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Studies on the Physico-chemical Characteristic and Nutrients in the Uppanar Estuary of Cuddalore, South East Coast of India

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Abstract: The Uppanar estuary runs behind the SIPCOT complex which is located at Cuddalore. As the estuary receives the treated and partially treated effluents from nearly 55 industries and it is said to be highly polluted. The present study was carried out to find out the changes of physicochemical parameters in two stations in Uppanar estuary. Among the various parameters, temperature was high in station-II, it was low in station-I. This may be due to the effluents discharged from SIPCOT complex in station II. The pH showed greater variation from 6.2 to 7.9 in both the stations due to irregular treatment of the effluents reloaded into the estuary. The dissolved oxygen concentrations found to be lower and salinity was higher in lower reaches. The total dissolved solids, calcium, total phosphorus content, nitrite and ammonia was found to be higher in the station-II than in station I.

Key words: Uppanar estuary, SIPCOT, Ammonia, nitrite, salinity, dissolved oxygen and pH and effluents

INTRODUCTION

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 determining 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 and Panigraphy, 1991). In the present study the Uppanar estuary has been chosen since the effluents from the SIPCOT industrial complex, Cuddalore is directly released into the estuary. Hence, the present study was designed to investigate the changes of physico-chemical parameters and nutrients in the Uppanar estuary.

MATERIALS AND METHODS

The Uppanar estuary is situated at Cuddalore (Lat. 11˚ 43'N, Long. 79˚ 46' E). This river flows between Cuddalore in Chidambaram Talks and joins with the Bay of Bengal by the mouth of Gadilam river. It is a tributary of Gadilam river which originates from the foot hills of north-east part of the Shevaroy hills and runs along for a distance of 95 km and joins the adjoining Paravanar estuary forming Uppanar – Paravanar estuarine complex. It runs behind the SIPCOT (State Industrial promotion Corporation of Taminadu Limited) industrial complex which consists of many chemical and Pharmaceutical industries. The effluents of these industries are released untreated. In addition to the industrial wastes, the estuary receives also the municipal wastes and domestic sewage from Cuddalore old town and also waste from coconut husk retting. The Uppanar estuary is an open type of estuary which has semidiurnal tides with the tidal effects extending up to a distance of about 1m. The mean tidal level in this estuary is about 90 cm and the maximum level is about 120 cm. The average depth of Uppanar estuary is about 3.5 m near the mouth and 2.5 m towards the upstream. The Uppanar estuary forms a potential fishing ground with annual average landing of about 2,000 t. The raw and partially treated effluents from SIPCOT immediately enter in to the estuary, so the water at lower reaches are polluted more when compared to the upper reaches. In the present investigation two stations were selected in the Uuppanar estuary for the physico-chemical studies and were compared each other.

The various physico-chemical parameters of the water in upper reaches (Station-I) and lower reaches (Station-II) were observed during the monthly interval time for 6 months (January to June 2007). The temperature of the water in both places was recorded using a standard mercury centigrade thermometer. The pH of water has been recorded in the field itself using an Elico pH meter (model-LI-120). Salinity was estimated with the help of refrectometer model E-2. Total dissolved solids were estimated by evaporate the samples upto dryness (Course Manual NEERI, 1979) by using an evaporating dish in suitable size and weight. On a water bath, a filtered sample was taken in the evaporating dish was noted after cooling in dessicator. The TDS was calculated and expressed in mg/1. Dissolved oxygen was

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Table 1: Physico-chemical parameters of the upper reaches of Uppanar estuary during January to June, 2007.

Months / Parameters	January	February	March	April	May	June
Temperature (ºC)	30.2	32.4	33.2	34.2	36.0	36.6
pH	7.4	7.2	7.4	7.6	7.9	7.6
Dissolved oxygen(mg/l)	5.2	4.3	5.3	4.8	4.2	4.4
Salinity (ppt)	12.3	15.0	12.8	15.2	15.0	16.2
Total dissolved solids (mg/l)	350	450	450	500	500	450
Calcium (mg/l)	40.2	41.4	40.3	42.2	42.4	43.0
Total phosphorus (ppm)	1.96	1.92	1.00	1.02	0.98	0.92
Nitrite (ppm)	0.98	0.96	0.92	0.72	0.63	0.80
Ammonia (ppm)	0.23	0.13	0.16	0.12	0.10	0.08

Table 2. Physico-chemical parameters of the lower reaches of Uppanar estuary during January to June, 2007.

Months / Parameters	January	February	March	April	May	June
Temperature (˚C)	36.2	36.0	35.6	37.2	38.6	39.2
pH 6.2 6.0	7.0	6.3	7.6	7.9		
Dissolved oxygen(mg/l)	5.0	4.5	5.0	4.6	4.1	4.4
Salinity (ppt)	26.2	27.6	26.8	28.2	26.9	28.3
Total dissolved solids (mg/l)	850	850	900	900	950	900
Calcium (mg/l)	95.0	95.4	96.4	96.8	94.2	97.4
Total phosphorus (ppm)	1.72	1.86	1.93	1.84	1.92	1.72
Nitrite (ppm)	2.03	2.01	2.06	1.86	1.73	1.88
Ammonia (ppm)	0.32	0.26	0.32	0.16	0.12	0.18

estimated by modified Winkler's method (Strickland and Parsons, 1972). Calcium was estimated directly by employing EDTA titrimetric method using murixidei and erichrome black-T as indicators. Nutrients like, total phosphorus, nitrite, ammonia were estimated by adopting the methods described by Strickland and Parsons (1972).

RESULTS

Temperature: The temperature in the upper reaches was varied from 30.2 to 36.6ºC. Minimum was recorded during January and maximum during the month of June. It varied in lower reaches from 35.6 to 39.2º C. Minimum was recorded during March and maximum during the month of June (Table 1 and 2).

pH: pH at upper reaches varied from 7.2 to 7.9. Minimum was recorded during the month of February and maximum during the month of May. At lower reaches, pH varied from 6.0 to 7.9. Minimum was recorded during the month of February and maximum during the month of June (Table 1 and 2).

Dissolved oxygen: Dissolved oxygen in upper reaches was varied from 4.2-to 5.3 mg/l. Minimum was recorded during the month of May and maximum during the month of March. In lower reaches, it varied from 4.1 to 5.0 mg/l. Minimum was recorded during the month of May and the maximum during the month of March (Table 1 and 2).

Salinity: The salinity in the upper reaches was minimum (12.3 ppt) during the month of January and maximum (16.2 ppt) during the month of June. The salinity in the lower reaches was varied from 26.2 to 28.3. Minimum was recorded during the month of January and the maximum during the month of June (Table 1 and 2).

Total dissolved solids: The total dissolved solids in the upper reaches were varied from 350 to 500 mg/1. Minimum was recorded during the month of January and maximum during the months of April and May. The total dissolved solids in the lower reaches were varied from 850 to 950 mg/1. Minimum was recorded during the months of January and February and the maximum during the month of May (Table 1 and 2).

Calcium: The calcium in the upper reaches was varied 40.2 to 43.0 mg/1. Minimum was recorded during the months of January and the maximum during the month of June. The calcium in the lower reaches was varied from 94.2 to 97.4 mg/1. Minimum was recorded during the month of May and the maximum during the month of June (Table 1 and 2).

Total phosphorus: The total phosphorus in the upper reaches was minimum (1.00 ppm) in the month of March and maximum (1.96 ppm) in the month of January. The total phosphorus in the lower reaches was Minimum (1.72 ppm) in the months of January and June and maximum (1.93 ppm) in the month of March (Table 1 and 2).

Nitrite: The nitrite in the upper reaches was varied from 0.63 to 0.98 ppm. Minimum was recorded during the month of May and the maximum during the month of January. The nitrite in lower reaches was minimum in the month of April (1.73 ppm) and maximum in the month of March (2.06 ppm) (Table 1 and 2).

Ammonia: The total ammonia in the upper reaches was minimum (0.08 ppm) in the month of June and maximum (0.23 ppm) in the month of January. The ammonia in the lower reaches was minimum (0.12 ppm) in the month of May and maximum (0.32 ppm) in the months of January and March (Table 1 and 2).

DISCUSSION

The temperature variation is one of the factors in the coastal and estuarine system, which may influence the physico – chemical characteristics and also influence the

distribution and abundance of flora and fauna. In the present study, it has been observed that high temperature was noticed in the months of April to June at station-I and station- II in the Uppanar estuary. Lower temperature in the months of January to March was due to cloudy sky and rainfall brought down the temperature to the minimum (Kannan and Kannan, 1996). Similar observations have been reported by Thangaraj (1985), Gothandaraman (1993) and Seenivasan (1998) from Vellar estuary. Mani (1989), Vasantha (1989), Kaliyaperumal (1992) and Karuppusamy (1997) from Pichavaram mangroves water. Saraswati (1993) from Arasalar and Kaveri estuarine complex and Kannan and Kannan (1996) from Palk Bay.

Ananthan (1994) has stated that the higher value of pH during summer was due to the uptake of CO_2 by photosynthesizing organisms. The low pH observed during the months of January to March may be due to the influence of fresh water influx, dilution of sea water, low temperature and organic matter decomposition as suggested by Ganesan (1992). Similar trend in pH was reported by Thangaraj (1985), Hemalatha (1996) and Seenivasan (1998) from the Veller estuarine system. Mathevan Pillai (1994) from Cuddalore Uppanar waters and Ananthan (1994) from Pondicherry coastal water. In the present study, it has been observed in lower reaches (station-II) that the pH showed grater variation due to irregular treatment of the industrial effluents and subsequently released into the estuary.

Dissolved oxygen concentration varies according to many factors; the main factors are due to photosynthesis and respiration by plants and animals in water. It has been observed from the present study that the amounts of dissolved oxygen content during different months (January to June, 2007) have shown minimum quantity in lower reaches when compared to upper reaches. This is because of the oxygen is consumed more by the aquatic animals due to effluents stress.

Salinity is one of the important factors which profoundly influence the abundance and distribution of the animals in estuarine environment. In the present study, the lower salinity was recorded during the months of January to March was due to heavy rainfall and large quantity of freshwater inflow. Similar trend in the salinity values were also observed from Vellar estuary (Hemalatha, 1996; Seenivasan, 1998), Pichavaram mangrove water (Mani, 1989; Kaliyaperumal, 1992), Cuddalore Uppanar water (Mathevan Pillai, 1994), Pondicherry coast (Ananthan, 1994), Palk Bay (Kannan and Kannan, 1996) and coastal waters of Kalpakkam (Satpathy, 1996). In the present study, the salinity was higher in the months of April to June due to low rainfall, decreased fresh water inflow, land drainage and rise in temperature. In lower reaches, it has been observed that the salinity range was not usual because of the effluents release.

In the present study, the total dissolved solids are comparatively more during the months of April to June in lower reaches. It is due to the industrial waste, animal waste, agricultural waste etc., and also caused by evaporation and less rainfall. Verma *et al.* (1978) have observed that the large amount of dissolved solids may result in high osmotic pressure. The high amount of solids recorded in Station-II, could be attributed due to the effluent discharge as evidenced by Ushamary *et al*. (1998) in the Paravanar river.

In the present study, the accumulation of calcium content was more in lower reaches. This may be due to more calcium contents in effluents discharged in that area. The calcium content was high in Arabian Sea and Mandovi and Zuari estuaries (Sen Gupta and Sugandhini, 1981), west coast of India (Sugandhini *et al*., 1982) and Vellar estuary (Palanichamy and Balasubramanian, 1989).

Total phosphorus content was found to be high during the months of April to June in lower reaches than upper reaches. This may be due the impact of industrial effluents. Similar conditions were observed by Sundararaj and Krishnamurthy (1975) from Pitchavaram waters and Rajasegar (1998) from Vellar estuary.

Nitrite content was also found to be higher during the months of January to May in the lower reaches than the upper reaches 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 and Kannan, 1996). The low contents of nitrites during the months of April to May was due to less freshwater input, higher salinity, higher pH and also uptake by phytoplankton. The same was recorded by Chandran (1982), Sivakumar (1992) and Shekar (1987) from Vellar estuary; Patterson Edwards and Ayyakannu (1991) from Kolhdarn estuary and Mathevan Pillai (1994) from Cuddalore Uppanar estuary. Kannan and Kannan (1996) from Palk Bay from Uppanar estuary and Satpthy (1996) from coastal water of Kalpakkam.

In the present investigation, ammonia was found to be high in lower reaches 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 and Hariharan, 1989; Ananthan, 1994; Rajasekar, 1998). It has been observed from the present study that the high content was found in lower reaches which may be due to the industrial effluents mixing up with estuary.

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