Studies on The Physico-Chemical Status of Coleroon Coastal Waters, Southeast Coast of India

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Abstract- *In the present investigation an attempt was made to assess the nutrient dynamics and its sources in the estuarine and coastal regions of Coleroon coastal waters during April 2015 – March 2016. Six stations were fixed which covered a distance of about 10 km from the Coleroon mouth to the last station with 1.5km intervals. The study has incorporated the general hydrographic parameters like water temperature, salinity, dissolved oxygen, pH, turbidity and total suspended soiled. The nutrients parameters such as nitrate, nitrite, ammonia, total phosphate, inorganic phosphate and silicate were also recorded seasonally from the surveyed stations. The observed maximum, minimum, mean and standard deviation values of physico-chemical parameters are following; Water temperature 23.16 to 34.45, 29.06±2.72°C, Salinity 20.30 to 33.84, 26.60±1.28 PSU, pH 7.53 to 8.35, 7.89±0.06 pH, Dissolved Oxygen 3.18 to 5.65, 4.38±0.15 mg/l, Turbidity 3.18 to 8.32, 5.51±0.77 NTU and Total Suspended Solids 1.10 to 148.94, 94.54±30.49 PPM. The higher and lower values of nutrients parameters such as Nitrite 0.27 to 1.32, 0.75±0.07 µmol/l, Nitrate 3.16 to 5. 46, 4.32±0.10 µmol/l, total nitrogen 19.86 to 27.19, 24.71±0.53 µmol/l, ammonia 0.020 to 0.087, 0.049±0.007 µmol/l, Total phosphate 1.03 to 2.26, 1.49±0.02 µmol/l, Inorganic phosphate 0.20 to 1.24, 0.67±0.08 µmol/l, Silicate 30.17 to 71.79, 47.22±2.94 µmol/l and POC 33.00 and 128.50, 87.72±27.90 mgC/l. The water quality determines the diversity of flora and fauna of an area and therefore regular monitoring of physico-chemical parameters is essential to know the health of an aquatic ecosystem.*

Keywords- Physico-chemical, nutrient flux, seasonal variation, Coleroon coastal waters

I. INTRODUCTION

The hydrosphere, which covers more than 70 percent of the earth's crust, supports about 71% of the life on earth. Though coastal and estuarine waters constitute only a very small fraction of the hydrosphere, it accounts for about 25% of the aquatic productivity. Industrial effluents are the major sources of water pollutants and the disposal of these effluents without affecting the biota of the surrounding system has become a serious concern of the day. Major sources of nutrients to estuaries include precipitation, freshwater flow, salt marsh production and sediment pore waters during resuspension processes. However, in estuaries near densely populated regions the nutrient supply is augmented by domestic and industrial waste waters, urban drainage and agricultural effluents (Pereira-Filho *et al.*, 2001; Hauxwell and Valiela, 2004).

Estuaries are most productive sheltered ecosystems in the world (McLusky and Elliott, 2004) providing valuable resources for a multitude of human activities. Research on spatial-temporal variations of estuarine water quality has been conducted in many basins. Studies investigating the spatial and seasonal variability of water quality have reported that water quality issues such as eutrophication are highly dependent on land use patterns and influence from watershed runoff discharge (Caccia and Boyer, 2005; Zhang *et al.*, 2007). Studies undertaken in major cities of the world have demonstrated a significant relationship between urbanization and surface water quality (Wang *et al.*, 2008; Duh *et al.*, 2008). The importance of defining and implementing effective long-term management strategies in estuarine environments is worldwide recognized and therefore this study was conducted to determine the physico-chemical and nutrient dynamics of Coleroon coastal waters.

II. MATERIALS AND METHODS

Kollidam is formally referred to as “Coleroon” (in Colonial English), is a distributary of the river Cauvery and it mixes with the Bay of Bengal at Pazhayaru (lat. 11^0 21’N and long. 79^0 50’ E). In Coleroon estuary, the tidal influence is felt over a distance of about 15 km in the upstream. The depth of estuary near the mouth is about 5-7 m during high tide while in low tide nearly 4-5 m, which enables both mechanized and non-mechanized vessels enter the estuary and the Pazhayar landing centre. In the present study, six stations (C-1 to C-6) were fixed which covers a distance of about 10 km from the Coleroon mouth to the last station with 1.5km intervals (Fig. 1).

Sample collection and analysis

Water samples for the analysis of physical and nutrient parameters were collected seasonally from the above mentioned stations during low and high tide from April 2015 – March 2016. The surface water samples were collected using precleaned plastic buckets and were transferred to precleaned polyethylene bottle of 1 litter capacity and similarly the sub-surface (10m-20m) water samples were collected using a Niskin water sampler. The temperature of surface water and sub-surface water was measured using a standard centigrade mercury thermometer. Salinity was measured with the help of a digital portable Refractometer and the seawater pH was measured using ERMA pH meter. Dissolved oxygen was estimated by the modified Winkler's method Strickland and Parson, (1972) and expressed as mg/l. for the analysis of water nutrients, samples were collected in clean polyethylene bottles and kept in an ice box and transported immediately to the laboratory. The 500 ml of the sample water was filtered using Millipore filtering systems and analyzed for dissolved inorganic phosphate, nitrate, nitrite and reactive silicate by adopting the standard methods (Grasshoff *et al.,* 1999). Further the intensity of colour was measured in a spectrophotometer (LAMBDA-750) UV-VIS-NIR. The nutrient concentration was expressed in µmol/l.

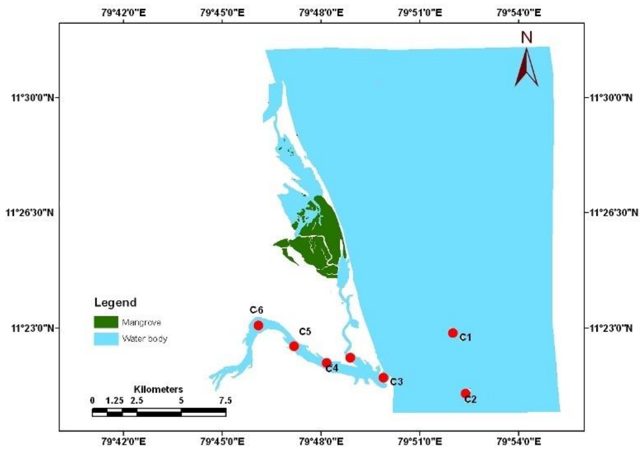

Figure 1: study area map

III. RESULT

The physcio-chemical characteristics are considered as one of the most important feature that is capable of influencing the marine environment. All the physico-chemical parameters showed clear seasonal patterns which are very typical to the tropical marine environment. Sea water temperature (surface and sub surface) ranged from 23.16 to 34.45°C with a mean value 29.06±2.72°C. The minimum water temperature was observed during monsoon season at station C5-HT-SS and the maximum was registered during summer season at station C3-HT (Fig. 2)

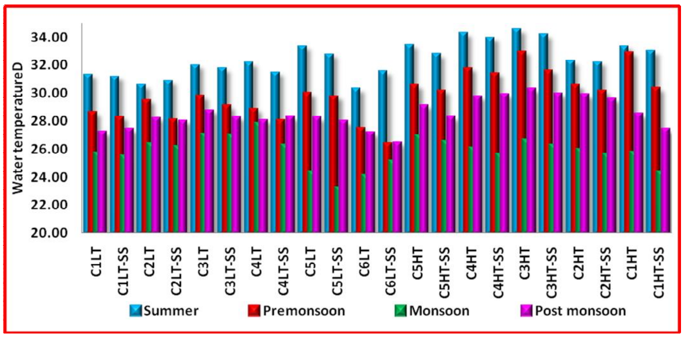

Figure 2: Seasonal variation of water temperature recorded in various stations of Coleroon estuary

Salinity values fluctuated between 20.30 and 33.84 PSU with a mean value 26.60±1.28 PSU. The salinity showed a regular trend of variation with tides. The lowest salinity was recorded during monsoon season and highest values were observed during summer season (Fig. 3). pH value ranged from 7.53 to 8.35pH with a mean value 7.89±0.06 pH. In general, higher pH value was recorded during summer season at station C4-HT-SS and a comparatively lesser value during monsoon at station C3-LT (Fig. 4).

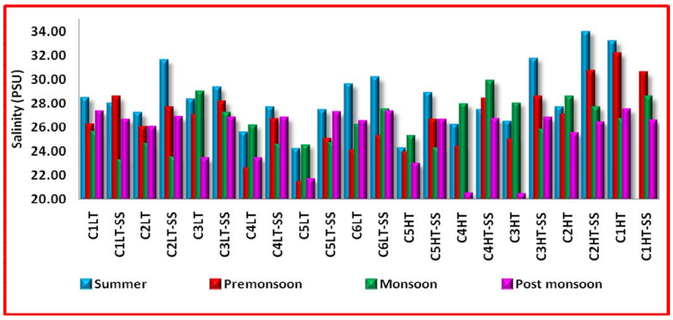

Figure 3: Seasonal variation of salinity recorded in various stations of Coleroon estuary

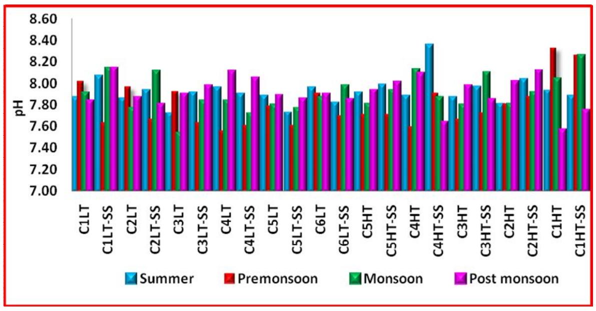

Figure 4: Seasonal variation of pH recorded in various stations of Coleroon estuary

The total amount of dissolved oxygen (DO) ranged from 3.18 to 5.65mg/l with a mean value 4.38±0.15 mg/l. The values of DO increased sharply during monsoon at station C3-HT-SS and decreased gradually during summer season at station C4-HT-SS (Fig. 5). The turbidity was minimum

3.18NTU during the summer season at station C3-LT and the maximum 8.32NTU was observed during monsoon season at station C2-HT-SS (Fig. 6). Seasonal variations of Total suspended solids (TSS) values ranged between 1.10 to 148.94ppm with a mean value 94.54±30.49 ppm. The highest value of TSS was recorded in station C4-HT-SS during monsoon season and lowest value was observed in station C5-LT during monsoon season (Fig. 7).

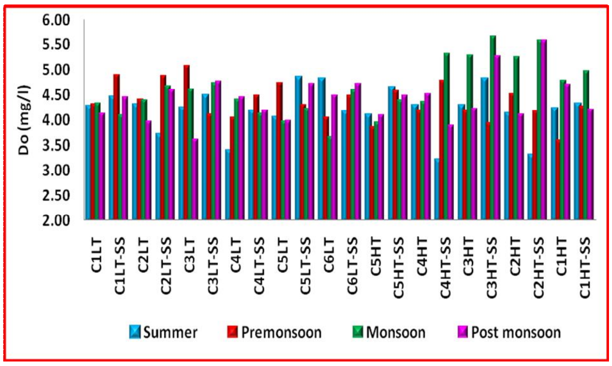

Figure 5: Seasonal variation of dissolved oxygen observed in various stations of Coleroon estuary

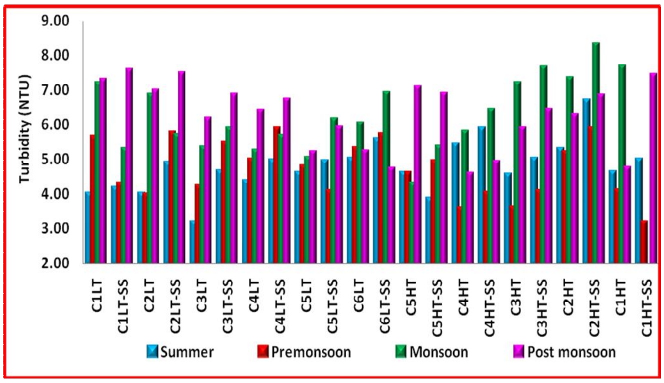

Figure 6: Seasonal variation of turbidity observed in various stations of Coleroon estuary

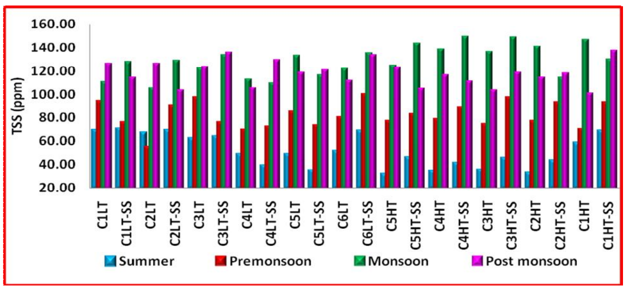

Figure 7: Seasonal variation of total suspend soiled observed in various stations of Coleroon estuary

Nutrients level in surface and sub surface water of Coleroon estuary

The Nitrite concentration ranged from 0.27 to 1.32µmol/l with a mean value of 0.75±0.07 µmol/l. The maximum value was recorded in monsoon season at station C2-LT-SS and the minimum value was recorded in pre monsoon season at station C6-HT-SS (Fig. 8). The minimum nitrate concentration 3.16µmol/l was observed at station C3-LT during summer season and the maximum value 5. 46µmol/l was recorded during monsoon season at station C6-HT-SS. The mean value of nitrate concentration was estimated as 4.32±0.10 µmol/l (Fig. 9).

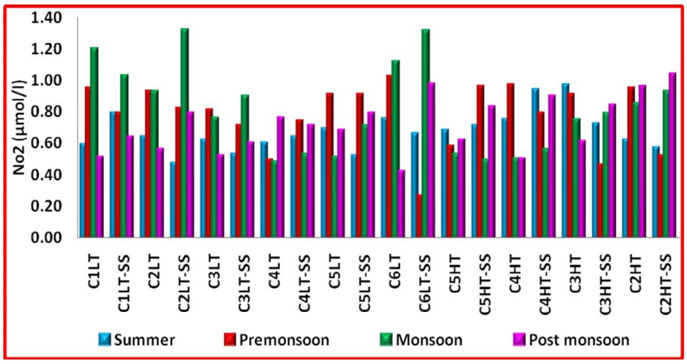

Figure 8: Seasonal variation of nitrite recorded in various stations of Coleroon estuary

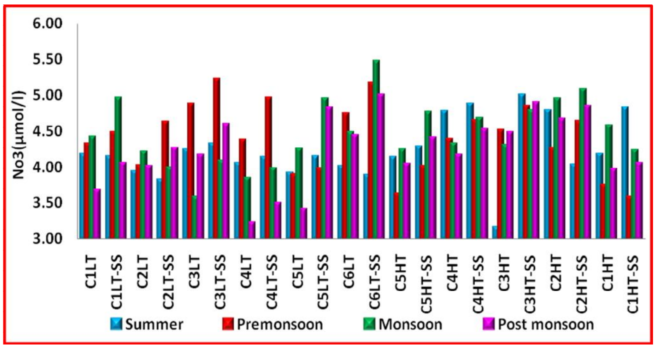

Figure 9: Seasonal variation of nitrate recorded in various stations of Coleroon estuary

The total nitrogen concentration ranged from 19.86 to 27.19µmol/l with a mean value 24.71±0.53 µmol/l. The highest value was observed in monsoon season at station C3-HT-SS whereas, the lowest value was observed in summer at station C3-LT (Fig. 10). Ammonia concentration in Coleroon estuary ranged from 0.020 to 0.087µmol/l, with a mean value 0.049±0.007 µmol/l. The higher concentration of ammonia was recorded in stationC4-HT and lower value was observed during summer at station C1-LT-SS (Fig. 11).

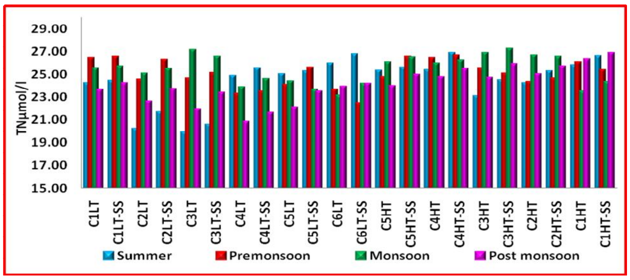

Figure 10: Seasonal variation of total nitrogen observed in various stations of Coleroon estuary

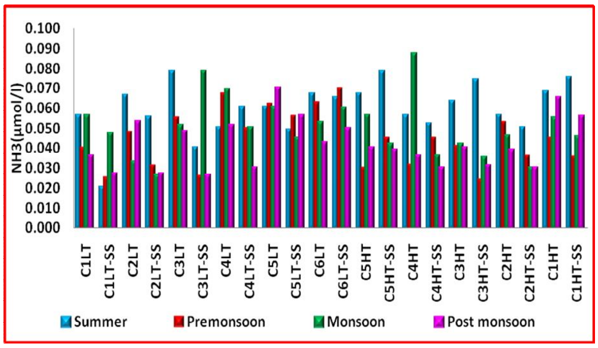

Figure 11: Seasonal variation of ammonia observed in various stations of Coleroon estuary

The concentration of total phosphate varied between 1.03 to 2.26µmol/l with a mean value 1.49±0.02 µmol/l. The minimum was rerecorded during summer season at station C3-LT and the maximum was recorded at station C4-HT-SS during monsoon season (Fig.12). The inorganic phosphate varied from 0.20 to 1.24µmol/l with a mean value 0.67±0.08 µmol/l. The maximum value was observed at C4-HT-SS during monsoon and minimum at C1-LT during pre-monsoon (Fig.13).

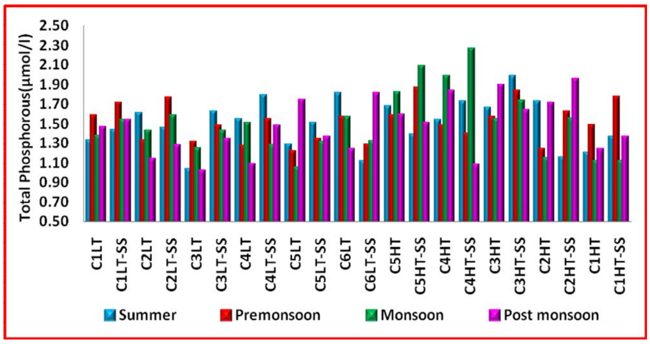

Figure 12: Seasonal variation of total phosphate recorded in various stations of Coleroon estuary

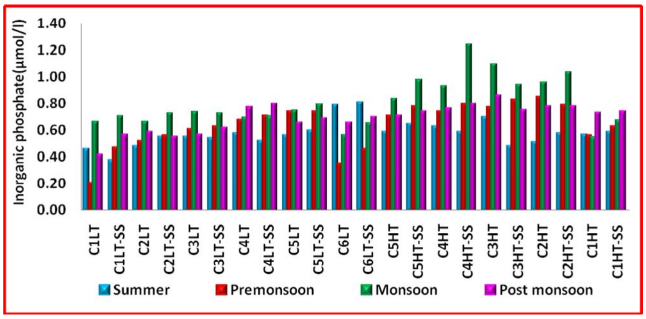

Figure 13: Seasonal variation of inorganic phosphate recorded in various stations of Coleroon estuary

The reactive silicate level ranged from 30.17 to 71.79µmol/l with a mean value of 47.22±2.94 µmol/l. The maximum value was observed at C5-LT-SS during monsoon and minimum at C2-HT during pre-monsoon (Fig. 14). The particulate organic carbon level ranged between 33.00 and 128.50mgC/l with a mean value 87.72±27.90mgC/l with minimum value (33.00mgC/l) atC5-LT-SS and the maximum at (128.50mgC/l) atC5-HT-SS (Fig.15).

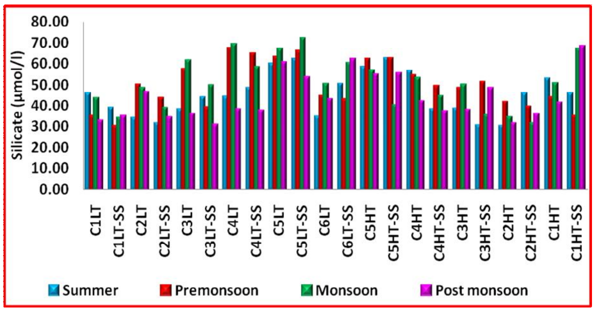

Figure 14: Seasonal variation of reactive silicate showed in various stations of Coleroon estuary

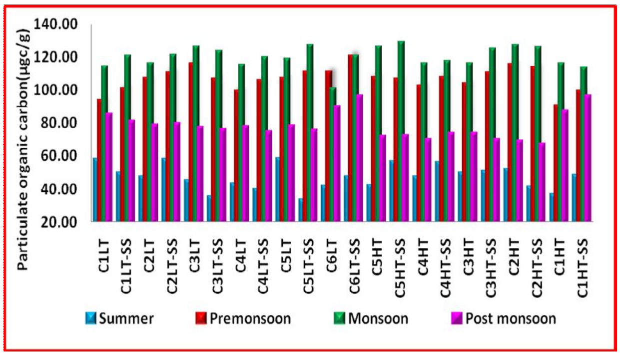

Figure 15: Seasonal variation f particulate organic carbon showed in various stations of Coleroon estuary

Co-relation of environmental variables

The Co-relation analysis of the hydrographical parameters was done to understand the inter-relationship between the water quality parameters of Coleroon estuary (Table 1). Among the parameters, the temperature was found to exhibit a positive correlation with TSS, DO and Inorganic Phosphate whereas, highly negative correlation with nitrite. The salinity showed positive correlation with pH, ammonia and negative correlation with DO, nitrite, nitrate, inorganic phosphate and total organic carbon. The nutrient parameters such as nitrite showed positive correlation with total nitrogen, total phosphorus and negative correlation with ammonia. Inorganic phosphate showed positive correlation with silicate. There is strong positive relationship of temperature and salinity with above parameters.

Table 1: Correlation matrix between the physico-chemical characteristics in different station of Coleroon estuarine complex

Parameters	Temp	Salinity	pH	TSS	Turbidity	DO	NO_2	NO_3	NH_3	TN	TP	IP	SiO_2	POC
Temp	1													
Salinity	0.968**	1												
pH	0.216	0.412	1											
TSS	-0.975**	-0.949**	-0.106	1										
Turbidity	-0.826**	-0.738**	0.298	0.912**	1									
DO	-0.814**	-0.764**	-0.410	0.666*	0.407	1								
NO_2	-0.765**	-0.769**	-0.603*	0.609*	0.284	0.975**	1							
NO_3	-0.481	-0.589	-0.897**	0.319	-0.091	0.761**	0.884**	1						
NH_3	0.546	0.724**	0.583	-0.614*	-0.412	-0.194	-0.313	-0.423	1					
TN	-0.523	-0.508	-0.583	0.323	0.000	0.914	0.941**	0.874**	-0.030	1				
TP	0.197	0.129	-0.674*	-0.396	-0.703**	0.360	0.479	0.715**	0.207	0.707**	1			
IP	-0.985**	-0.913**	-0.111	0.946**	0.827**	0.849**	0.770	0.434	-0.395	0.561	-0.182	1		
SiO_2	-0.524	-0.542	-0.684*	0.329	-0.026	0.895**	0.949**	0.931**	-0.137	0.991**	0.729**	0.539	1	
POC	-0.828**	-0.892**	-0.705**	0.721**	0.378	0.885**	0.946**	0.887**	-0.603	0.801**	0.332	0.780	0.844**	1

Correlation is significant at the 5% level ($P<0.05$)

Correlation is significant at the 1% level ($P<0.01$)

IV. DISCUSSION

The estuarine environments are subjected to various changes in physico-chemical properties due to continuous mixing of fresh water with marine water. The estimation of water quality is very important in determining the health of an ecosystem (Chang, 2008). The surface water temperature fluctuated seasonally and the higher surface water temperature was recorded during summer season, which might be due to the intensity of solar radiation, evaporation, freshwater influx and cooling and mix up with ebb and flow from adjoining neritic waters (Kumar *et al.*, 2006; Saravanakumar *et al.*, 2008). The lower value of surface water temperature recorded during monsoon season might be possibly due to strong land sea breeze and precipitation. Similar findings were recorded earlier by Ashok Prabu *et al.* (2008) and Rajkumar *et al.* (2009). It is vividly clear from the results that there were no significant variations in surface water temperature across stations.

In Coleroon estuary, higher concentrations of salinity were recorded mostly during summer periods which signify the role of tidal influence on the increased salinity and the minimum values recorded during monsoon is ascribed due to high freshwater inflow which leads to a decrease in salinity along the estuarine regions. Similar reports were observed earlier by several authors such as Senthilkumar *et al.* (2002); Balasubramanian and Kannan (2005); Sridhar *et al.* (2006); Asha and Diwakar (2007). The maximum pH was recorded during monsoon and the lower pH value was observed during monsoon season, the high pH values recorded during summer might be due to the influence of seawater penetration and high biological activity. The present findings are in agreement with that of Saravanakumar *et al.* (2008) and Murugesan *et al.* (2011). In the present study, higher dissolved oxygen concentration was recorded during monsoon, which might be due to the cumulative effect of higher wind velocity coupled with heavy rainfall and the resultant freshwater mixing. Similar trends were also observed earlier by Das *et al.* (1997) and Saravanakumar *et al.* (2007) and they attributed seasonal variation of dissolved oxygen mainly to freshwater influx and ferruginous impact of sediments.

The maximum turbidity was observed during monsoon season and minimum during postmonsoon at Coleroon estuary. The turbidity of the estuarine waters in the surface region was found within normal ranges indicating the existence of un-turbid and clear water whereas in the bottom waters the turbidity was high due to movement of underwater currents. This view point is supported by Dagaonkar and Saksena (1992) and Garg *et al.* (2006). The higher value of nitrite and ammonia was recorded during monsoon season and it might be due to variation in phytoplankton excretion, oxidation of ammonia and reduction of nitrate and by recycling of nitrogen and bacterial decomposition of planktonic detritus present in the environment (Asha and Diwakar, 2007) and also due to denitrification and air-sea interaction and exchange of chemicals (Rajasegar, 2003; Ashok Prabu *et al.*, 2008). The low nitrite value during summer season might be ascribed to high salinity (Saravanakumar *et al.*, 2008). The higher values of nitrate and total nitrogen content were observed during monsoon season indicating the source of river run-off along the estuary. Similar results were obtained by Prasannakumar *et al.* (2002) on eastern Arabian Sea and Senthilkumar *et al.* (2002); Santhanam and Perumal (2003) in Vellar estuary.

The high concentration of inorganic phosphate observed during monsoon season might be possibly due to intrusion of upwelling seawater into the creek that caused increased level of phosphate (Nair *et al.*, 1984). The low values observed during postmonsoon seasons due to decreased runoff (Ramakrishnan *et al.*, 1999). The silicate content was higher than the other nutrients (NO_3, NO_2 and PO_4), and reached the maximum value during monsoon due to heavy influx of freshwater derived from land drainage carrying silicate leached out from rocks and also from the bottom sediments (Mishra *et al.,* 1993). The low value recorded in postmonsoon and summer could be attributed to uptake of silicate by phytoplankton for their biological activity as reported by Mishra *et al.* (1993). High content of POC during the monsoon could be attributed to a lot of sewage discharge reaching to the study area by land run-off. Lower content of POC was recorded in during summer season, which may be due to continuous feeding of organic matter by the detrivorous organisms Raju *et al.* (1990).

The Co-relation analysis of the hydrographical parameters showed that the temperature exhibits a positive correlation with TSS, DO and Inorganic Phosphate whereas, highly negative correlation with nitrite. The salinity shows positive correlation with pH, ammonia and negative correlation with DO, nitrite, nitrate, inorganic phosphate and total organic carbon. Similarly nutrient parameters such as nitrite showed positive correlation with total nitrogen, total phosphorus and negative correlation with ammonia. Inorganic phosphate showed positive correlation with silicate. There is strong positive relationship of temperature and salinity with above parameters. This view point is in good agreement with earlier works that they have pointed out that these parameters are the most important factor in controlling the estuarine environments (Juggins, 1992; Hassan *et al.,* 2007).

V. CONCLUSION

Coleroon coastal water is subjected to seasonal fluctuations in physico-chemical parameters depending upon the seasonal amplitude and freshwater influx resulting in a continuous exchange of organic and inorganic matters. Analyzing the entire data set of the six Physico-chemical parameters and eight nutrients parameters, it could be concluded those seasons plays a major role in regulating these parameters. During the monsoon, owing to the companied effect of enhanced freshwater flow and high precipitation, DO showed higher values during monsoon season while the salinity level increased during summer season. The levels of nutrient parameters gradually decreased during summer season. In future, this data should be acquired throughout the year to have a clear idea with a more holistic approach.

VI. ACKNOWLEDGMENTS

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