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BASELINE ECOLOGY OF EDAIYUR – SADRAS ESTUARINE SYSTEM AT KALPAKKAM PART I — GENERAL HYDROGRAPHIC AND CHEMICAL FEATURE

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ABSTRACT

Hydrographic and ecological investigations in Edaiyur and Sadras backwaters and coastal waters showed that the surface temperature data from the water bodies were characterised by maxima in April and October and minima in January and July. From the seasonal salinity variations Sadras could be considered as a 'positive' estuary throughout the year and Edaiyur as 'positive' from August to March and 'negative' from April to July. Distribution of seston was characterised by maxima in July (35.5 mg/l) and April (42.9 mg/l) in Sadras and in July (58.3 mg/l) and November (33.7 mg/l) in coastal waters. Secchi disc depth data showed a water transparency maximum in Sadras in December, Edaiyur in October and two maxima in March and October in coastal waters. Silicates were higher in backwaters than in coastal waters. Northeast monsoon plays a significant role in the regulation of ecological conditions in these water bodies. Phosphates and silicates increased in coastal waters following the opening of bar mouths during the northeast monsoon, the backwaters thus serving as a reservoir of nutrients for the coastal waters.

Key-words : Ecology, estuary, Kalpakkam.

INTRODUCTION

Aquatic ecological surveys around electricity generation systems have assumed increasing significance in recent years, particularly with the advent of large nuclear and thermal power stations. Such surveys during varying stages of construction and operation of power stations are insisted upon by regulatory agencies in countries like U.S.A. Although, at present no such regulations exist in India, it was felt that a survey of the baseline ecology is an essential pre-requisite for an assessment of environmental impact of coolant waters.

A nuclear power station consisting of two units of 235 MW(e) each is under construction at Kalpakkam, 60 km south of Madras (Madras Atomic Power Project) on the east coast of India. It is envisaged that the power station (MAPP) will use the adjacent coastal waters as a heat sink and as a receptacle of low level liquid radioactive wastes. The principal water bodies (Fig. 1) around the power station consists of (1) coastal waters of Bay of Bengal to the east (2) Edaiyur and Sadras backwaters situated to the north and south of the reactor respectively and (3) Palar river entering the sea about 5 km south of Sadras bar. The backwaters get connected to the sea

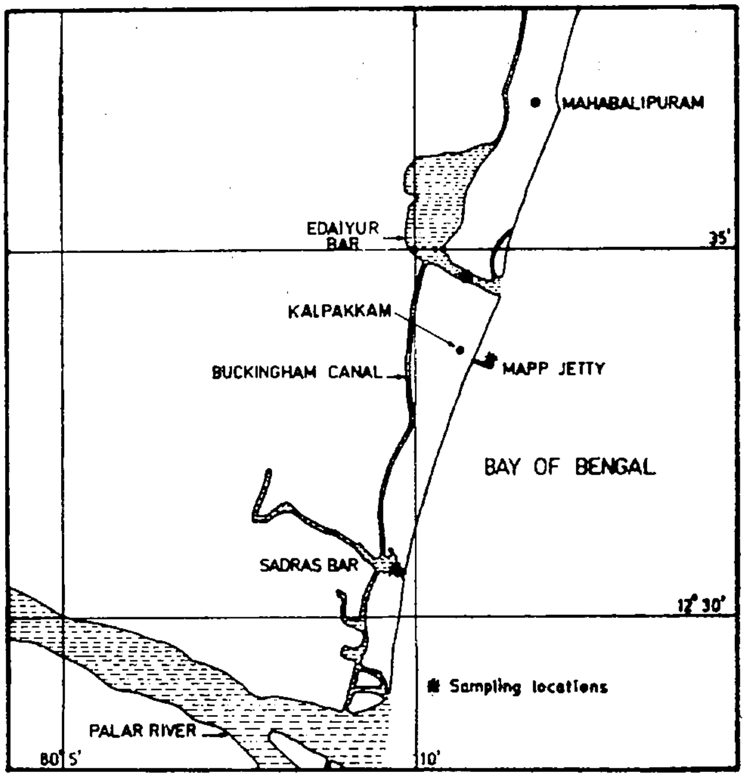

Fig. 1. Principal water bodies at Kalpakkam.

during the period of heavy rainfall (October to January) at Kalpakkam. The Palar river remains dry almost throughout the year and significant discharges into the sea occur only during a spell of heavy rainfall.

Hydrographic and ecological investigations were initiated in the three water bodies in 1980. The present paper reports results on hydrographic and chemical features.

MATERIALS AND METHODS

Surface water samples were collected at weekly intervals from the two bars and the jetty. The sampling locations are given in Fig. 1. The samples were analysed for salinity and dissolved oxygen besides temperature measurements. In addition, PO_4-P, total P, SiO_4Si and seston were determined fortnightly. All measurements of chemical parameters except PO_4-P and total P were carried out following Strickland and Parsons (1974). Total P and PO_4-P were estimated following Lange (1969).

RESULTS AND DISCUSSION

From a close study of the rainfall pattern and associated changes in hydrographic characteristics in this area, it was decided, for convenience of presentation of data, to divide the whole year into 3 seasons: (i) NE monsoon season (October – January) (ii) SW monsoon season (July – September) and (iii) Summer (February – June).

Edaiyur backwater

The data on temperature and salinity along with rainfall over a period of 1½ years (1980-81) are given in Fig. 2.

The seasonal surface temperature data were characterised by two maxima, one in April–May (33.5 °C) and the other in September–October (33.0 °C) and two minima, one in July (26.5 °C) and the other in January (26.0 °C) respectively.

The seasonal average values of dissolved oxygen, seston, secchi disc depths and nutrients are given in Table I. From the seasonal salinity varia-

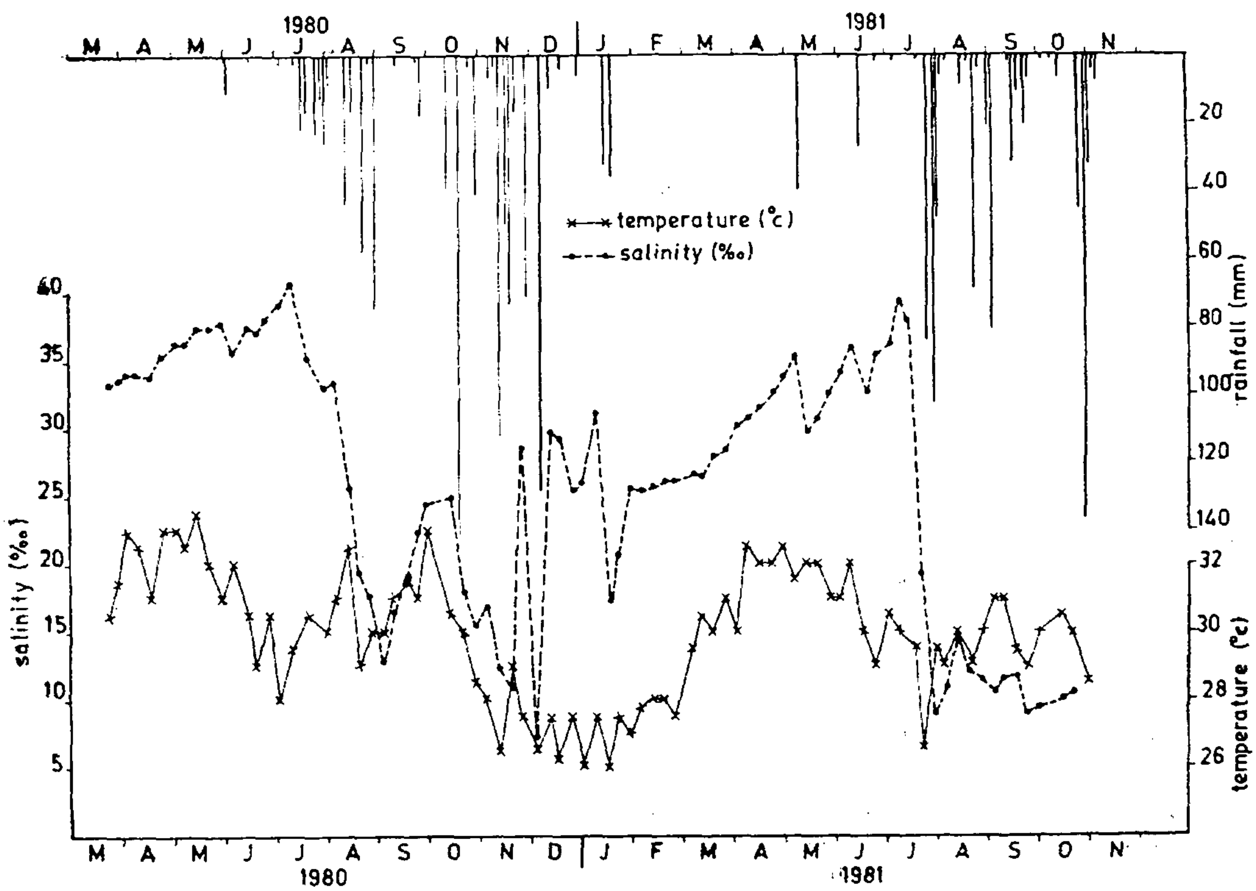

Fig. 2. Seasonal distribution of salinity and temperature along with rainfall data at Edaiyur backwaters.

Table I. Hydrographic and chemical characteristics at Edaiyur backwaters (seasonal averages)

Period	DO (mg/l)	Seston (mg/l)	Secchi disc depth (cm)	PO_4-P	Total P (μg at/l)	SiO_2-Si
Feb. '80 – June '80	5.1	40.1	45	—	—	—
July '80 – Sep. '80	5.6	20.8	65	0.10	1.37	163.4
Oct. '80 – Jan. '81	6.4	17.7	90	0.31	0.92	63.6
Feb. '81 – June '81	4.7	58.7	42	0.03	2.91	132.4
July '81 – Sep. '81	6.1	28.3	79	0.14	1.26	124.4

tions, the Edaiyur backwaters can be considered as a 'positive' estuary from August to March and 'negative' estuary (Perkins, 1974) from April to July. The salinity values showed a gradual increase from 34‰ in April to 40‰ in July 1980. The pattern of salinity increase was nearly the same in 1981 also. This increase in salinity is possibily due to continued evaporation in this water body which remains in a land-locked state during the period.

During most of December, 1980 the bar mouth had remained open and this resulted in significant increase in salinity in the backwaters from 7‰ to 30‰, inspite of the fairly high rainfall during this period. The dissolved oxygen values during the period ranged from 3 to 8 mg/l with a mean of 5.6 mg/l. The values were relatively low during summer and high during SW and NE monsoon periods.

The seston content ranged from 6 to 113 mg/l with a mean of 16 mg/l. The seasonal distribution was characterised by a well defined maximum in April in 1980 and in May in 1981. The data on average seston content during different seasons showed that the values were relatively high during summer and low during the NE monsoon period. The data on phytoplankton pigments (Nair and Ganapathy, 1983) were also similarly high during summer suggesting that the seston in Edaiyur was of biological origin.

Secchi diso depth ranged from 0.2 m in May to 1.5 m in September. Seasonal variations in secchi disc depths showed water transparency maximum in September–October, when the seston content was the lowest. Similarly secchi disc visibility was low in April/May when the seston content was the highest.

Seasonal distribution of PO_4-P were characterised by relatively high values in NE monsoon and low values in the summer and SW monsoon periods. The data showed relatively high values of total P during the summer and SW monsoon periods. The PO_4-P maximum observed in NE monsoon could be due to the influence of land run-off following heavy rains. The low PO_4-P values during summer and SW monsoon periods were due to the high phytoplankton activity observed during this period (Nair and Hemalatha, 1983). The high values of total P during the same period could be due to dissolved organic phosphates contributed by phytoplankton.

Seasonal variations in silicates were characterised by high values in summer and SW monsoon periods and low values during the NE monsoon period.

Sadras backwaters

Data on temperature and salinity in Sadras backwaters along with rainfall for an year are given in Fig. 3. Table II gives seasonal average values of dissolved oxygen, seston, secchi disc depths and nutrients.

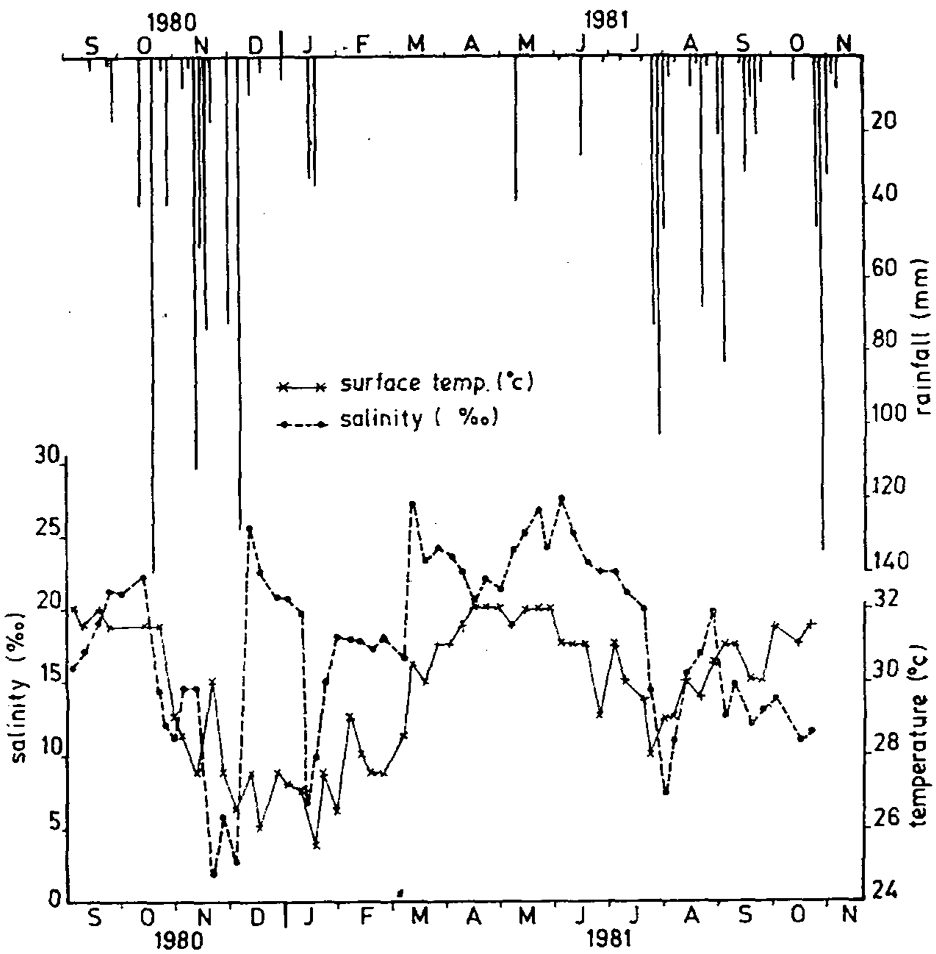

Fig. 3. Seasonal distribution of salinity and temperature along with rainfall data at Sadras backwaters.

The seasonal surface temperature distributions were characterised by two well defined maxima one in April–May (32.0 °C) and the other in September (32.0 °C) alternating with two minima one in January (25.5 °C) and the other in July (28 °C), similar to those observed in Edaiyur backwater.

The annual salinity distribution is characterised by a salinity minimum

Table II. Hydrographic and chemical characteristics of Sadras backwaters (seasonal averages)

Period	DO (mg/l)	Seston (mg/l)	Secchi disc depth (cm)	PO_4-P	Total (μg at/l)	SiO_4-Si
July '80 – Sep. '80	6.1	19.4	65	2.22	4.53	167.9
Oct. '80 – Jan. '81	6.5	9.8	100	0.96	2.29	191.5
Feb. '81 – June '81	6.1	21.6	80	2.11	5.95	96.6
July '81 – Sep. '81	5.8	14.4	90	2.04	8.18	198.9

in November. The salinity values were relatively high during the period March–June. At no time during the year the salinity in this backwaters had approached the sea water salinity. This might be due to the dilution resulting from a sewage outfall located on the Buckingham Canal, south of the Sadras Bar.

The dissolved oxygen levels ranged from 3.1 (June) to 10.3 (April) mg/l with a mean of 6.2 mg/l.

The seston content ranged from 3.2 to 43 mg/l with a mean of 34 mg/l. Seasonal distribution was characterised by a maximum in April and a minimum in October. However, October, 1981 is characterised by a very high value of seston which was not accompanied by a corresponding rise in chlorophyll level (Nair and Ganapathy, 1983) as observed in Edaiyur bar. Hence this high seston value is probably not of biological origin. Since this high seston content is preceded by the heaviest rainfall during the season, it could be due to terrigenous material contributed by run-off.

Secchi disc depths ranged from 0.35 to 1.7 m. Seasonal variations in secchi depths showed a water transparency maximum in October, 1981.

The PO_4-P values varied from BDL to 4.8 μg at/l with a mean of 1.8 μg at/l. The total P concentrations ranged from 0.2 to 16.4 μg at/l. Seasonal distributions of PO_4-P were characterised by high values in summer and SW monsoon periods and low values in NE monsoon period. Fairly high values of total P were observed during summer and SW monsoon as compared to the NE monsoon period. The very high PO_4-P concentration could be due to sewage nutrients whereas the low values during northeast monsoon are probably due to the dilution caused by the rainfall.

The silicate concentrations ranged from 23.5 μg at/l – 374 μg at/l with a mean of 166 μg at/l. The seasonal distribution of silicates was characterised by fairly high values during the SW and NE monsoon periods and low values in summer months. The low value in summer could possibly be due to the consumption of silicates by enhanced biological activity or phytoplankton observed during the period (Nair and Hemalatha, 1983).

Coastal waters (MAPP Jetty)

Data on temperature, salinity and rainfall for a 2 year period (1979–1981) are shown in Fig. 4.

Surface temperature data in 1980 showed two maxima, one in April (32 °C) and the other in October (31.8 °C) alternating with two minima, one in January (26.5 °C) and the other in July (27.8 °C). A nearly similar pattern was observed in 1981 also, although the maxima were relatively less prominent. The seasonal average values of dissolved oxygen, seston content, secchi disc depth and nutrients are given in Table III.

Table III. Hydrographic and chemical characteristics at MAPP Jetty (seasonal averages)

Period	DO (mg/l)	Seston (mg/l)	Secchi disc depth (cm)	PO_4-P	Total (μg at/l)	SiO_4-Si
Oct. '79 – Jan. '80	6.3	13.1	—	—		—
Feb. '80 – June '80	5.5	13.2	210	—		—
July '80 – Sep. '80	6.1	16.2	170	0.25	0.93	21.9
Oct. '80 – Jan. '81	6.3	12.6	180	0.14	0.64	15.4
Feb. '81 – June '81	5.8	12.8	202	BDL	0.79	8.5
July '81 – Sep. '81	5.6	15.7	214	0.07	0.94	27.7

BDL — Below Detection Limit

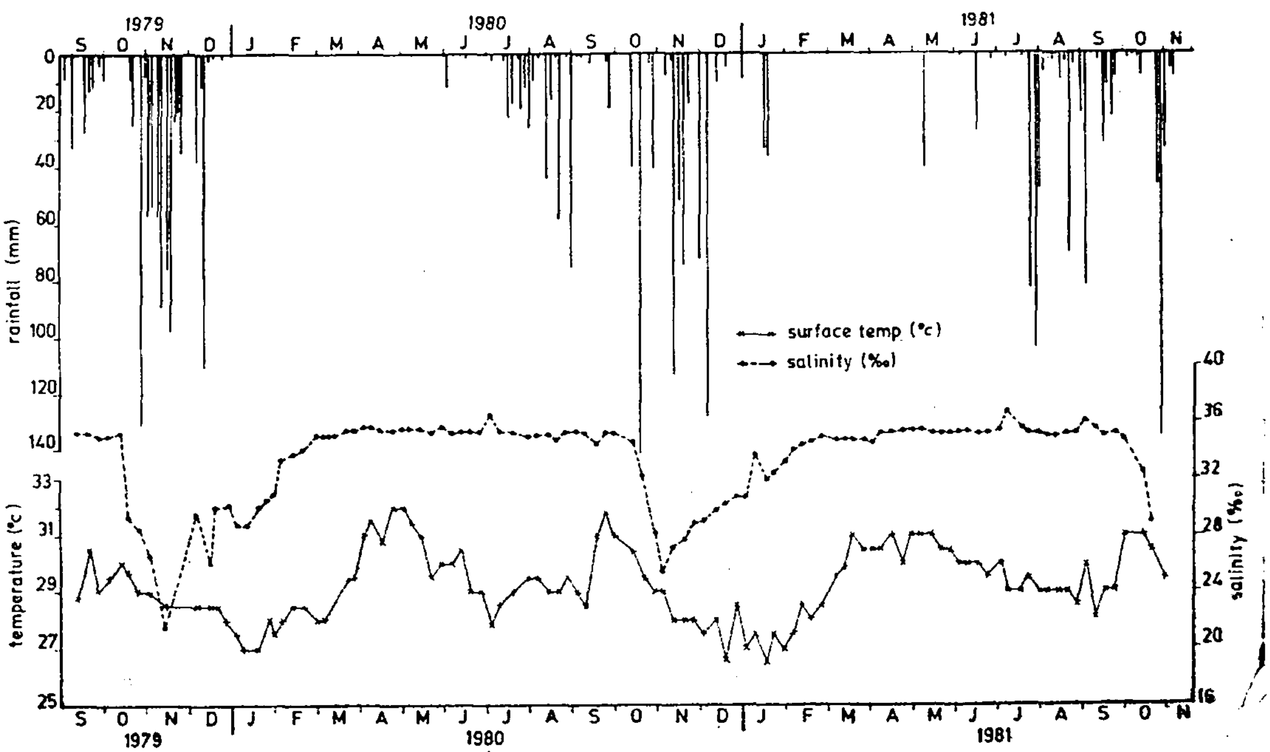

Fig. 4. Seasonal distribution of salinity and temperature along with rainfall data at MAPP Jetty.

The salinity values ranged from 22.5‰ to 35.5‰, with the exception of two high values, one in July 1980 (36.5‰) and the other in July 1981 (36.6‰). No explanation is offered for these two exceptionally high values. However, these high values coincided with the salinity maximum observed in the Edaiyur bar, although there was no surface connection between the Edaiyur bar and the coastal waters during the same period. Considerable lowering in salinity values was observed all along the coast during the periods of heavy rainfall. The SW monsoon rains in general did not have any influence on salinity in the coastal waters. However, the onset of NE monsoon rains appreciably influenced the coastal water salinity. When the two backwaters get directly connected to the sea through their bar mouths following heavy rains the coastal waters are getting considerably diluted.

The dissolved oxygen levels ranged from 4.7 to 7.1 mg/l with a mean of 5.9 mg/l. The NE and SW monsoon periods showed relatively high values as compared to summer.

The seston content ranged from 3 to 58 mg/l with a mean of 13.3 mg/l. Seasonal distributions were characterised by two maxima, one in November–December and the other in June–July. Generally low values were observed in October. The higher seston content seen in June–July was of biological origin as chlorophyll levels were relatively high during this period (Nair and Ganapathy, 1983).

Maximum secchi disc depth (5.6 m) was noticed in October against a correspondingly low seston content during the same period. The visibility in jetty in general was substantially high compared to both the backwaters.

The PO_4-P values ranged from BDL to 0.6 μg at/l with a mean concentration of 0.1 μg at/l. The total P levels ranged from 0.2 to 1.8 μg at/l. Both PO_4-P and total P were relatively low in the coastal waters as compared to the backwaters. The data showed that there is a total depletion of PO_4-P during summer months presumably due to the high primary productivity observed during the same periods (Nair and Ganapathy, 1983). The phosphate values were high during SW and NE monsoon periods. The high values during NE monsoon were apparently due to the opening of the bar-mouth through which nutrients from backwaters are drained into the sea. The increase observed during SW monsoon could be due to the release of PO_4 bound to the bottom sediments and also due to the turbulence following strong winds which prevailed during this period. Similar increase in phosphate levels during the SW monsoon period was reported from the Malabar coast by Jayaraman and Seshappa (1957).

The silicate values ranged from 6 to 54 μg at/l with a mean of 18.5 μg at/l. Relatively high values were observed in SW and NE monsoon periods compared to summer months. In general, the silicate values were very low compared to the backwaters. Burton (1970) in his studies on dissolved silicon in Vellar estuary has observed that silicate levels were two orders of magnitude lower in the coastal water compared to the estuary. In the present studies seasonal averages in the coastal water were an order of magnitude lower than those in the backwaters.

The baseline survey reveals the maxima and minima in the annual cycle of surface temperatures in the water bodies. It is significant to note that the temperature maxima range from 31.8 to 33.5 °C. Reports in the literature (Salo, 1969, Romberg, Spigarelli, Prepejchal and Thommes, 1979) indicate increase in surface temperatures ranging from 7–12 °C in the near vicinity of power station outfalls. Such increase could apparently have adverse effect on many tropical animals like prawns, crabs and other invertebrate adults which have upper thermal limits of 33–37 °C. The Edaiyur and Sadras backwaters as well as the coastal water form nursery areas for prawns. *Penaeus indicus* and *Penaeus monodon*.

The two backwaters, although located not very far from each other show significantly different hydrographic characteristics. The salinity and nutrient regimes are distinctly different. The nutrient levels (Particularly PO_4-P) are appreciably high and the salinity values low in Sadras backwaters as compared to Edaiyur, largely due to a sewage outfall located upstream in this waterbody.

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