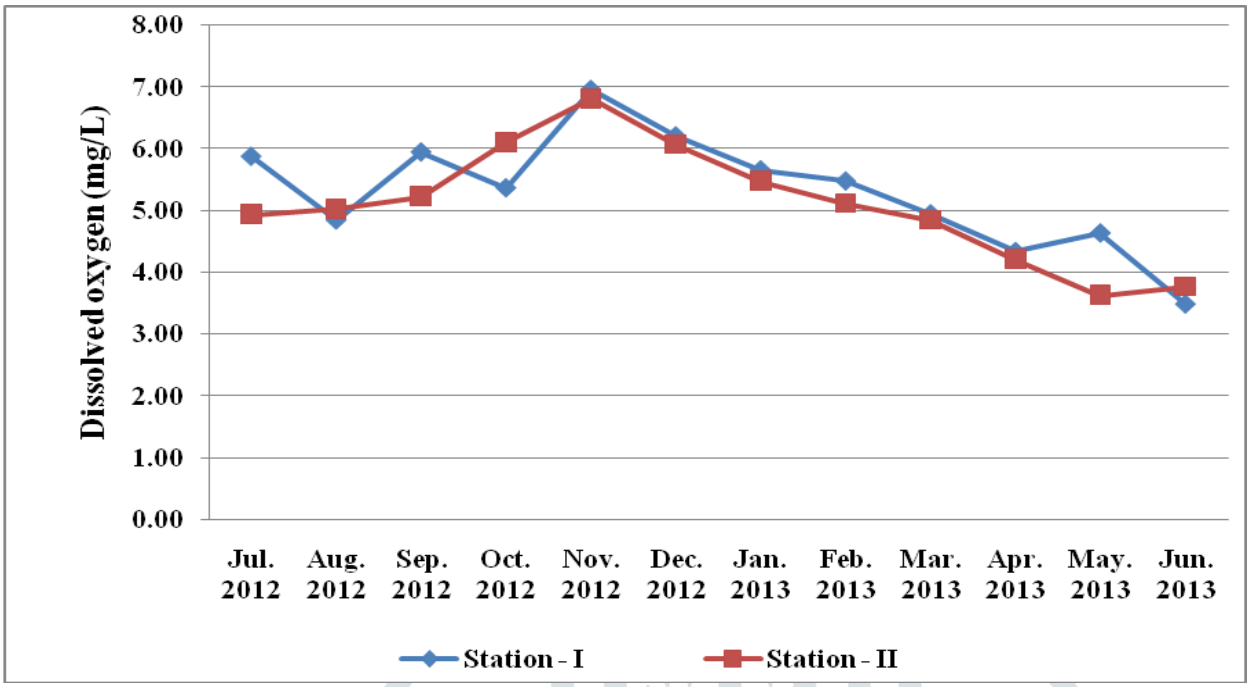

Fig. 6 Monthly variations of potassium content (m^{-1}) in the mouth of Muthupet estuary (Station–I and station-II)

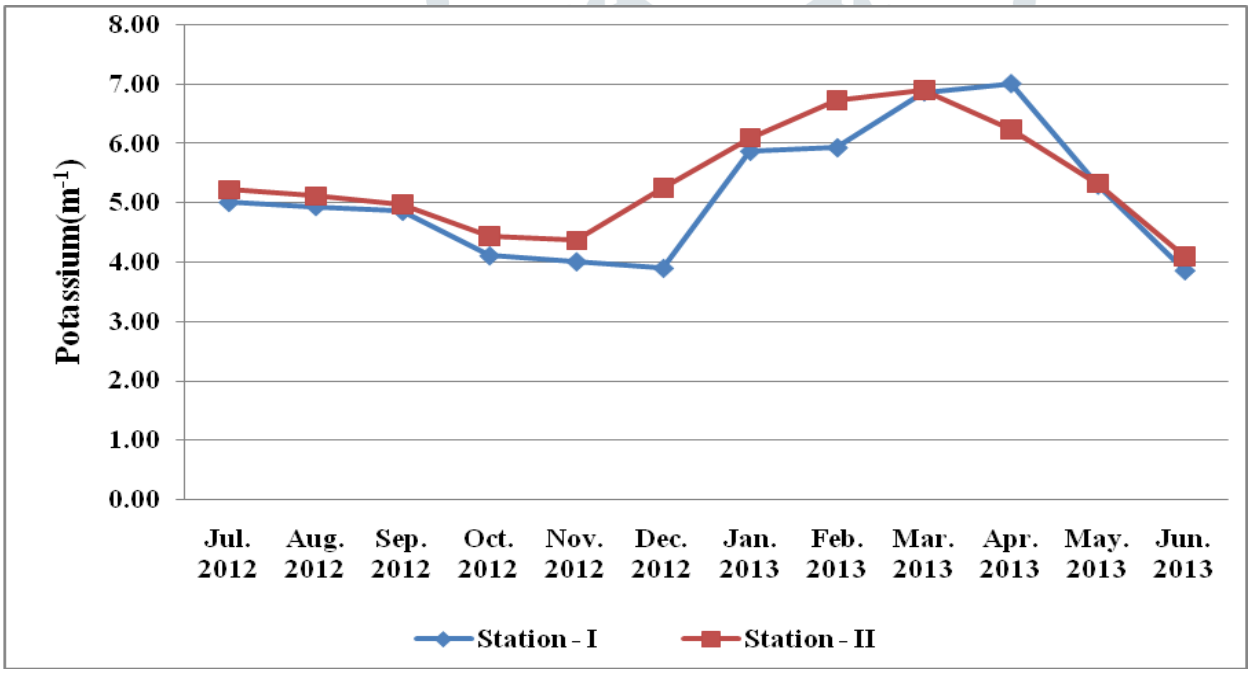

Fig. 7. Monthly variations of Nitrate (μg^{-1}) in the mouth of Muthupet estuary (Station–I and station-II)

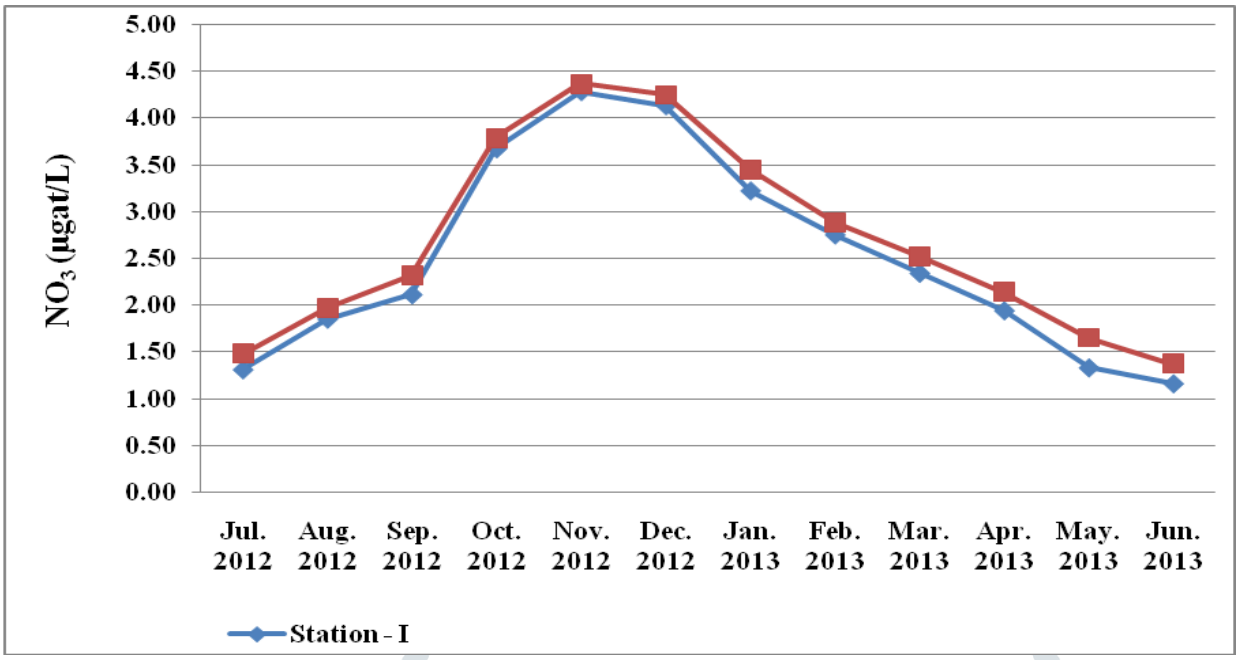

Fig. 8. Monthly variations of phosphate (μg^{-1}) in the mouth of Muthupet estuary (Station–I and station-II)

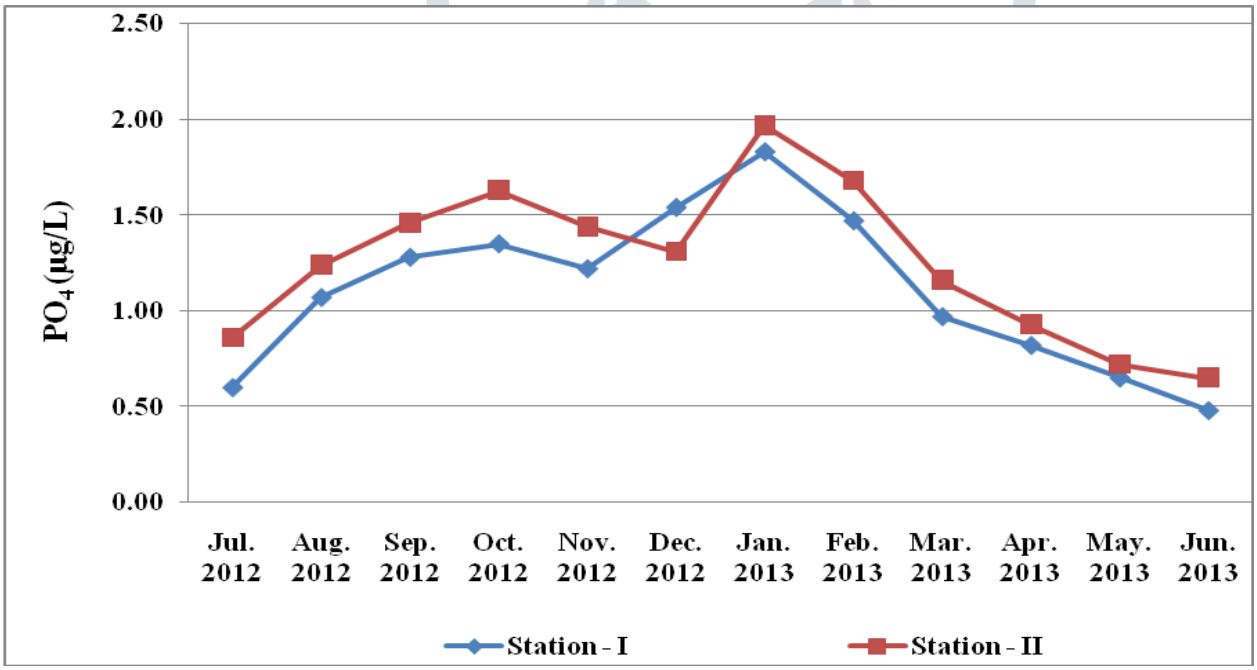

Fig. 9. Monthly variations of silicate in the mouth of Muthupet estuary (Station–I and station-II)

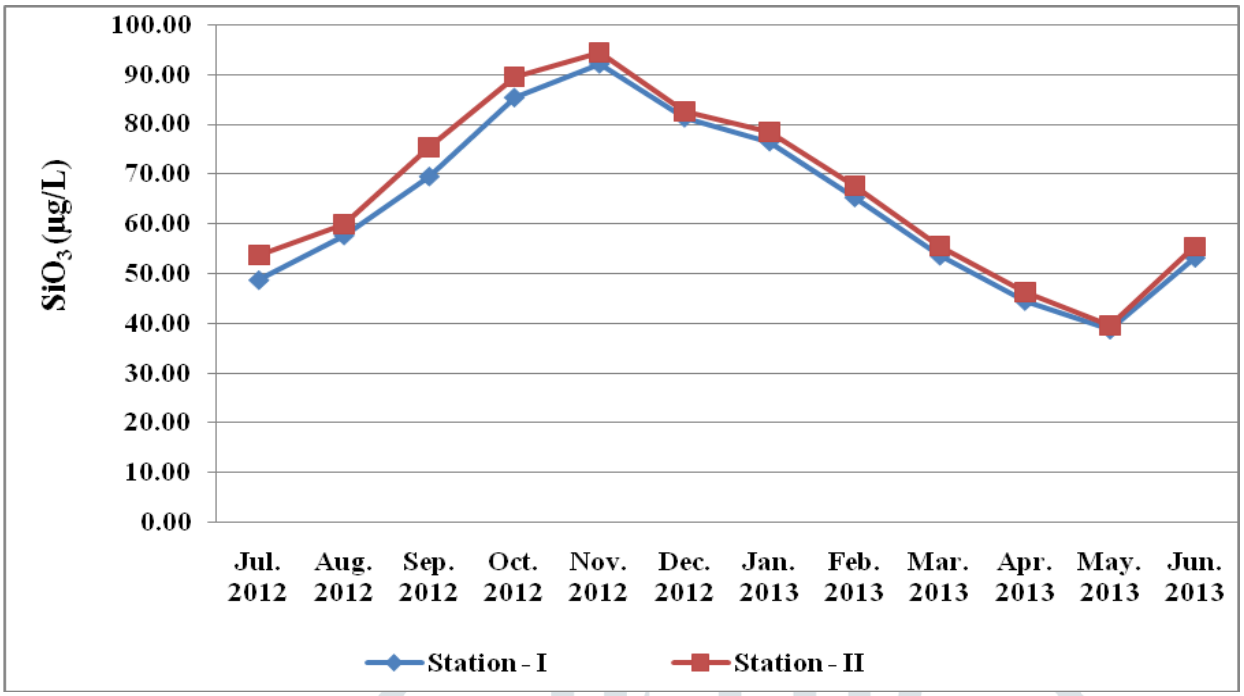

Table 3.Statistical analysis of Physico-chemical parameters (Station I).

Parameters	Surface Water Temp.	Salinity (ppt)	pH	D.O (mg/L)	K (m-1)	No_3	Po_4	Sio3 (µg/)
Water Temp.	1							
Salinity (ppt)	0.749(*)	1						
pH	0.762(**)	0.915(**)	1					
D.O (mg/L)	-0.849(**)	-0.714(*)	-0.584(*)	1				
K (m^{-1})	0.547(*)	0.298	0.333	-0.269	1			
No3	-0.656(*)	-0.883(**)	-0.835(**)	0.710(*)	-0.294	1		
Po4	-0.501(*)	-0.872(**)	-0.732(*)	0.593(*)	-0.024	0.779(**)	1	
Sio3 (µg/L)	-0.786(**)	-0.894(**)	-0.853(**)	0.712(*)	-0.519	0.912(**)	0.758(**)	1

* Significance 0.5 level, ** Significance 0.1 level

Table 4.Statistical analysis of Physico-chemical parameters (StationII).

Parameters	Surface Water Temp.	Salinity (ppt)	pH	D.O (mg/L)	K(m-)	No3	Po4	Sio3 (µgat/)
Surface Water Temp.	1							
Salinity (ppt)	0.789(**)	1						
pH	0.634 (*)	0.856(**)	1					
D.O (mg/L)	-0.927 (**)	-0.882 (**)	-0.787 (**)	1				
K (m-1)	0.364	-0.025	-0.017	-0.196	1			
No3	-0.725 (*)	-0.856 (**)	-0.894(**)	0.889 (**)	-0.0540	1		
Po4	-0.511 (*)	-0.824 (**)	-0.773(**)	0.709 (*)	0.219	0.713 (*)	1	
Sio3 (µgat/L)	-0.839 (**)	-0.863 (**)	-0.847 (**)	0.931 (**)	-0.341	0.877(**)	0.754(**)	1

* Significance 0.5 level, ** Significance 0.1 level

IV. DISCUSSION

Temperature is an universal factor of importance in the study of aquatic ecosystem. There are documents that measure the effect of temperature on the growth of phytoplankton in laboratory[11]. Temperature variations in the estuarine environment can influence the other physicochemical characteristics. High atmospheric temperature was recorded during the summer season due to clear sky with more solar radiation less solar radiation with cloudy sky and more rainfall during the monsoon season greatly reduced the atmospheric temperature. The surface water temperature largely depends on the intensity of solar radiation, evaporation and freshwater influx. The presently recorded summer peaks 33ºC at Station–1 and 32.1ºC at Station–2 are closely resemble the data generated earlier worker from the east and west coast of India[12&13].

In general, the salinity is considered to be the prime factor among the most important environmental parameters that control the dynamic situation of the estuarine environment. Salinity at both stations showed high values during the summer season due to less rainfall, decreased freshwater inflow and rise in temperature of the estuary and low during the monsoon season due to high rainfall and land runoff. Salinity is one of the important factors which profoundly influence the abundance and distribution of the fauna and flora in the estuarine environment which in turn depends on the inflow of freshwater and the prevailing temperature. During the monsoon season low salinity recorded due to heavy rainfall and large quantity of freshwater inflow. Thus, the variations in salinity were mainly influenced by the rainfall and entry of freshwater[14].

The pH was higher during the summer season while it was low during the monsoon period due to the uptake of CO_2 by the photosynthesizing organisms, especially phytoplankton and planktonic cyanobacteria from

the seawater could have increased the pH level during the summer season[15]. The low pH observed during the monsoon due to the influence of freshwater influx and dilution of seawater, reduction of salinity and temperature and decomposition of organic matter[16&17]. Dissolved oxygen concentration varied from 2.8 to 6 ml/l at station–1 and from 3.2 to 6.3 ml/l at station–2 with the maximum during the monsoon season in November and minimum during the post monsoon in March at both the stations. Distribution and behaviour of nutrients in the coastal environments particularly in the nearshore waters and estuaries would exhibit considerable seasonal variations depending upon the local conditions of rainfall, freshwater inflow, tidal incursion and some biological activity[18].

However, the freshwater inflow into the estuary and constant evaporation of the estuarine water together with mixing of sea water into the estuary are the important factors influenced the distribution of salinity in Muthupet estuary. The present observation of high salinity during summer and premonsoon and low salinity during monsoon and postmonsoon periods is in conformity with the earlier reports from different estuaries of India[19&20]. In the present study, maximum dissolved oxygen content was recorded during summer and premonsoon and minimum during monsoon period. The present study is in agreement with the earlier reports of Dehadrai [21] Nagarajaiah and Gupta[22] from Nethravati–Gurupur estuary and Nair[23] from Ashtamudi estuary.

The higher values of nitrate during the monsoon could be due to heavy rainfall, river and terrestrial run–off[24]. The higher values of nitrite concentration recorded at both stations during the monsoon season could be related to the terrigenous input by river and the low values of nitrate observed during the summer season might be due to the lesser amount of freshwater inflow and higher salinity[25]. Inorganic phosphate registered its peak values during the monsoon season 0.10 to 1.65µm and there was a decrease in the concentration during the post monsoon season to summer. The high value in the estuary during the monsoon season was due to fertilizers from the agricultural land run-off and erosion of phosphate rock[26]. Low concentration of phosphate observed during the summer season was due to the decreased land drainage, utilization by phytoplankton[13] . The reactive silicate concentration was comparatively higher than other nutrients. High concentration was recorded during monsoon season and low concentrations was recorded during summer and premonsoon seasons which were due to the considerable reduction in the freshwater input and greater utilization of this nutrients by the abundantly occurring phytoplankton and cyanobacteria for their biological activity. This is in agreement with the earlier observation in Mulki estuary by Vijayakumar, *et al.*[27].

V. CONCLUSION

The variation in physico-chemical parameters mainly depends on monsoon rains. The fluctuations in physico-chemical parameter influence the natural activity and efficiency of estuarine organism. While in the non monsoon season the water showed predominantly saline characteristics. Salinity plays a dominant role in controlling the water quality. In addition intense pollution from agricultural inputs and retting activities deteriorate the water quality of this estuary. Thus the present baseline information of the physico-chemical properties of water would form a useful tool for further ecological assessment and monitoring of this estuary.

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