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EVALUATION OF PHYSICO-CHEMICAL PARAMETERS AND NUTRIENTS IN THE MANGROVE ECOSYSTEM OF MANAKUDY ESTUARY, SOUTHWEST COAST OF INDIA.

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Abstract- The present study was carried out to determine the physico- chemical characteristics of water in mangrove ecosystem of Manakudy estuary, South west coast of India, for a period from June 2012 to May 2013. The study revealed that the physico- chemical parameters like ambient temperature, water temperature, transparency, hydrogen ion concentration, electrical conductivity, total dissolved solids, salinity, dissolved oxygen, carbonate, bicarbonate and nutrients nitrite, nitrate, phosphate, silicate and chlorides exhibited considerable seasonal and spatial variations. The study exemplified the fact that the Manakudy mangrove ecosystem is in a good state of health.

Key words: *Seasonal variation, nutrients,physico-chemical parameters, mangrove.*

I. INTRODUCTION

Mangrove ecosystem variously referred to as tidal forest, coastal woodland, are productive wetlands found in tropical and subtropical regions. Mangroves possess characteristics that, in total make them structurally and functionally unique. Mangrove ecosystem acts as a buffer between nearshore and lagoon or estuarine environments with regard to the influence of freshwater discharge and salinity regime (Ramanathan, 1993) Good quality of water depends on a large number of physico-chemical parameters and the magnitude and source of any pollution load and to assess, that monitoring of these parameters are essential (Reddi et al., 1993). The mangrove system plays a major role in the global cycle of carbon, nitrogen as well as sulphur and acts as reservoirs of waste materials (Kathiresan and Bingham 2001; Kathiresan, 2000). A few authors have studied the physical and chemical characteristics of some Indian estuaries and mangroves (Satpathy, 1996; Govindasamy et al., 2000; Rajasekar et al., 2005 and Asha and Diwakar 2007). The present investigation is an attempt to study some of the crucial, physical and chemical parameters of Manakudy estuary in relation to the assessment of the state of health of the mangroves.

II. STUDY AREA

The mangrove forest at Manakudy is located on the southern extremity of Indian Peninsula (Lat $8^0$2'N Long $77^0$30'E) along the south west coast of India, about 10 km from Kanyakumari. The Manakudy estuary is the confluence of river Pazhayar and has an area of 150 ha. There is luxuriant growth of mangroves on the mud flats of Manakudyestuary. Four sampling stations were selected around the mangroves.

III. MATERIALS AND METHODS

Physico-chemical parameters of the monthly samples of water around Manakudy mangrove were recorded from June 2012 – May 2013 in the four stations. Surface water samples were collected in plastic containers and bottom samples were collected using Meyer's water sampler. Air and water temperatures were measured using thermometer. Salinity was measured using Atago refractometer. Dissolved oxygen was analysed by Winkler's method and transparency by using Secchi disc. Analysis of calcium and magnesium were done titrimetrically. The inorganic phosphates was determined based on the method by Murphy and Riley (1962), Nitrates (NO_3^-) and nitrites (NO_2^-) were measured spectrophotometrically by following the method of Strickland and Parson (1972). The rainfall data was obtained from the meteorological stations at Kanyakumari, Cape Comorin.

The data on physico-chemical parameters were subjected to two way ANOVA to find out the interaction of parameters between months and stations. Further Pearson product movement correlation co-efficient (Sokal and Rohif, 1995) was applied to the hydrographic parameters within each station.

IV. RESULTS AND DISCUSSION

The Kanyakumari District receives rainfall both during the south west monsoon and north east monsoon. There are also summer showers during April. During the study period south west monsoon started during June 2012 and extended upto

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September 2012. The northeast monsoon started during October 2012 and the heaviest rainfall was observed during October 2012 (174mm). The total of 299mm rainfall was recorded during the northeast monsoon and 110.8mm of rainfall during the southwest monsoon. Rainfall is the most important cyclic phenomenon in tropical countries as it brings important changes in the hydrographical characteristics of the marine and estuarine environments. In the study area also there was monsoonal influence on all parameters studied. Rainfall showed negative correlations with pH, salinity and temperature but it showed positive correlation with turbidity, DO and the nutrients nitrite, nitrate and phosphate.

The atmospheric temperature varied from 26.8 to 29.38^{0}C. The air temperature showed marked variation in relation to seasons. The surface water temperature ranged between 26.8 and 27.4^{0}C and the bottom varied from 26.3 to 27.2^{0}C. The student 't' test results showed that there was no significant difference between the surface and bottom waters for all stations. Generally surface water temperature is influenced by the intensity of solar radiation, evaporation, fresh water influx and cooling and mix up with ebb and flow from adjoining neritic waters (Govindasamy et al., 2000, Saravanakumar et al., 2008). As observed by several workers like Desai, (1992), Arthur (2000), Saravanakumar et al., (2008) in the west coast of India, the present work also showed summer peaks and monsoonal troughs in air and water temperature.

There was marked difference in depth at all four stations and was comparatively shallow with a maximum of 1.7m. Water transparency in terms of extinction coefficient showed marked fluctuations in relation to season and stations. The maximum transparency value was recorded during the premonsoon period. The ANOVA results showed significant difference in extinction co-efficient between months ($P<0.05$) and between stations ($P<0.05$). Light extinction coefficient (K) is a measure of the reduction of light intensity in a vertical column of water. Low transparency obtained during the monsoon indicate the high turbidity of the water column and it was due to the presence of higher amount of suspended sediment load as a consequence of heavy fresh water influx and resuspension of bottom sediments. The flow of water and removal of sand causing disturbance at the bottom were the main factors governing light penetration in this estuarine mangrove ecosystem as noticed in other monsoon fed tidal estuaries (Trivedi and Goel, 1984 and Tharadevi, 2002).

The pH varied from 7.5 to 7.81 at the surface and between 7.4 and 7.75 at the bottom. The vertical gradient remained less significant in the present study and on most of the occasions higher pH may be due to higher decomposition of organic matter. Generally fluctuations in pH values during different seasons of the year is attributed to factors like removal of CO_2in photosynthesis, through bicarbonate degradation, dilution of seawater by freshwater influx, reduction of salinity, temperature and decomposition of organic matter (Upadhyay, 1988;Rajasegar 2003 and Saravanakumar et al, 2008).

The conductivity values varied from 2.4 to 5.48 ds/m. Conductivity is an important parameter to assess the water quality. Any change in the concentration of sulphates and chlorides are reflected in corresponding changes in the conductivity. The pollution by inorganic or organic wastes containing excessive amount of dissolved solids increase the concentration of salts in water. There was significant difference in EC between months and stations at surface water ($P<0.05$). However there was no significant difference in EC between months and stations at bottom water ($P>0.05$). This was in agreement with the studies of Thomas et al (2001) in Kuttanad wetland ecosystem in the west coast of India.

Average amount of Total dissolved solids (TDS) in the surface waters ranged from 1.98 to 3.8 ppt and at the bottom between 2.43 to 4.38 ppt. The amount of TDS had a monsoonal influence indicating maximum flow of turbid water from the upstream of the river. This was in agreement with the studies of Das et al (1997) in the Mahanadi estuary in the east coast of India.

Salinity, in brackish water habitats such as estuaries, backwater and mangroves are influenced by fresh water influx from land run off, by monsoon or by tidal influence.Salinity showed a significant positive correlation with temperature. The variation in salinity in the study area was mainly influenced by the rainfall during monsoon and entry of sea water when the bar opens as reported by Kumar (2007) earlier in Manakudy mangroves.

The dissolved oxygen showed seasonal variation in all the stations, with maximum values in monsoon. Temperature and salinity influenced the dissolved oxygen content. As reported by Saravanakumar et al (2008) the present study also showed higher value of dissolved oxygen during monsoon months and this might be due to the cumulative effect of higher wind velocity with heavy rainfall and the resultant fresh water mixing and ferruginous impact of sediments. The low levels of dissolved oxygen in the bottom water may be due to microbial demand for oxygen in decomposition of suspended organic matter (Murugan and Ayyakkannu, 1991). The decaying organic matter abundant in the mangroves which increase the organic load resulting in very high BOD may also cause a depletion in dissolved oxygen level (Vareethiah and Haniffa, 1998).

Alkalinity showed marked variation in the stations studied and there was significant correlation of alkalinity between months and stations ($P<0.05$). Further anions like carbonates, bicarbonates and chloride also showed marked variations among the stations.

In mangrove ecosystem nutrients are considered as the most important parameters that influence growth, reproduction and metabolic activities of biotic components. The distribution of nutrients is mainly based on season, tidal conditions and fresh water influx from land (Sarvanakumar et al., 2008).

The phosphate concentration was high in all stations and comparatively higher in the bottom water than in the surface water. The maximum phosphate value was recorded during monsoon season. High concentrations of phosphate during the monsoon season were reported earlier by Sankaranarayanan and Qasim (1969) Mishra et al., (1993). High concentration of phosphate observed during monsoon reason might be possibly due to intrusion of upwelling seawater, which increased the level of phosphate (Nair et al., 1984). According to Chandran and Ramamoorthy (1984) the turbulence of water column during monsoon would have released phosphorus from bottom mud into the water. The leaching of phosphates from the sediments may also be

attributed to the higher value. According to Saisastry and Chandramohan (1990) the mudflat and mangroves are known to trap phosphates during period of annual run off and release the same at a later time to the water.

The nitrite and nitrate content in the mangroves were highly variable. The minimum nitrite values were recorded during premonsoon. The reduction of nitrite content may be attributed to low river discharge during premonsoon resulting in extreme stagnations and also by the use of nitrite by phytoplankton (Saisastry and Chandramohan 1990; Prema, 2000). Higher values of nitrite were observed during monsoon and it may be due to drainage of fresh water bringing nitrite ions from catchment area (Das et al., 1997) and weathering of rocks. (Gowda et al., 2001). Another possible way of higher nitrite is through oxidation of ammonia form of nitrogen to nitrite and then consequently to nitrate (Rajasegar, 2003). Further higher values of nitrite recorded during monsoon may be due to variation in phytoplankton excretion, oxidation of ammonia, reduction of nitrate and bacterial decomposition of planktonic detritus and mangrove detritus present in the environment (Govindasamy et al., 2000).

The silicate values were comparatively higher than other nutrients (NO_3^-, NO_2^- and PO_4^{3-}). The high monsoonal content of silicates may be due to heavy influx of fresh water derived from land drainage carrying silicates leached out from rocks and also from bottom sediments exchanging with overlying water due to the turbulent nature of water in the mangrove environment (Ashok Prabu et al., 1993). According to Mishra et al., (1993) during non monsoonal season there is depletion in silicate content due to the uptake of silicate by phytoplankton for their biological activities.

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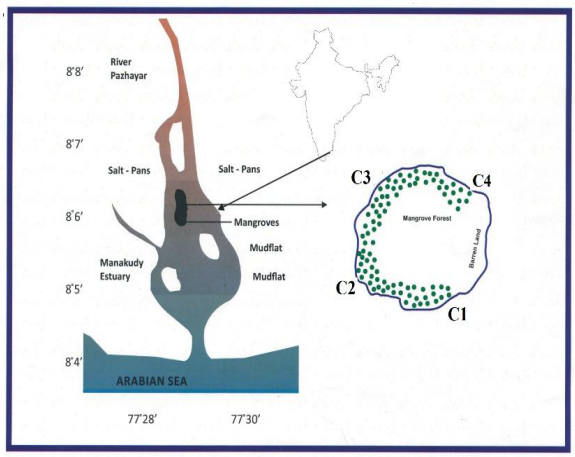

Fig : 1 Location of the study area

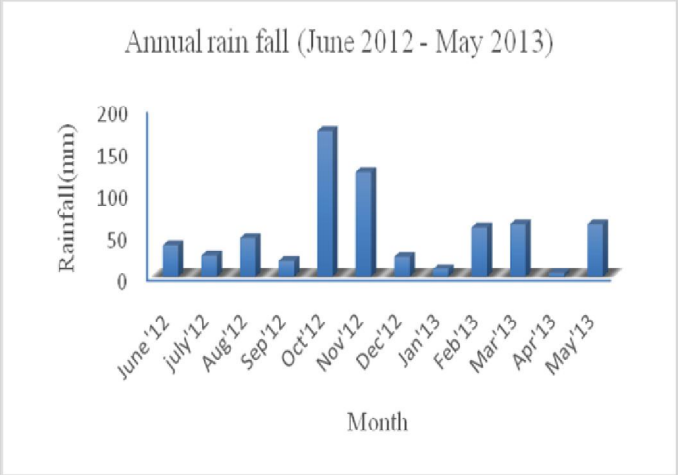

Fig.2.Annual rainfall in the study period

Table 1.Physico -chemical parameters recorded at the station 1(C1) (Mean ± SD)

S.No	Parameters	Layer	Premonsoon	Monsoon	Postmonsoon
1	Atmospheric temperature		29.38±0.98	28.25±2.5	27.8±2.3
2	Water temperature	S	28.65±1.8	27.3±2.25	26.5±2.56
		B	27.81±1.29	27±1.85	26.5±2.71
3	Total depth (m)		2.68±1.61	1.38±1.4	1.46±0.09
4	Extinction coefficient(K)		2.14±0.08	2.31±0.14	2.32±0.2
5	pH	S	7.75±0.31	7.31±0.28	7.85±0.23
		B	7.8±0.29	7.6±0.4	8.01±0.32
6	EC(ds/m)	S	5.63±1.84	2.68±1.61	3.03±0.89
		B	4.75±1.96	2.9±1.35	3.7±0.74
7	TDS(ppt)	S	2.71±1.5	2.1±0.38	1.39±0.78
		B	2.85±1.31	3.14±0.87	1.81±1.16
8	Salinity (‰)	S	8.95±4.91	8.75±5.2	6.8±3.6
		B	13.76±6.4	10.75±6.81	7.4±3.4
9	Dissolved Oxygen (ml/L)	S	4.6±1.8	5.6±1.75	4.46±0.71
		B	3.7±0.81	3.91±0.5	3.93±0.5
10	Nitrite -N(µg/L)	S	0.98±0.56	0.43±0.42	1.34±0.31
		B	1.4±0.63	1.1±0.85	1.53±0.68
11	Nitrate -N(µg/L)	S	10.86±1.8	13.21±5.81	8.76±031
		B	8.92±2.41	13.75±6.71	8.1±3.71
12	Phosphate (µg/L)	S	0.52±0.16	0.52±0.31	0.43±0.27
		B	0.58±0.26	0.85±0.21	0.53±0.16
13	Silicate(µg/L)	S	51±21.13	84.36±24.4	66.7±34.81
		B	68±28.2	94.16±17.1	58.6±23.11
14	Alkalinity(mg/L)		8.12±3.8	6.14±3.81	13.2±7.4
15	Chloride	S	194.8±12.3	52.1±7.3	142.63±10.8
		B	209.6±14.2	60.9±7.9	152.63±11.2
16	Carbonate	S	43.8±4.3	29.8±3.9	70.5±5.8
		B	45.3±3.9	32±4.3	73.3±6.1
17	Bicarbonate	S	14±3.2	11±3.4	22.8±3.2
		B	22.75±4.1	18.3±3.2	24.5±4.6

Table 2.Physico -chemical parameters recorded at the station 2 (C2) (Mean ± SD)

S.No	Parameters	layer	Premonsoon	Monsoon	Postmonsoon
1	Atmospheric temperature		27.5±2.10	27.25±2.3	27.0±2.14
2	Water temperature	S	28.5±1.71	26.75±2.3	26.85±2.35
		B	28.18±2.5	26.5±2.27	26.88±3.2
3	Total depth (m)		1.42±0.26	1.49±0.45	1.37±0.18
4	Extinction coefficient(K)		2.59±0.26	2.18±0.71	2.34±0.46
5	pH	S	7.62±0.34	7.26±0.28	7.94±0.48
		B	7.72±0.29	7.38±0.34	8.12±0.28
6	EC(ds/m)	S	4.28±1.65	3.7±2.45	3.53±1.25
		B	3.82±1.46	3.68±2.1	5.91±1.23
7	TDS(ppt)	S	3.12±0.48	1.98±1.25	2.4±0.58
		B	1.85±0.67	1.96±1.36	2.6±0.89
8	Salinity (‰)	S	9.58±3.28	9.2±6.04	4.63±0.59
		B	13.41±4.25	9.51±4.65	5.9±1.92
9	Dissolved Oxygen (ml/L)	S	3.85±1.61	5.6±1.32	4.78±0.64
		B	3.32±0.82	4.38±1,34	3.98±0.61
10	Nitrite -N(µg/L)	S	0.68±0.14	0.98±0.75	1.14±0.45
		B	0.95±0.36	1.45±0.96	1.05±0.48
11	Nitrate -N(µg/L)	S	4.52±2.81	6.55±2.9	4.08±1.48
		B	4.2±2.91	6.18±2.6	3.51±2.8
12	Phosphate (µg/L)	S	0.48±0.18	0.56±0.42	0.53±0.14
		B	0.58±0.28	1.25±0.68	0.89±0.23
13	Silicate(µg/L)	S	63±24.9	84.48±28.1	68.4±29.4
		B	58±21.48	7998±18.66	32.9±23.58
14	Alkalinity(mg/L)		5.36±1.39	14.9±6.78	7.8±1.62
15	Chloride	S	195.3±10.5	48.5±5.1	135.7±13.1
		B	206.9±9.6	62±4.9	146.3±12.8
16	Carbonate	S	47.5±2.8	37±4.3	74.8±6.2
		B	49.8±3.4	40.7±4.8	73.8±5.9
17	Bicarbonate	S	14.5±3.4	11±2.9	22.3±3.6
		B	15.8±3.7	15.5±3.2	26±3.8

Table 3.Physico -chemical parameters recorded at the station 3 (C3) (Mean ± SD)

S.No	Parameters	Layer	Premonsoon	Monsoon	Postmonsoon
1	Atmospheric temperature		28.2±0.62	28.35±2.8	26.8±0.5
2	Water temperature	S	29.1±1.19	27.73±2.04	27.18±2.45
		B	29.2±1.18	26.63±2.14	26.48±3.1
3	Total depth (m)		1.35±0.45	0.98±0.38	1.19±0.3
4	Extinction coefficient(K)		3.19±0.8	2.14±0.4	2.94±1.02
5	pH	S	7.5±0.31	7.4±0.39	7.75±0.38
		B	7.75±0.19	7.49±0.31	7.96±0.18
6	EC(ds/m)	S	3.61±1.26	2.5±1.3	2.26±0.25
		B	5.48±2.3	2.40±1.43	2.8±0.71
7	TDS(ppt)	S	2.46±0.52	1,75±0.94	1.55±0.43
		B	3.6±1.2	1.70±1.32	1.85±0.40
8	Salinity (‰)	S	9.1±4.75	7.94±5.91	3.56±1.47
		B	12.10±3.41	9.43±6.58	4.75±2.42
9	Dissolved Oxygen (ml/L)	S	4.2±1.08	5.31±1.42	5.12±0.8
		B	2.98±0.57	4.21±0.78	4.8±0.5
10	Nitrite -N(µg/L)	S	1.38±0.96	1.21±0.90	1.06±0.18
		B	1.46±1.14	1.36±1,08	0.95±0.04
11	Nitrate -N(µg/L)	S	4.86±4.69	7.54±3.61	4.75±2.58
		B	4.16±2.39	7.52±4.06	3.65±2.41
12	Phosphate (µg/L)	S	0.56±0.37	0.58±0.41	0.57±0.31
		B	0.49±0.32	0.68±0.51	0.75±0.62
13	Silicate(µg/L)	S	56.34±36.56	84.72±23.8	68.35±26.5
		B	52.16±38.66	85.41±21.3	62±32.5
14	Alkalinity(mg/L)		13.63±4.19	14.31±10.27	8.0±1.24
15	Chloride	S	194.1±16.4	58.5±2.9	147.05±14.8
		B	204.1±14.8	61.3±3.1	150.3±15.1
16	Carbonate	S	46.85±3.8	44.8±4.1	74.8±3.8
		B	50±2.9	46.3±5.3	72.8±4.2
17	Bicarbonate	S	13.8±2.8	10±2.9	25±4.1
		B	19.3±3.1	18.8±3.4	26.3±3.8

Table 4.Physico -chemical parameters recorded at the station 4 (C4) (Mean ± SD)

S.No	Parameters	Layer	Premonsoon	Monsoon	Postmonsoon
1	Atmospheric temperature		29.32±0.81	29.26±2.6	27.5±2.02
2	Water temperature	S	28.51±0.65	28.51±2.4	26.2±1.5
		B	27.5±0.32	28.43±2.1	25.63±1.68
3	Total depth (m)		2.42±0.38	2.38±0.45	2.34±0.43
4	Extinction coefficient(K)		2.14±0.36	1.85±0.16	2.31±0.28
5	pH	S	7.28±0.43	7.36±0.35	7.78±0.29
		B	7.32±0.38	7.35±0.41	7.79±0.3
6	EC(ds/m)	S	2.81±0.68	1.9±1.04	1.72±1.4
		B	3.32±0.67	4.3±1.14	7.85±4.34
7	TDS(ppt)	S	3.26±2.4	5.95±1.3	2.9±0.14
		B	8.04±5.6	3.95±3.4	4.42±2.08
8	Salinity (‰)	S	6.41±3.27	8.94±2.5	4.15±0.9
		B	8.76±2.64	9.5±3.7	4.55±0.36
9	Dissolved Oxygen (ml/L)	S	5.72±0.54	5.81±1.14	4.92±0.8
		B	4.23±0.81	4.09±0.68	4.85±0.35
10	Nitrite -N(µg/L)	S	1.94±1.54	0.58±0.1	1.36±0.41
		B	2.45±1.25	0.76±0.21	1.72±0.32
11	Nitrate -N(µg/L)	S	4.05±0.54	2.75±1.84	2.5±1.2
		B	3.04±1.6	3.35±1.86	2.45±1.33
12	Phosphate (µg/L)	S	0.45±0.14	0.58±0.21	0.41±0.12
		B	0.48±0.25	0.59±0.4	0.36±0.16
13	Silicate(µg/L)	S	58.04±2.91	78.14±24.4	77.68±29.23
		B	67.88±3.74	79±19.5	78.87±29.8
14	Alkalinity(mg/L)		15.29±7.28	12.05±7.78	12.04±3.46
15	Chloride	S	184.5±12.6	45.4±4.9	146.5±14.9
		B	190.9±13.5	50.6±5.1	140.4±16.4
16	Carbonate	S	52.3±3.8	40.8±2.9	78.3±8.2
		B	55.3±4.1	43.3±3.6	80.3±9.4
17	Bicarbonate	S	17.5±2.4	12±2.8	26.5±4.2
		B	17.5±2.4	17±3.1	27.5±3.9