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Studies on the physico-chemical characteristic and nutrients in the Kottakudi Estuary of Thirupulani, Ramanathapuram - District, South East Coast of India

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Abstract. The present study was carried out to determine the physico-chemical characteristics and nutrients in two stations in Kottakudi Estuary, Thirupulani, Ramanathapuram, Southeast coast of India during January to December 2009. Various parameters have been studied: surface water temperature, salinity, pH, dissolved oxygen, nitrate, nitrite, ammonia, phosphate, silicate. Concerning the salinity, the maximum value has been recorded in the station 2 when compared to station 1 and this is due to salt pane discharge and evaporation also. The minimum and maximum values of pH and dissolved oxygen (mg L^{-1}) were: 7.4-8.2 and 4.8-5.4, respectively. The nitrate, nitrite, phosphate, silicate and ammonia were found to be higher in the station 2 than in station 1. It has been observed from the present study that the higher values are observed in station 2 than station 1 may be due to the industrial effluents mixing up with estuary.
Key words: Kottakudi estuary, water quality, ammonia, nitrite, nitrate, phosphate, Ramanathapuram.

Introduction. The availability of good quality water is an indispensable feature for preventing diseases and improving quality of life (Oluduro & Aderiye 2007). Estuarine and coastal areas are complex and dynamic aquatic environment (Morris et al 1995). When river water mixes with seawater, a large number of physical and chemical processes take place, which may influence the water quality. The quality of surface water is a very sensitive issue. The rapid industrialization and aquaculture practices along the estuarine system and the coastal areas have brought considerable decline in the water quality of brackish water and the estuaries. Coastal zones and estuaries are important ecological systems and resource for variety of uses. The total life of the world depends on water and hence the hydrological study is very much essential to understand the relationship between its different trophic levels and food webs. The environmental conditions such as topography, water movement and stratification, salinity, oxygen, temperature and nutrients characterizing particular water mass also determine the composition of its biota (Karande 1991). Usually in the near shore waters and estuaries, they exhibit considerable seasonal variations depending on the local conditions of rainfall, tidal incursions, various abiotic and biotic processes, quantum of fresh water inflow affecting the nutrient cycle of different coastal environments (Choudhury & Panigrahy 1991). The present investigation was carried out to study the seasonal effects on the

physico-chemical parameters as well as nutrients at two stations from Kottakudi estuary, southeast coast of India.

Materials and Methods. The present study was carried out in Kottakudi estuary (near to Koraikulam village) which is situated on the Ramnad DT, southeast coast of India (Fig. 1). It has a year round connection with the open sea. Station 1 is near to the mouth of Kottakudi estuary (Latitude 9°15'05.81"North and Longitude 78°49'50.43"East) and the average depth of the station is about 2m (Fig. 2). Station 2 is situated near Bridge (Latitude 9°16'11.38"North and Longitude 78°49'40.52"East) and about 1.5 km from the mouth of Kottakudi estuary. The average depth of the station is about 1.5m (Fig. 3).

Figure 1. View of Kottakudi estuary (source: www.earthgoogle.com).

Figure 2. Station 1 (source: www.earthgoogle.com).

Station 2 (near the bridge)

Figure 3. Station 2 (source: www.earthgoogle.com).

Surface water samples were collected at monthly intervals from Kottakudi estuary station 1 and station 2 for a period of one year from January to December 2009 for the estimation of various physico-chemical parameters: surface water temperature, salinity, pH, dissolved oxygen, nitrate, nitrite, ammonia, phosphate, silicate. Temperature was measured using a standard centigrade thermometer and pH was measured using Elico pH meter (Model LC-120). Salinity was estimated with the help of a refractometer (Atago, Japan) and dissolved oxygen was estimated by the modified Winkler's method (Strickland & Parsons 1972) and is expressed as mg L^{-1}. The ammonia and the nutrients of the water samples were estimated by adopting standard procedure as described by Strickland & Parson (1972).

Results. During study period the maximum water temperature (32^{o}C) has been recorded in the month of June and minimum (25^{o}C) in the month of December at both the stations.

The salinity in the station 1 was minimum (24 ppt) during the month of December and maximum (37 ppt) during the month of July. The salinity in the station 2 has varied from 22 to 42 ppt. Minimum was recorded during the month of December and the maximum during the month of July.

The pH of the water varied from 7.5 to 8.1 in station 1 and 7.4 to 8.2 in station 2. Minimum pH value has been recorded in the month of December and maximum in the month of July at both the stations.

Dissolved oxygen concentration has varied from 4.8 to 5.4 mg L^{-1} respectively. The minimum value has been recorded during July in station 1 and the maximum values during March at station 2.

The nitrite in the station 1 was minimum in the month of January (1.4 µM) and maximum in the month of December (11.2 µM). The nitrite concentration has varied from 1.2 to 11.2 µM at station 2. Minimum has been recorded during the month of July and the maximum during the month of December.

The highest nitrate value (26 µM) has been recorded in the month of February at station 1. In the month of March maximum value (27 µM) has been recorded in station 2.

Silicate values have ranged from 10 to 51 µM at station 1. The maximum value has been recorded in the month of November and the minimum in the month of February. In station 2 maximum (41 µM) has recorded in the month of December and the minimum (8 µM) has been recorded in the month of February.

The phosphate value was minimum (2.2 µM) in the month of February and maximum (8.6 µM) in the month of December at station 1. The phosphate in the station 2 was maximum (5.9 µM) in the month of December and minimum (1.4 µM) in the month of February.

The total ammonia was minimum (0.01 µM) in the month of April to October and maximum (1.5 µM) in the month of January at station 1. The ammonia in the station 2 was minimum (0.2 µM) in the month of November and maximum (1.8 µM) in the months of May and June.

All the above results are also presented in Tables 1 and 2.

Table 1

Physico-chemical parameters of the station 1 of Kottakudi estuary during January to December, 2009

Station 1	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*June*	*July*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
Surface water temp. (^oC)	27	27	28	30	30	32	31	30	30	28	26	25
Salinity (ppt)	25	27	25	25	27	34	37	33	33	36	27	24
pH	7.6	7.6	7.8	7.8	7.6	7.8	8.1	8.0	8.0	7.7	7.6	7.5
Dissolved oxygen (mg L^{-1})	5.2	5.0	5.4	5.2	5.1	5.0	4.8	5.1	5.0	5.3	5	5.2
Nitrate (µM)	23	26	22	20	15	18	22	20	14	18	21	24
Nitrite (µM)	7	2.6	5	5.2	9	1.4	5.8	8.5	4	6.8	14	11.2
Ammonia (µM)	1.5	0.8	0.6	0.1	0.1	0.1	0.1	0	0.1	0.1	0.2	0.3
Phosphate (µM)	3	2.2	5.6	4	7.4	7.2	4.9	5.8	3.8	7.5	8	8.6
Silicate (µM)	15	10	17	22	35	30	38	21	42	40	51	47

Table 2

Physico-chemical parameters of the station 2 of Kottakudi estuary during January to December, 2009

Station 2	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*June*	*July*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
Surface water temp. (^oC)	27	27	28	30	30	32	31	30	30	28	26	25
Salinity (ppt)	23	25	27	25	30	37	42	31	32	40	23	22
pH	7.5	7.5	7.6	7.6	7.7	7.9	8.2	8.0	8.0	8.1	7.7	7.4
Dissolved oxygen (mg L^{-1})	5.3	5	5.4	5.2	5.2	4	3.5	5	5	3.2	5.3	5.2
Nitrate (µM)	20	24	27	23	17	13	18	14	16	12	13	16
Nitrite (µM)	3.8	3	4.5	6	6	5	1.2	5.7	4	5.1	8.7	11.2
Ammonia (µM)	1	1.3	1.5	1	1.8	1.8	2	1.5	1.2	1	0.2	0.3
Phosphate (µM)	2	1.4	3	3.5	4	3.7	5	3.2	2.7	1.8	5.6	5.9
Silicate (µM)	19	8	15	15	27	24	27	12	28	28	37	41

Discussion. Temperature variation is an important factor in the coastal and estuarine ecosystems, which influences the physico-chemical characters of coastal and estuarine waters to a greater extend triggering the breeding and spawning of marine fishes. The maximum temperature was recorded during the summer season (March to September) and minimum was recorded during monsoon (October to February) and this situation could be ascribed to the effect of atmospheric cooling. In the present study due to high solar radiation the temperature was recorded maximum during the month of June and minimum temperature was recorded due to strong land sea breeze and precipitation in the month of December. Similar conclusion has also been drawn by Rajasegar (2003) and Sundaramanickam et al (2008).

Salinity is considered to be the prime factor among the environmental variables influencing the dynamic nature of the estuarine and coastal waters by the freshwater inflow and the prevailing temperature. The salinity was found to be high during summer season (July) and low during the monsoon season (December) at both the stations; in the present study higher values recorded could be attributed to the low amount of

rainfall, higher rate of evaporation and also due to neritic water dominance (Balasubramanian & Kannan 2005; Asha & Diwakar 2007). During the monsoon season, the rainfall and the freshwater inflow from the land moderately reduced the salinity.

The hydrogen-ion concentration (pH) gets changed with time due to the changes in temperature, salinity and biological activity. Hydrogen ion concentration (pH) in surface waters remained alkaline throughout the study period at both stations with maximum value during (July) summer season and the minimum during (December) monsoon. Generally, its seasonal variation is attributed to factors like removal of CO_2 by photosynthesis through bicarbonate degradation, dilution of seawater by freshwater influx, low primary productivity, reduction of salinity and temperature, and decomposition of organic matter (Paramasivam & Kannan 2005; Bragadeeswaran et al 2007). The high summer pH might be due to the influence of seawater penetration and high biological activity (Govindasamy et al 2000) and due to the occurrence of high photosynthetic activity (Sridhar et al 2006; Saravanakumar et al 2008). The pH was also quite low during floods in the peak monsoon season due to the influence of freshwater influx, dilution of saline water, reduction of salinity and temperature and decomposition of organic matter (Zingde et al 1985).

Dissolved oxygen concentration varies according to many factors; the main factors are due to photosynthesis and respiration by plants and animals in water. It is well known that the temperature and salinity affect the dissolution of oxygen (Saravanakumar et al 2008). In the present investigation, higher values of dissolved oxygen were recorded during monsoon season which might be due to the cumulative effect of higher wind velocity coupled with heavy rainfall and the resultant freshwater mixing (Govindasamy et al 2000; Rajasegar 2003; Saravanakumar et al 2008). Paramasivam & Kannan (2005) attributed that seasonal variation of dissolved oxygen is mainly due to freshwater flow and terrigenous impact of sediments.

Nitrate is a form of nitrogen and a vital nutrient for growth, reproduction, and the survival of organisms. High nitrate levels (>1 mg L^{-1}) are not good for aquatic life. In present study the high level of nitrate observed during this study is in agreement with Wolfhard & Reinhard (1998), who concluded that nitrates are usually built up during dry seasons and that high levels of nitrates are only observed during early rainy seasons. This is because initial rains flush out deposited nitrate from near-surface soils and nitrate level reduces drastically as rainy season progresses.

Nitrite content was also found to be higher during the months of October to December for both stations and which could be attributed due to the influence of seasonal floods. The higher concentration of nitrite and seasonal variation could be attributed due to the variation in phytoplankton, excretion and oxidation of ammonia and reduction of nitrite (Kannan & Kannan 1996). The low content of nitrites during the months of July was due to less freshwater input, higher salinity, higher pH and also uptake by phytoplankton. The same was recorded by Sivakumar (1982) from Vellar estuary and by Edwards & Ayyakannu (1991) from Kolhdarn estuary.

In our study high monsoonal phosphate value might be due to the regeneration and release of total phosphorus from bottom mud into the water column by turbulence and mixing (Saravanakumar et al 2008). Moreover, the bulk of weathering's of rocks soluble alkali metal phosphates (in the upstream area) are carried into the estuaries (Govindasamy et al 2000). The post-monsoonal low value could be attributed to the limited flow of freshwater, high salinity and utilization of phosphate by phytoplankton (Rajasegar 2003). The variation may also be due to the processes like adsorption and desorption of phosphates and buffering action of sediment under varying environmental conditions (Rajasegar 2003).

Silicate content was higher than that of the other nutrients recorded in this study. The high monsoon values could be due to large influx of freshwater derived from land drainage carrying silicate leached out from rocks and also from the bottom sediment (Govindasamy et al 2000; Rajasegar 2003). The low values recorded in the summer could be attributed to uptake of silicates by phytoplankton for their biological activity (Saravanakumar et al 2008).

In the present investigation, ammonia was found to be high in station 2 and this may be partly due to the death and subsequent decomposition of phytoplankton and also might be the excretion of ammonia by planktonic organisms (Segar & Hariharan 1989; Ananthan 1994; Rajasegar 1998).

Conclusions. The importance of the studied esturaine system, physico-chemical parameters and nutrients results exhibit distinct variations in the station 1 and station 2. It has been observed that the higher values were recorded in station 2 than station 1. In addition to that, pollution of H_2S from both agricultural and industrial inputs mixing up with estuary. The physico-chemical and nutrient status of the waters of the Kottakudi estuary, using this methodology, is good in general.

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