

# STUDIES ON THE PHYSICO-CHEMICAL CHARACTERISTICS OF KODIAKKARAI COAST AND MANGROVE IN NAGAPATTINAM DISTRICT, TAMIL NADU, INDIA

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## Abstract

*Seasonal variation in physico-chemical characteristics of water samples Station-I (Kodiakkarai coastal water ) and Station-II (Kodiakkarai mangrove water) were studied in Kodiakkarai, Nagapattinam District, Tamil Nadu, India, for a period of two years (July 2017 to June 2019). By using standard methods eight different physico-chemical parameters were analyzed. Rainfall varied between 49.72 to 228.67mm, Atmospheric temperature was varied from 28.05 to 32.55 °C, Water temperature was varied from 26.68 to 31.87°C, pH ranged from 6.63 to 8.53. Salinity was varied from 25.27 to 37.87 ppt, Dissolved Oxygen content varied from 3.38 to 5.88 mg/L, nitrate (0.44 to 0.87 mg/L) and phosphate (0.23 to 39 mg/L) were also studied.*

**Key words:** Physico-Chemical characteristics, Seasonal Variations, Mangrove, Coastal water.

## Introduction

In India, the Palk Bay has landmarks between the Point Calimere and Rameshwaram Island as northern and southern borders, respectively. The eastern part of the bay is connected with Srilanka whereas the western part of the bay is the border of the Indian subcontinent. The plants and animals of this bay are dependent on various physicochemical factors including nutrients, which are responsible for the fertility of the water masses (Harvey, 1995).

Water is one of the most important compounds to the ecosystem and better quality of water described by its physical, chemical and biological characteristics. 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 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). The physicochemical parameters and the magnitude and source of any pollution load and to assess that monitoring of these parameters is essential (Reddi et al., 1993). Assessment of water resource quality of any region is an important aspect of developmental activities of the region, because rivers, lakes and manmade reservoirs

are used for water supply to domestic, industrial, agricultural and fish culture (Jakher and Rawat, 2003).

The Palk Bay region has not been paid much attention when compared to the adjacent Gulf of Mannar and most of the available literature and studies do not indicate the present scenario of the bay. Jayaraman (1954) has studied the water quality parameters of inshore waters of the Mandapam region. Prasad and Nair (1960) have studied the distribution and occurrence of diatoms in the inshore waters of the Palk Bay.

Murthy and Udaya Varma (1964) have studied the hydrographical features of the Palk Bay. After this, there is no work directly dealing with the water quality of the Palk Bay except that of Kannan and Kannan (1996) who have studied the physicochemical characteristics of the seaweed beds of the Katumavadi and Kottaipattinam regions of the Palk Bay. Some studies (Oswin and Rahman, 1997; Kannan et al., 2003) are available on the Muthupettai mangroves of this region. Though, considerable attention has been paid in the recent years to study the physicochemical parameters of the coastal waters around India in order to ascertain the water quality and productivity, very little information is available on these aspects of the Palk Bay. Hence, the present study was undertaken on the seasonal variation of water quality characteristics for a period of two years from July 2017 to June 2019 at Kodiakkarai, a coastal region and mangrove in the Nagapattinam district, Tamil Nadu, India.

### Materials and methods

Kodiakkarai (Lat.  $10^{\circ} 37' N$ , long  $79^{\circ} 84' E$ ) is located at the southern end of Tamil Nadu India. Surface water samples were collected from Kodiakkarai coast and mangrove covering two sampling sites (Station-I. Coastal water and Station-II. Mangrove) at monthly interval for a period of one year from July 2012 to June 2013, for the quantitative estimation of following hydrographical characteristic. Various physico-chemical parameters were analyzed by using standard methods (APHA, 1998). Temperature: Water temperature of the tank water recorded by using Mercury field celcius thermometer. Salinity: Salinity were determined by Mohr's titration method. pH: The pH was determined by using Elico, model LI. 120 Digital pH meter. Dissolved oxygen: The Dissolved oxygen was determined by the modified Winkler's method (1888). The other parameters like, phosphate estimated stannous chloride method. The nitrate was determined by the Brucine method.

### Results

In the present observation, seasonal variations in meteorological and physico- chemical parameters viz., rainfall, atmospheric and water temperature, pH, salinity, dissolved oxygen, nitrate and phosphate contents in Kodiakkarai coastal area station-I and mangrove water samples station-II were recorded for a period of two year from July 2017 to June 2019 (Table 1 & 2 and Figures 1-8).

## Rainfall

Seasonal variations of rainfall were recorded in in Kodiakkarai coastal area station-I and mangrove water samples station-II are shown in the Table 1 & 2 and Fig.1. The rainfall was minimum (49.72 mm) post monsoon season and maximum (221.47 mm) in monsoon season station-I (Table 1 and Fig. 1). At station-II the rainfall in mangrove was varied between 65.75 and 228.67 mm. Minimum rainfall was recorded during post monsoon season and maximum in monsoon season (Table 2 and Fig.1).

## Atmospheric temperature

Seasonal variations of atmospheric temperature of the water observed in Kodiakkarai coastal area station-I and mangrove water samples station-II are graphically represented in Table 1 & 2 and Fig. 2. The atmospheric temperature showed a minimum value of 28.05°C (monsoon season) and a maximum value of 32.62°C (summer season) (Table 1 and Fig.2) at station-I. At station-II the atmospheric temperature showed a minimum value of 28.83 °C in monsoon season and a maximum value of 32.55°C in summer season (Table 2 and Fig. 2).

## Water temperature

During the study period surface water temperature varied from 26.68 to 31.23°C. The minimum was recorded during monsoon season and maximum during the summer season in station-I (Table 1 and Fig. 3). At station-II, the surface water temperature ranged from 27.08°C to 30.67°C. The minimum surface water temperature (27.08°C) was recorded during monsoon season and maximum (30.67°C) was recorded during the summer season (Table 2 and Fig.3).

## pH

Seasonal values of hydrogen ion concentration of water varied from 6.63 to 7.13. Maximum values of pH were observed in the post monsoon season and minimum values were recorded in the monsoon seasons (Table 1 and Fig. 4) at station-I. At station-II the seasonally mean values of hydrogen ion concentration of water varied from 7.62 to 8.53. The minimum values were recorded in the monsoon seasons and maximum values of pH were observed in the summer season (Table 2 and Fig. 4).

## Salinity

The seasonal variation of salinity in Kodiakkarai coast and mangrove was observed throughout the study period. Minimum salinity (25.27 ‰) was recorded during the post monsoon and was attained maximum (31.87‰) during summer seasons (Table 1 and Fig. 5) at station-I. At station-II the seasonal values of salinity in water samples varied from 31.17 to 37.87 ‰. The minimum values were recorded in the monsoon seasons and maximum values of salinity were observed in the summer season (Table 2 and Fig. 5).

### Dissolved oxygen

Dissolved oxygen (DO) in Kodiakkarai coastal water was varied between 3.38 and 5.88 mg/L. Minimum DO was recorded during the pre-monsoon season and maximum in monsoon season (Table 1 and Fig.6) at station-I. At station-II the dissolved oxygen (DO) in Kodiakkarai mangrove water was varied between 3.88 and 4.67 mg/L. Minimum dissolved oxygen was recorded during the summer season and maximum in monsoon season (Table 2 and Fig.6).

### Nitrate

The nitrate was varied from 0.44 to 0.57 mg/L. Minimum was recorded during summer season whereas maximum during the monsoon season (Table 1 and Fig. 7) at station-I. At station-II the nitrate values were varied from 0.64 to 0.87 mg/L. Minimum was recorded during the pre-monsoon season whereas maximum during the post monsoon season (Table 2 and Fig. 7).

### Phosphate

The total phosphate was minimum (0.23 mg/L) in the post monsoon season and maximum (0.31 mg/L) in the summer season (Table 1 and Fig. 8) at station-I. At station-II the total phosphate was minimum (0.26 mg/L) in the post monsoon season and maximum (0.39 mg/L) in the pre-monsoon season (Table 2 and Fig. 8).

Table 1. Seasonal variations of physico-chemical characteristics in the Kodiakkarai coastal area water samples during the study period of July 2017 to June 2019 (Station-I).

Parameters	Pre-monsoon	Monsoon	Post monsoon	Summer
Rainfall (mm)	66.47 ± 29.13	221.47 ± 94.44	49.72 ± 41.59	130.52 ± 76.49
Atmospheric Temp. (°C)	29.15 ± 1.68	28.05 ± 1.32	30.22 ± 2.57	32.62 ± 2.28
Water Temperature (°C)	28.17 ± 0.63	26.68 ± 1.01	27.85 ± 1.33	31.23 ± 1.86
pH	6.87 ± 0.33	6.63 ± 0.19	7.13 ± 0.27	6.77 ± 0.15
Salinity (ppt)	31.37 ± 2.33	28.58 ± 4.54	25.27 ± 2.47	31.87 ± 3.17
Dissolved oxygen (ml/L)	3.38 ± 0.32	5.88 ± 3.72	4.28 ± 5.69	3.95 ± 3.27
Nitrate (mg/L)	0.45 ± 0.17	0.57 ± 0.12	0.52 ± 0.15	0.44 ± 0.04
Phosphate (mg/L)	0.28 ± 0.02	0.30 ± 0.05	0.23 ± 0.03	0.31 ± 0.03

Each value is the mean ± S.D. of six observations

Table 2. Seasonal variations of physico-chemical characteristics in the Kodiakkarai mangrove area water samples during the study period of July 2017 to June 2019 (Station-II).

Parameters	Pre-monsoon	Monsoon	Post monsoon	Summer
Rainfall (mm)	90.73 ± 59.34	228.67 ± 90.78	65.75 ± 67.75	86.63 ± 81.27
Atmospheric Temp. (°C)	29.12 ± 0.74	28.83 ± 0.73	31.23 ± 2.65	32.55 ± 2.39
Water Temperature (°C)	28.97 ± 1.29	27.08 ± 0.76	29.52 ± 1.64	30.67 ± 1.42
pH	8.12 ± 0.23	7.62 ± 0.27	8.32 ± 0.24	8.53 ± 0.24
Salinity (ppt)	33.67 ± 2.34	31.17 ± 1.94	32.83 ± 1.47	37.87 ± 2.32
Dissolved oxygen (ml/L)	4.18 ± 0.19	4.67 ± 0.39	4.72 ± 0.84	3.88 ± 0.47
Nitrate (mg/L)	0.64 ± 0.09	0.83 ± 0.02	0.87 ± 0.03	0.72 ± 0.04
Phosphate (mg/L)	0.39 ± 0.09	0.34 ± 0.03	0.26 ± 0.06	0.28 ± 0.03

Each value is the mean ± S.D. of six observations

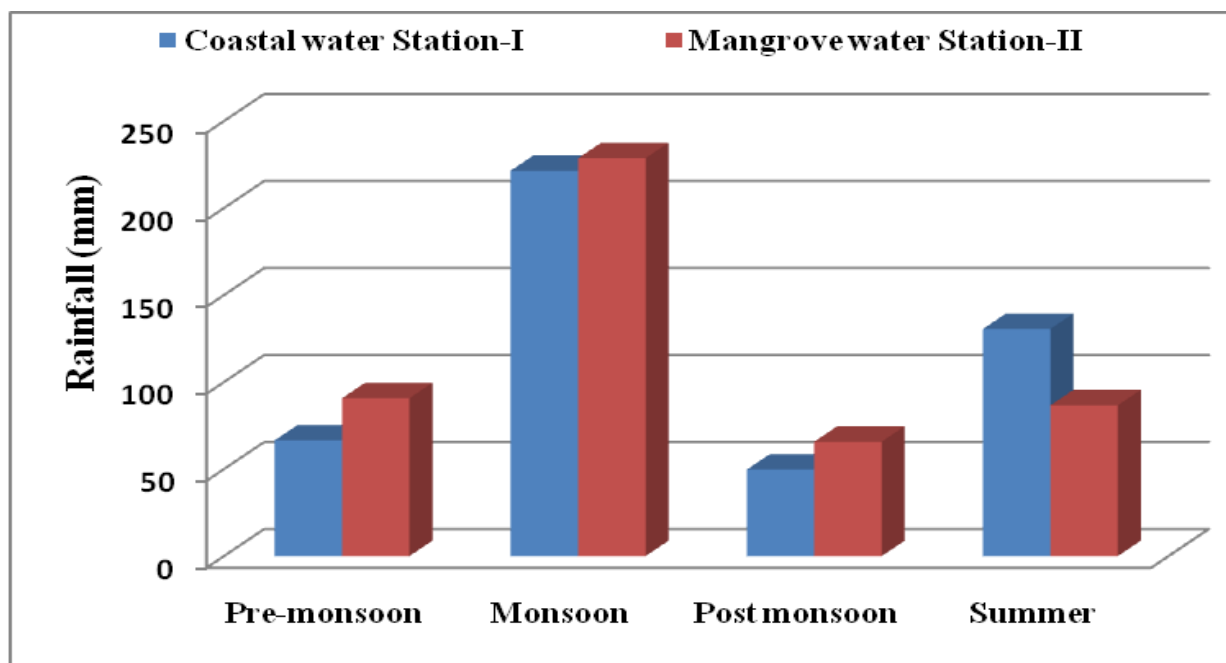


Fig. 1. Seasonal variations of rainfall in Kodiakkarai coastal area and mangrove during the period of July 2017 to June 2019 (Station-I and station-II).

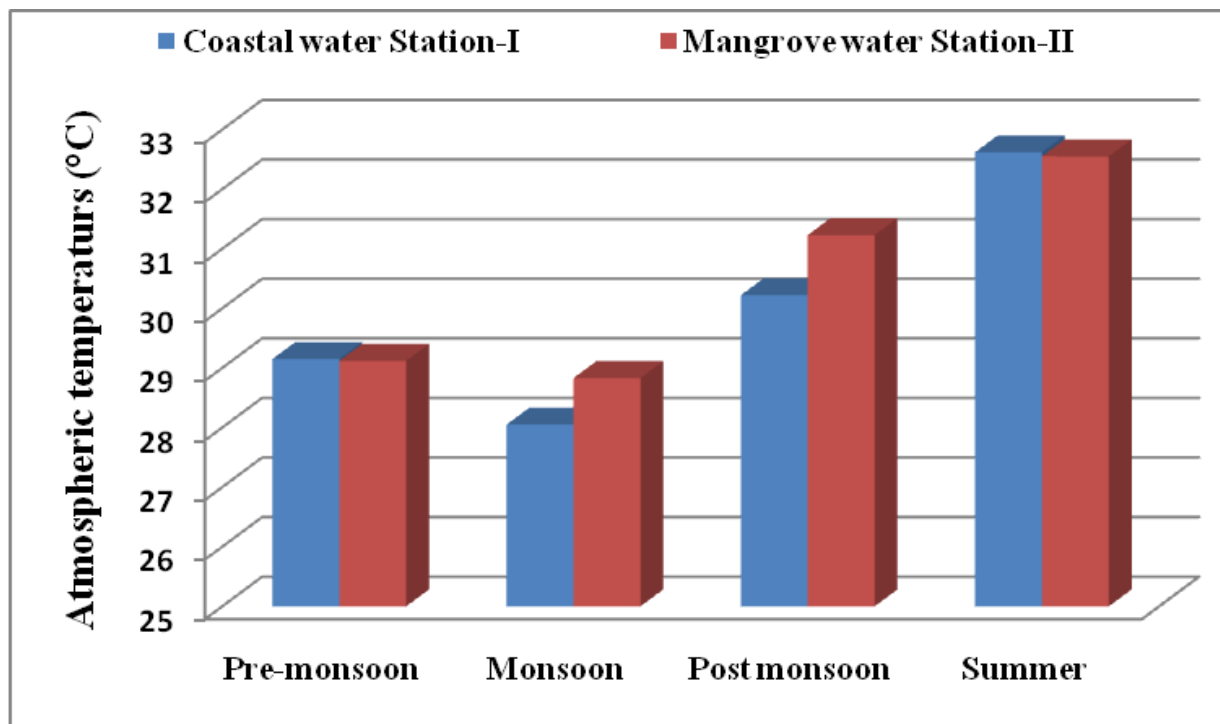


Fig. 2. Seasonal variations of air temperature (°C) in Kodiakkarai coastal area and mangrove during the period of July 2017 to June 2019 (Station-I and station-II).

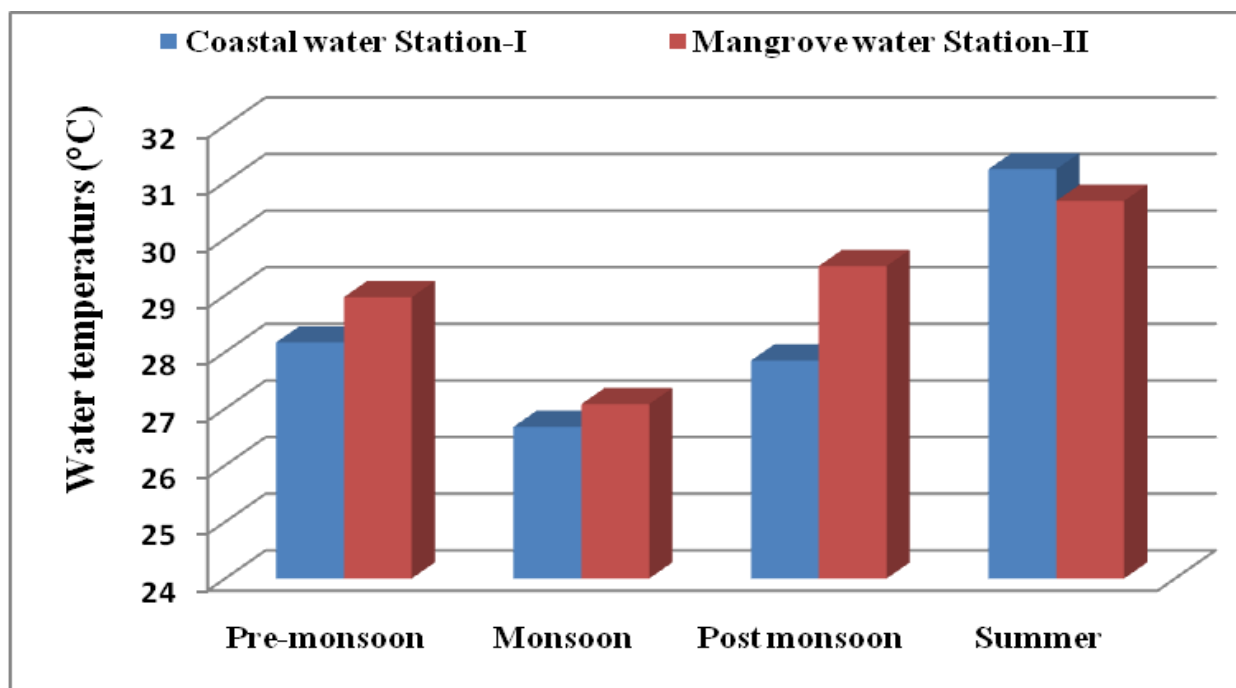


Fig. 3. Seasonal variations of water temperature (°C) in Kodiakkarai coastal area and mangrove during the period of July 2017 to June 2019 (Station-I and station-II).

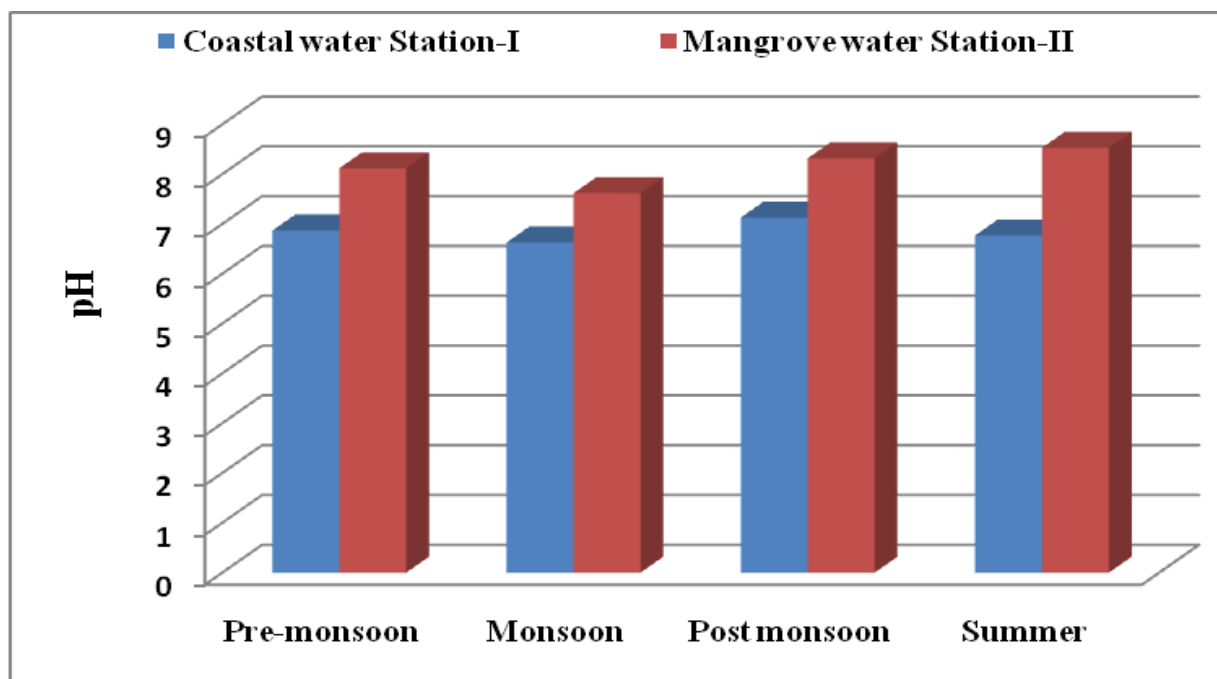


Fig. 4. Seasonal variations of pH in Kodiakkarai coastal area and mangrove during the period of July 2017 to June 2019 (Station-I and station-II).

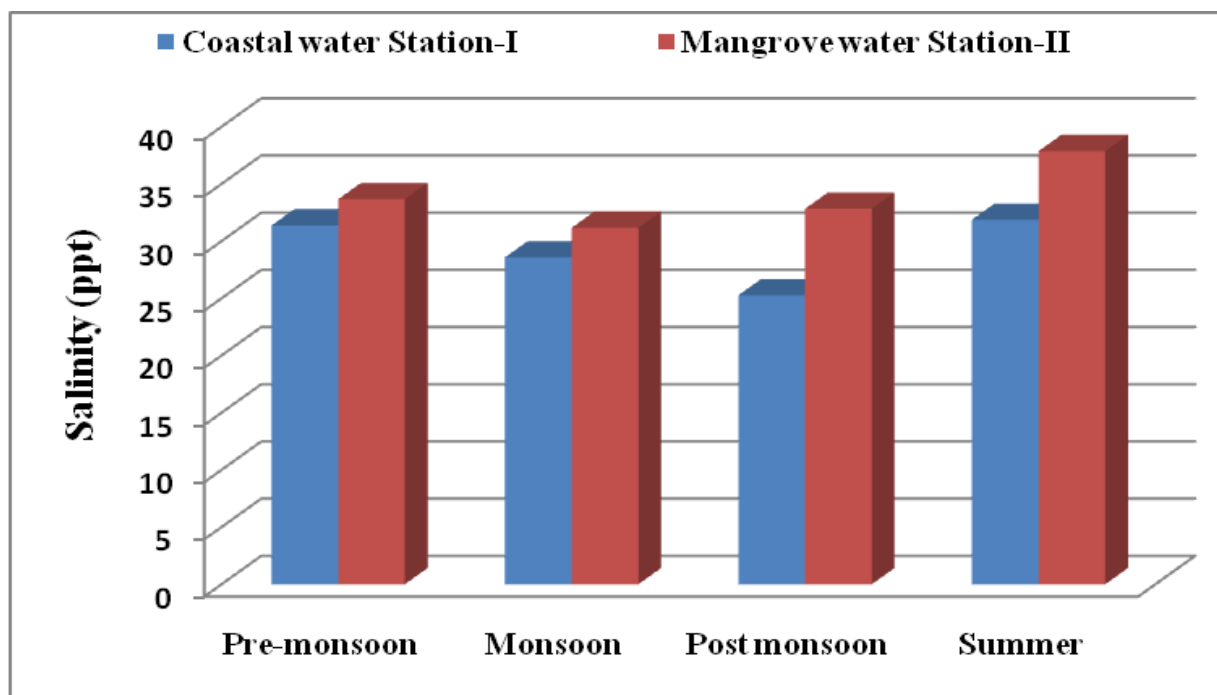


Fig.5. Seasonal variations of salinity (ppt) in Kodiakkarai coastal area and mangrove during the period of July 2017 to June 2019 (Station-I and station-II).

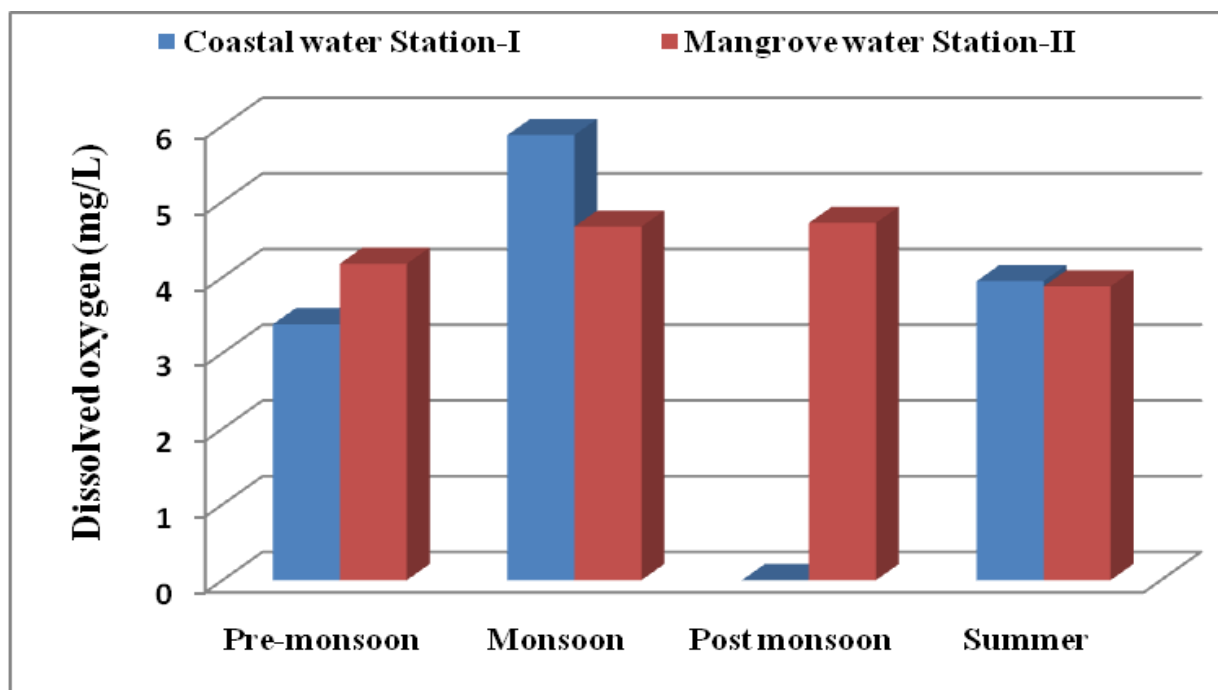


Fig. 6. Seasonal variations of dissolved oxygen (mg/L) in Kodiakkarai coastal area and mangrove during the period of July 2017 to June 2019 (Station-I and station-II).

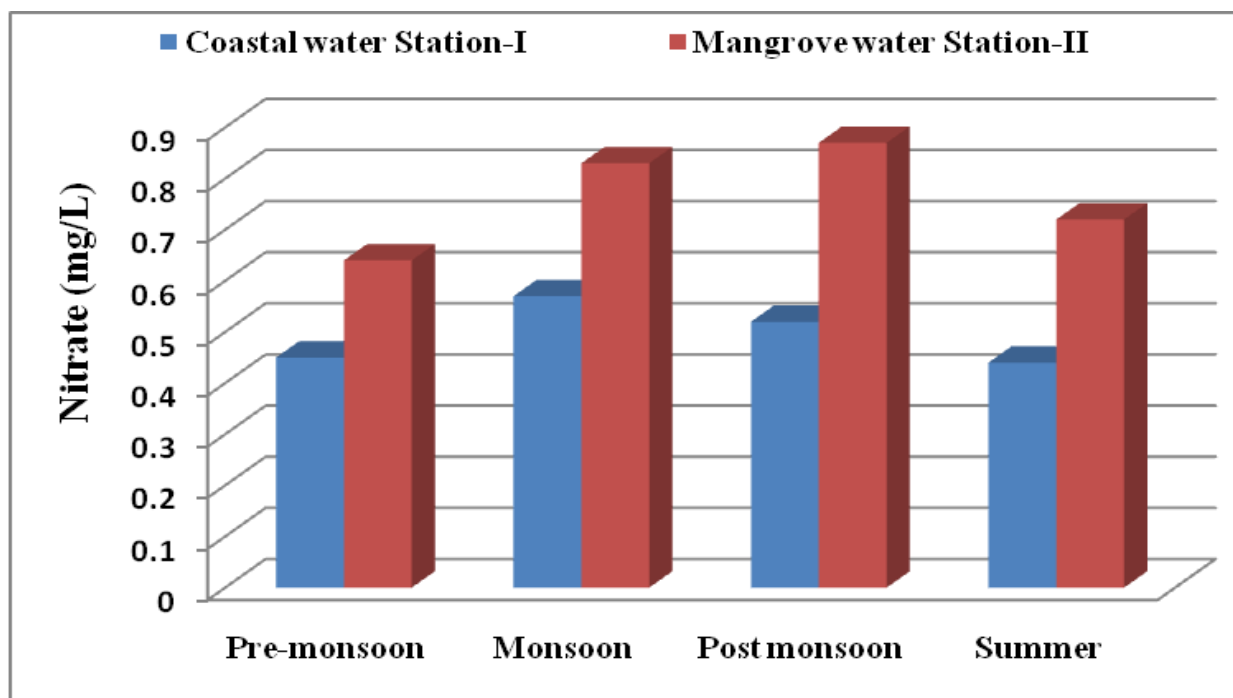


Fig. 7. Seasonal variations of nitrate (mg/L) in Kodiakkarai coastal area and mangrove during the period of July 2017 to June 2019 (Station-I and station-II).



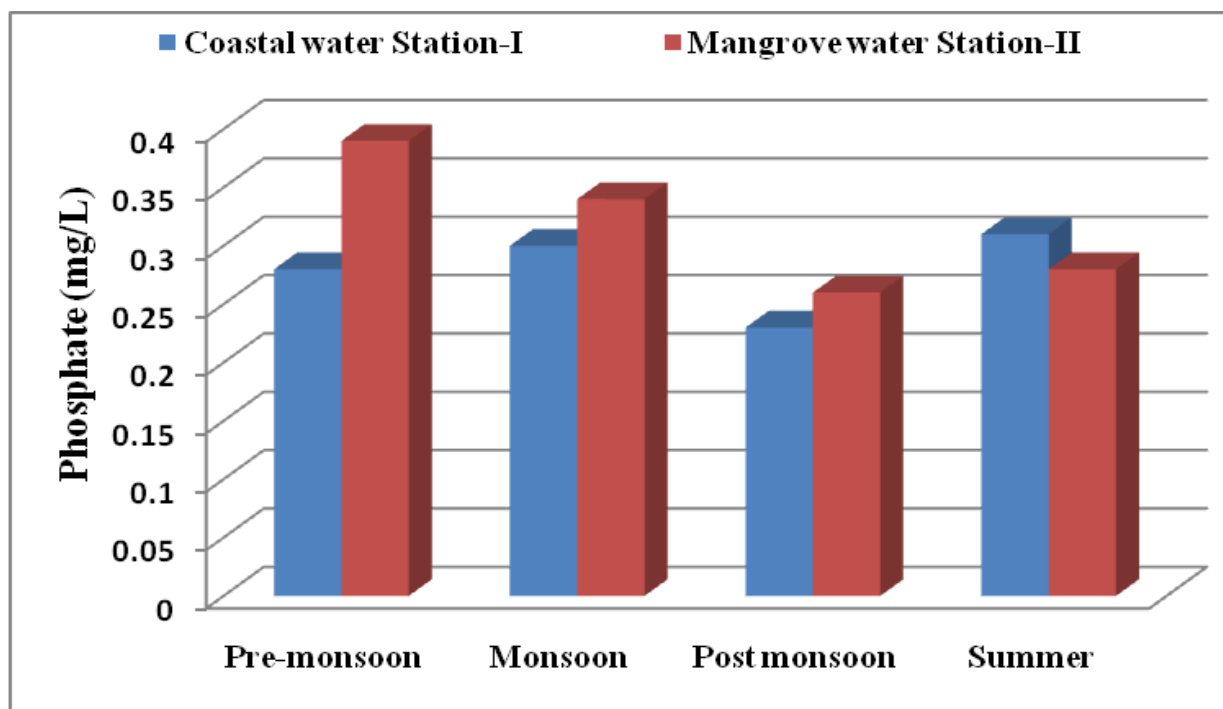


Fig. 8. Seasonal variations of phosphate (mg/L) in Kodiakkarai coastal area and mangrove during the period of July 2017 to June 2019 (Station-I and station-II).

### Discussion

Rainfall is the most important cyclic phenomenon in tropical countries as it brings important changes in the hydrological characteristics of the coastal marine environment (Chandran and Ramamoorthi *et al.*, 1984). Atmospheric temperature varied from 28°C to 32.50°C with the minimum (28.0°C) during the monsoon season and the maximum (32.5°C) during the summer season (Sridhar *et al.*, 2006). The maximum surface water temperature (32.0°C) was recorded during the summer season and the minimum (27.5°C) was recorded during the monsoon season (Sridhar *et al.*, 2006).

The water temperature during monsoon season (October to December) was low because of strong land sea breeze and precipitation and the recorded high value during summer season (April to June) could be attributed to high solar radiation (Sampathkumar and Kannan, 1998 and Ajithkumar *et al.*, 2006). The seasonal variation in the water temperature depends upon the wind force, freshwater discharge influx of the inshore water and atmospheric temperature (James Balgan Anand and Mary Jelastin Kala, 2015). The results are coincides the present investigation.

In the present study, the marine water samples maximum pH was observed in summer and minimum was recorded in the post monsoon season of first year. The minimum pH was noted in the post monsoon season and maximum was observed in the summer season of second

year. Hydrogen ion concentration or pH as one of the vital environmental characteristics decides the survival, metabolism, physiology and growth of aquatic organisms. pH is influenced by acidity of the bottom sediment and biological activities (Balasubramanian and Kannan., 2005). pH may be affected by total alkalinity and acidity, run off from surrounding rocks and water discharges (Velsamy *et al.*, 2013).

The salinity was act as a prime factor (important environmental parameter) in the distributions of estuarine living organisms. The intrusion of neritic water and low river discharge may be responsible for high salinity, the monsoonal rain and continuous flow of the freshwater of the rivers may be responsible for low salinity. The salinity of water indicates the presence of ionic substances that may come from the reaction of metals and acids containing in water. A marked seasonal change in salinity was observed throughout the study period. Minimum salinity (5.6‰) was recorded during monsoon and was slowly increased during post monsoon and attained maximum during summer seasons (Anand and Kumarasamy, 2013).

Salinity is regarded as the second important physical characteristic of the marine environment. This salinity factor has high influence on the fauna. In the present work, the salinity content of marine water sample maximum was recorded in the summer season and minimum was noted in the monsoon season during the study period of first year. It was found to be low in the post monsoon season and high in the summer season of second year. Less wave and tidal action with decreased freshwater inflow and land drainage may also be considered fluctuations in salinity (Sampathkumar and Kannan, 1998). Drop in salinity during monsoon season 31.54 (‰) at Mandapam is related to heavy showers and consecutive floodwater from up streams (Mitra *et al.*, 1990 and Sundaramanickam, 2004).

Dissolved oxygen can be removed from the water by discharges of the oxygen demanding anthropogenic wastes, other inorganic reductants like hydrogen sulphide, ammonia, ferrous, nitrate and other oxidizable substances tends to decrease dissolved oxygen in water. It is well known that the temperature and salinity affect the dissolution of oxygen (Saravanakumar *et al.*, 2008). In the earilar investigation, higher values of dissolved oxygen 5.95 mg/l at Kanyakumari were recorded during monsoon season might be due to the cumulative effect of higher wind velocity coupled with heavy rainfall and the resultant freshwater mixing attributed that seasonal variation of dissolved oxygen is mainly due to freshwater flow and terrigenous impact of sediments (Govindasamy *et al.*, 2000). Similar observations have been made by Padmavathi and Satyanarayana (1999) from the coastal waters of the Godavari.

Nitrates are the most oxidized forms of nitrogen and the end product of the aerobic decomposition of organic nitrogenous matter. The increasing nitrates level was due to the freshwater in flow, litter fall decomposition and terrestrial runoff water during the monsoon seasons (Mathivanan *et al.*, 2008). Plants and micro-organisms reduce nitrate into nitrite but nutrition is quickly oxidized back to nitrate once in reenters the water. The observed high

monsoonal phosphate value might be due to the regeneration and release of total phosphorus from bottom solid into the water column by turbulence and mixing (Khaiwal *et al.*, 2003).

Nitrate content in the marine water samples were found to be low in monsoon season and high in summer season of first year. It was found to be maximum in summer season and minimum in post monsoon season during the study period of second year. Nitrate is one of the most important indicators of pollution of water which represents the highest oxidized form of nitrogen. It plays a significant role in sustaining the aquatic life in marine environment. The increased nitrates level 10.17  $\mu\text{M/l}$  at Thoothukudi during monsoon season is due to fresh water inflow, to leaching of rocks, fertilizer, chemical industries, domestic and municipal sewage, organic matter decomposition and terrestrial run-off during the monsoon season (Grasshoff *et al.*, 1999; Rajaram *et al.*, 2005; Ashok Prabu *et al.*, 2005). Low concentration of phosphate observed during the summer season was due to the decreased land drainage, utilization by phytoplankton (Srinivasa Rao and Umamaheswara Rao 2002; Sevimpolat and Mine Percin Piner, 2002).

### Conclusion

The variation in physico-chemical parameters mainly depends on monsoon rains. The fluctuations in physico-chemical parameter influence the natural activity and efficiency of estuarine organism. While in the non-monsoon season the water showed predominantly saline characteristics. Salinity plays a dominant role in controlling the water quality of coast and mangrove. Thus the present baseline information of the physico-chemical properties of water would form a useful tool for further ecological assessment and monitoring of this estuary.

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