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Some Physico-Chemical Analysis of Soil and Water of Keezhathottam Mangrove, Tamil Nadu, India

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Abstract : Mangroves the uniquely saltadapted trees and shrubs that line our tropical and subtropical coasts, the critical membrane between land and sea are disappearing at faster rates than virtually any other ecosystem on Earth. The present survey has been made to know the some physico-chemical parameters in the water and soil of Keezhathottam mangroves during the year 2013-2014 at four-seasonal intervals. The water was slightly alkaline and contained high amounts of pH. The concentration of salinity, total, inorganic and organic phosphate, ammonia, nitrite and nitrate were fairly stable. Other nutrients such as calcium, magnesium, chloride, and bicarbonate concentration showed remarkable variations. The mangrove soil was clay in all the seasons. pH and Organic matter level were very low during monsoon and high in summer. The chemical properties of the soils varied considerably among samples particularly in nutrient and iron level. The total amount of N, P, K, Na, Ca and Mg were maximum in the monsoon and minimum in summer season. The micronutrients such as zinc, copper, iron and manganese also present in moderate level in all the season.
Key words: Water analysis, Soil analysis, Keezhathottam mangroves,pH,temperature

Introduction

Mangroves are woody, specialized types of trees of the tropics that can found on sheltered coastlines and river deltas, they grow in brackish wetlands between land and sea where other plants can't grow. They act as filters for our water supply, reduce erosion, serve as nurseries for commercial fisheries, provide opportunities for recreation, nurture vital marine biodiversity, and can act as "carbon sinks," which reduce greenhouse gas emissions.Mangrove has unique features and specialadaptations like high osmotic potential of cell sap, reaction to salinity and desalination. Mangrove ecosystems are productive wetlands found in tropical and subtropical regions which provide suitable shelter for both marine and terrestrial organisms[1].The wetlands also regulate water quality, quantity, nutrient cycling and act as a buffer between terrestrial and aquatic systems[2].Mangroves provide humans with many useful products and ecological services. Due to their coastal location mangroves maintain coastal water qualityform a barrier for coastal protection from wave storm and flood damage[3,4].Mangroves are also important breeding grounds for juvenile fish that stock many offshore adult populations including fishery species and can also sustain fisheries through their nutrient export[5].The destruction and degradation of these natural systems because of factors such as climate change, development, tourism, wood extraction, and non-sustainable farming bring about tremendous ecological, social, and economic losses, the extent of which we are only now just realizing.But there is hope for mangroves. The world is starting to notice just how important they are and is beginning to take steps to prevent further loss.

Mangroves have recently been recognized as a key component of the global carbon cycle. They are the most carbon-rich forests in the tropics and are able to sequester carbon at a faster rate than terrestrial forests[6].Coastal lagoons occupy as much as 13% of the world's coastline. A number of lagoons are distributed

all along the east and west coasts of India. There are 17 noteworthy lagoons along the Indian coasts 8 on the east and 9 on the west coasts. They are under considerable natural stress due to the great variability of temperatures, salinity, strength of waves and currents, ice cover in winter, and sometimes bad connections with the open sea[7].

Description of the study area

India is a land of villages which is entirely different from that of the towns. Keezhathottam a tiny, coastal hamlet of northern palk bay of India is located in Thanjavur district of Tamil Nadu, South India. The village is connected with nearby village Eripurakarai and Rajamadam by a narrow road (Fig.1). Rajamadam is located in the East Coast Road (ECR).

Figure 1.Map showing the study area

Village history:

King Sarfoji of Thanjavur, who ruled Thanjavur area two hundred years ago used to stay in "Rajamadam" a nearby village of Keezhathottam. He planted a large area of banana trees on the eastern side of Rajamadam village, which was then officially called "Keezhathottam" which means Eastern Garden. The village is also called "Alayatthi" is due to the presence of mangroves in this village prevent the waves enter into the land mass. In Tamil 'Ala' means waves 'Yatthi' means decrease the tidal action located in the northeastern shore of "Agniar" estuary (Lat. 10^{o} 20'N; Long 79^{o} 23'E).

Coastal environment plays a vital role in nation's economy by virtue of the resources, productive habitats and rich biodiversity. India has a coastline of about 7,500 kms. The coastline of Tamil Nadu has a length of about 1076 kms constitutes about 15% of the total coastal length of India and stretches along the Bay of Bengal, Indian Ocean and Arabian Sea. On the char, fishermen do not have any permanent establishment.

This fishery is known as the Dubla Char winter fishery, an integrated part of the inshore and offshore marine fishes. Through it is an important forest for its plants, animals and mangrove fishery but there is limited information regarding its soil and water condition. In view of the above, the present study was done to measure the some physico-chemical parameters of waterand soil of Keezhathottam mangrove forest.

Materials and Methods

The soil and water samples were collected from coastal area of Keezhathottam mangrove forest of Thanjavur district, Tamil Nadu, India. A sampling programme was consisting of seasonal physico-chemical parameters of water and soil. They survey was conducted for a period of one year from Oct. 2013 to Sep. 2014. The Physico-chemical characteristics of water were done according to the Standard Methods (APHA, 1981)[7a]. The Physico-chemical characteristics of soil were also done according to the standard methods [7b]. The temperature and pH of the water and soil were measured at the station itself.

Results and Discussion

This study of some Physico-chemical analysis of Keezhathottam mangrove water parameters such as atmospheric temperature, surface water temperature, pH, alkalinity, salinity, TDS, calcium, magnesium, chloride, ammonia, nitrate, nitrite inorganic and organic phosphate in all the four seasons examined (Table 1). Most of the parameters tested were slightly higher in summer than the monsoon seasons. Alkalinity and salinity were observed more during the summer. In general, the characteristics of water tested in all the four seasons were not varied much.

Table 1:Physico-chemical analysis of Keezhathottam mangrove water (October 2013 to September 2014)

S.No.	Parameters	Monsoon	Post-monsoon	Summer	Pre-monsoon
		(Oct-Dec)	(Jan-Mar)	(Apr-June)	(July-Sep)
01.	Atmospheric Temperature(^{0}C)	28	29	30	29
02	Surface water Temperature(^{0}C)	27	28	29	28
03.	pH	7.8	8.8	9.5	8.7
04.	Alkalinity (ppm)	19.1	25.1	29.6	23.5
05.	Salinity (ppt)	22	27	32	28
06.	TDS (ppm)	1445	1875	1980	1610
07.	Calcium (ppm)	850	925	985	910
08.	Magnesium (ppm)	325	365	410	391
09.	Chloride (ppm)	225	245	251	242
10.	Ammonia (ppm)	11.5	10.7	10.2	10.8
11.	Nitrate (ppm)	25.2	22.5	47.8	19.5
12.	Nitrite (ppm)	9.5	8.2	6.1	8.7
13.	Inorganic Phosphorus (ppm)	1.085	0.964	0.693	0.987
14.	Organic Phosphorus (ppm)	0.658	0.554	0.41	0.534

The water temperature of sampling station ranged from 28^{0}C in monsoon, 29^{0}C in post monsoon, 30^{0}C in summer, and 29^{0}C in pre-monsoon season. As expected, the highest temperature (30^{0}C) was observed during the summer season whereas the lowest temperature(28^{0}C) was common in winter season (Fig.2). The average water temperature recorded at four stations was more or less uniform in the river; however, slightly higher temperature was found in the sea. This temperature profile is very common in a typical sub-tropical aquatic system[8].

Comparing among different seasons, the maximum pH was frequently found in the summer season and the minimum pH was appeared in the rainy season, as depicted in Figure 3. Low and high pH value is very harmful for the ecosystems of the river, and the recommended pH level of river water is around 7.4. The finding ofpHrevealed that is most important factor which controls the growth of the green algae[9].

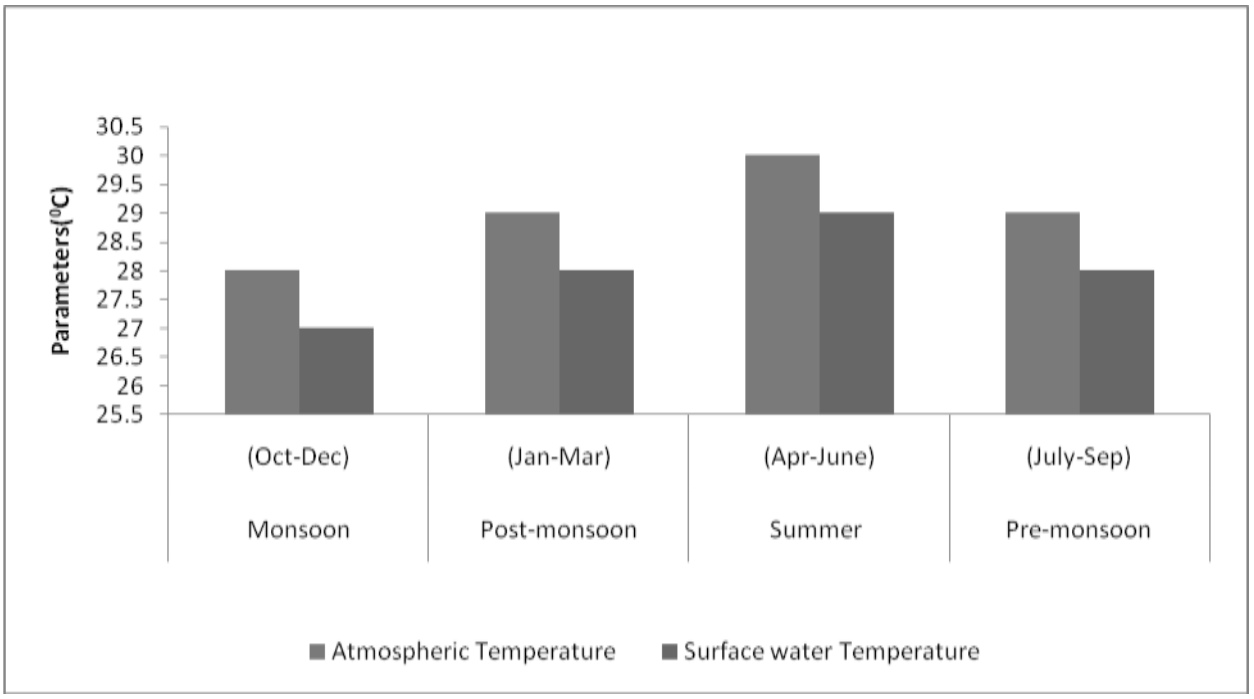

Figure 2.Physico-chemical analysis of Keezhathottam mangrove water (October 2013 to September 2014)

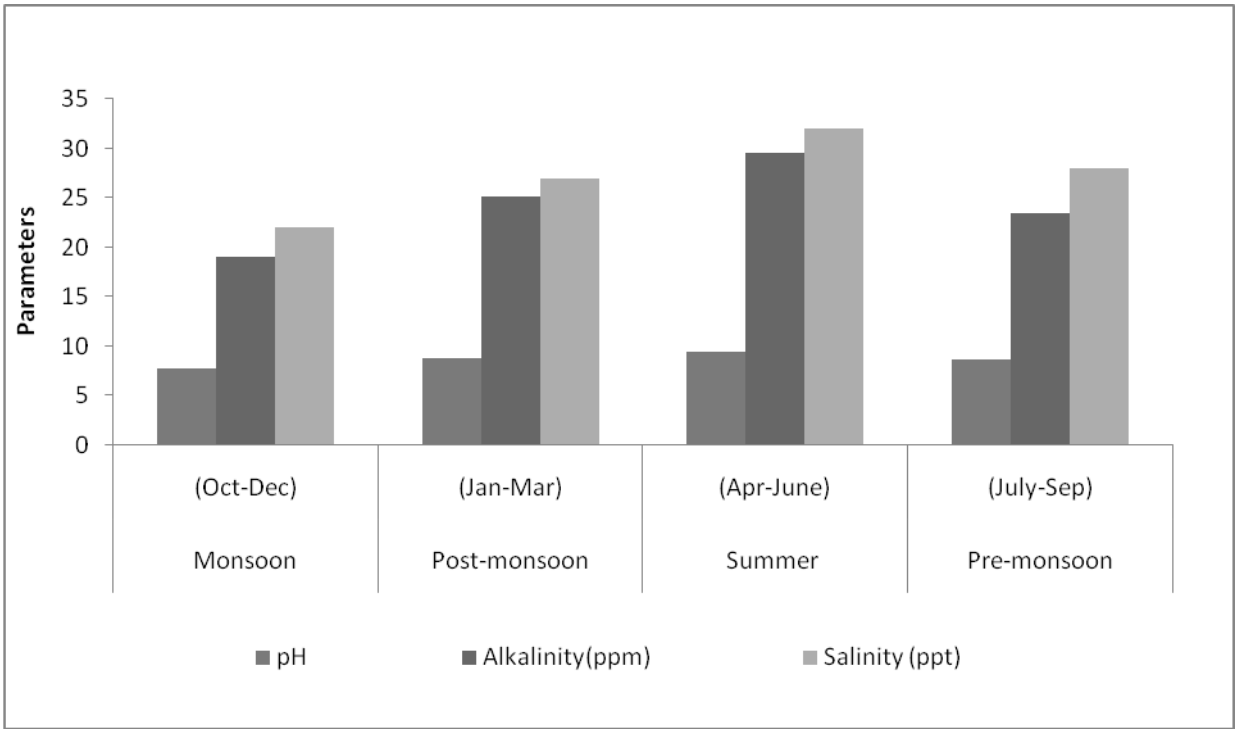

Figure 3.Physico-chemical analysis of Keezhathottam mangrove water (October 2013 to September 2014)

Salinity showed the highest values (32 ppt) in summer (Fig. 3) nearer to the coastal environment associated with low phosphorus (0.992) concentrations. The lowest value of salinity (22 ppt) was noticed in monsoon seasons, accompanying high phosphorus (1.635) concentration due to the freshwater zone of this aquatic environment. This in turn enhances the concentrations of ammonia (11.5 mg/l) and nitrite (9.5 mg/l) at

these monsoon periods. High nitrate (25.2 mg/l), Inorganic phosphorus (1.085 mg/l) and Organic phosphorus (0.658 mg/l) concentration observed in the monsoon periods indicates the impact of terrestrial runoff.

Total alkalinity values ranged from 19.1 to 29.6 mg/l (Fig.3). The higher total alkalinity values recorded in summer irrespective of the season may have been influenced by the presence of domestic waste and the absence of normal tidal action, which would have had flushing and diluting effect on dissolved constituents as well as bicarbonates, which could increase alkalinity levels.

The environmental parameters showed variations in different seasons in the study region depending on the topography. The water pH, temperature and salinity fluctuations in the Keezhathottam are consistent with seasonal cycles. However, the influence of the Keezhathottam mangroves on hydrographic conditions was observed at the sampling stations. The spatial and temporal differences in physicochemical variations indicate the diversity of habitats that exist within this lagoon. Monsoon season and post monsoon have a lower temperature and salinity than the premonsoon.

Hardness of water samples in Keezhathottam mangroves was found to be ranged from 1445 mg/L to 1875 mg/L and 1610 mg/L to 1980 mg/L in winter and summer seasons respectively as summarized in Figure4. For the standard case, the hardness of river water remains moderately high (75-100 mg/L) for the rainy season; however, the values are excessively high (300 mg/L) for the winter and summer seasons[10].Hardness of seawater is reasonably higher than that of river water. Typical seawater has a calcium hardness of

1000 mg/L, magnesium hardness of 5630 mg/L and total hardness of 6630 mg/L . A high level of hardness is occurred due to the divalent cations such as Ca^{2+} and Mg^{2+}. Cations higher than divalent can contribute low level of hardness and mono-valentcations cannot produce any hardness. The high level of hardness of the Keezhathottam mangroves water during the winter and summer seasons may be due to the seawater intrusion from Bay of Bengal to the fresh ground water.

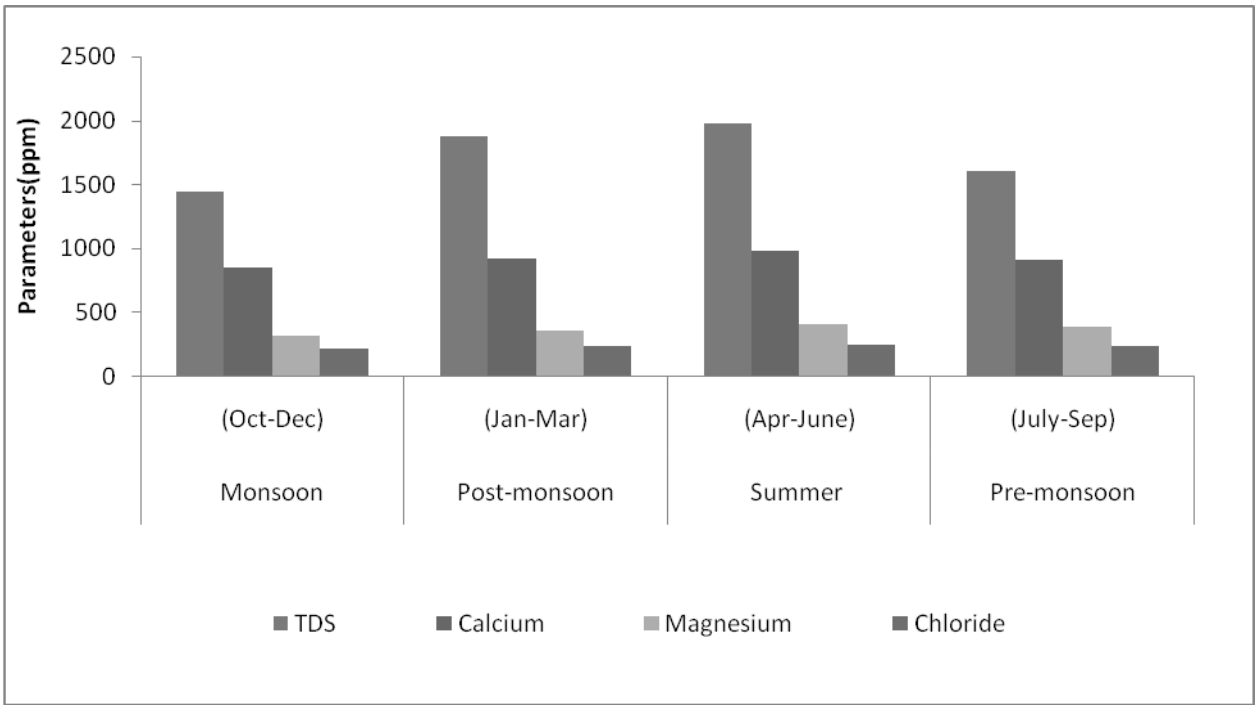

Figure4.Physico-chemical analysis of Keezhathottam mangrove water (October 2013 to September 2014)

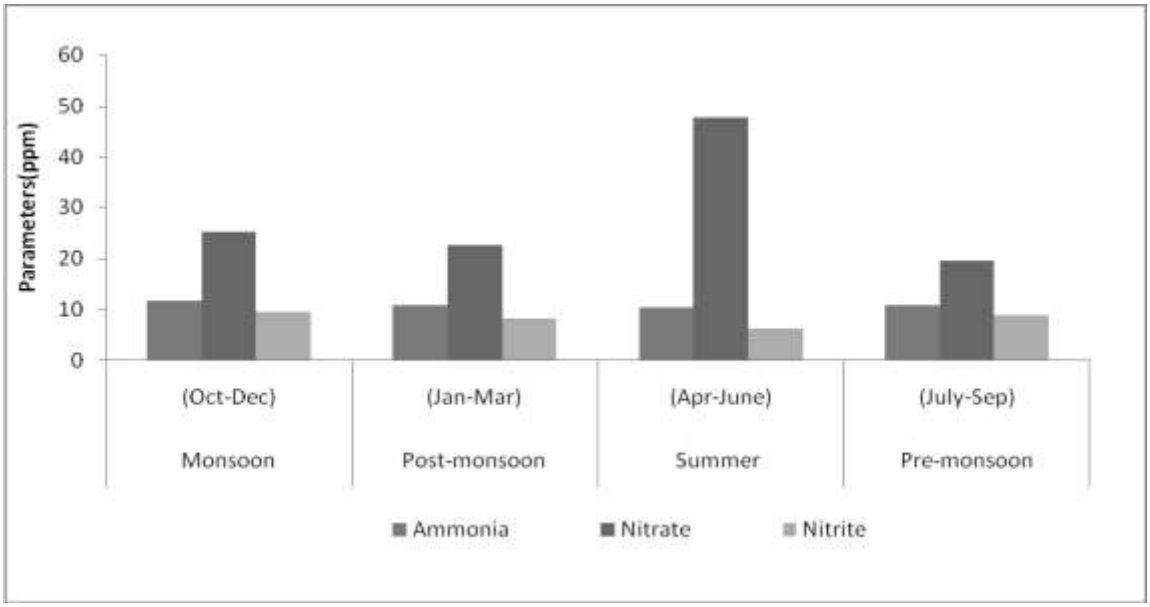

Figure 5.Physico-chemical analysis of Keezhathottam mangrove water (October 2013 to September 2014)

Nitrite and nitrate values varied from 6.1 to 9.5 mg/l and 19.5 to 47.8 mg/l respectively. In general the nitrite and nitrate values were high during monsoon and low during summer seasons (Fig. 5). The highest phosphate and nitrate values recorded during monsoon season may be attributed to heavy rainfall, land runoff, its autochthonous origin and weathering of rocks liberating soluble alkali metal phosphates, the bulk of which are carried into the mangrove waters[11,12].The low values recorded during non-monsoon period may be due to utilization by phytoplankton as evidenced by high photosynthetic activity and the dominance of neritic seawater having negligible amount of nitrate[11]. Another possible way of nitrate entry is through oxidation of ammonia form of nitrogen to nitrite and then consequently to nitrate[13]. The higher value of nitrite recorded during monsoon season may be due to various reasons including 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 environmentand also due to denitrification and airsea interaction exchange of chemicals[14,15].

Generally, ammonia concentrations were lower in the dry season months than in the rainy season months. Seasonal influence resulting to lower ammonia values during the summer season, over levels in the monsoon season in Muthupet mangrove was also reported[16].

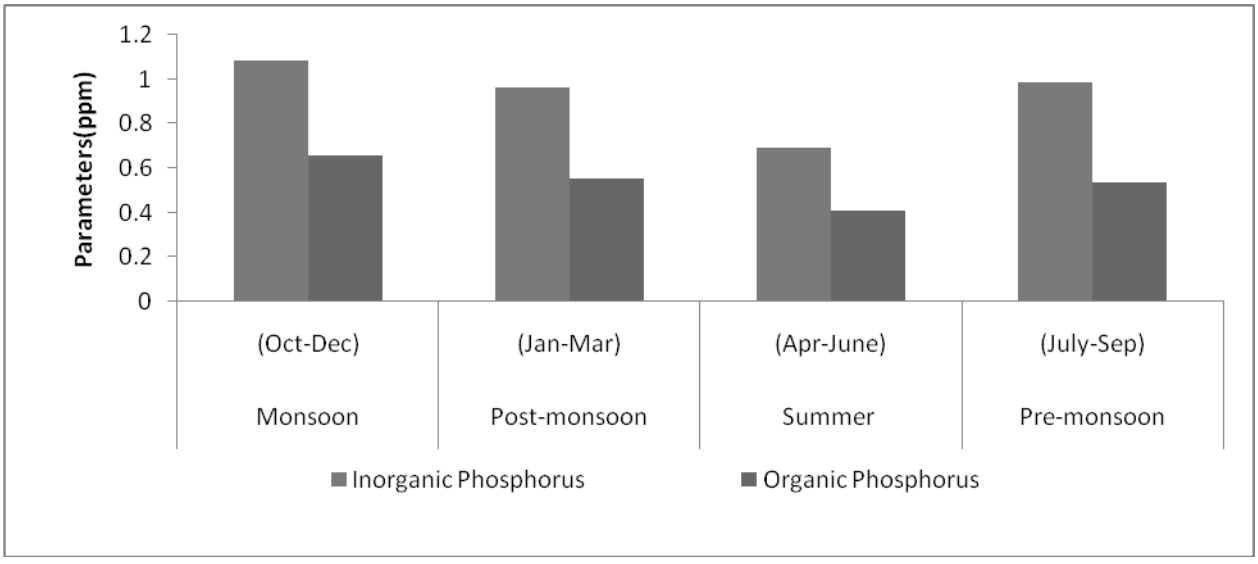

Figure 6.Physico-chemical analysis of Keezhathottam mangrove water (October 2013 to September 2014)

Total Phosphate concentrations ranged from 0.900 to 1.635 mgl^{-1}(Fig.6). Values were also higher in the rainy months and the lowest concentration of summer was recorded. The mangrove waters in general have relatively low stocks of inorganic phosphorus and nitrogen[17]. In some cases, the degree of human impact seems to control nutrient profiles[18].while in others the degree of upland influence and the hydrology of the system appear to be of greater importance[19]. The Muthupet mangrove ecosystem was found to be nutrient rich, and the ratios of N: P (10: 1) as well as TN:TP (8: 1) were low[16]. In the present study similar report was survey in Keezhathottam mangrove water.

The mangrove soil nutrients and physico-chemical characteristics of mangrove soil of study sites are given in (Table 2). Edaphic character sties of samples collected from study areas indicated that the soil were Brown to Red brown in colour and the texture was clay was present in the soil of Keezhathottam mangroves[20].The average percentage of clay at Sharankhola, Chandpai, Nalianala and Burigoalini respectively for Sundraban mangrove in Bangladesh was reported[20]. The percentage composition of soil in the chakaria mangrove areas were always found to be sand>clay>silt[21].

Table 2:Physico-chemical analysis of Keezhathottam mangrove soil (October 2013 to September 2014)

S.No.	Parameters	Monsoon	Post-monsoon	Summer	Pre-monsoon
		(Oct-Dec)	(Jan-Mar)	(Apr-June)	(July-Sep)
01.	pH	9.5	9.9	10.8	10.2
02	Organic matter (%)	13.5	14.3	16.2	14.6
03.	Nitrogen(ppm)	7.8	6.7	6.2	6.9
04.	Phosphorus(ppm)	13.5	11.2	10.5	12.2
05.	Potassium(ppm)	7.7	5.8	4.5	5.4
06.	Sodium(ppm)	1.9	1.5	1.2	1.6
07.	Calcium(ppm)	35	30	24	29
08.	Magnesium(ppm)	2.3	1.7	1.4	1.9
09.	Manganese(ppm)	5.8	5.45	5.01	5.5
10.	Zinc(ppm)	2.7	2.4	1.5	2.3
11.	Copper(ppm)	0.7	0.6	0.4	0.55
12.	Iron(ppm)	3.7	3.3	2.5	3.4

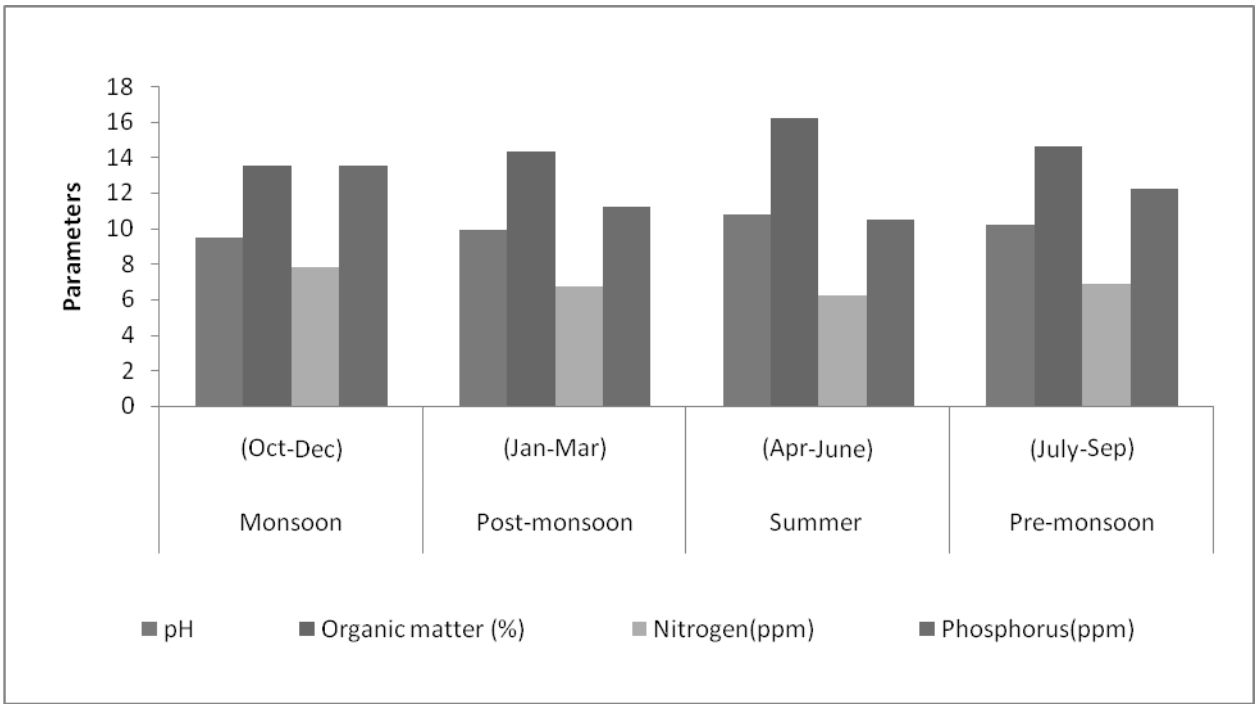

Figure 7.Physico-chemical analysis of Keezhathottam mangrove soil (October 2013 to September 2014)

The average pH values were determined by 9.5 to 10.8 in the study periods (Fig7) reported the average pH values were found 6.3, 6.73, 7.13 and 6.8 in the Sharankhola, Chandpai, Nalianala and Burigoalini respectively for Sundraban mangrove in Bangladesh[20]. Organic matter values in monsoon, post monsoon, pre monsoon and summer were 13.5, 14.3, 14.6 and 16.2 % respectively. Organic matter concentrations were greatest inthe summer in the mangrove (16.2%). Five percent organic matter is ideal for the proper composition of soil. Due to more decomposition of plant and animal residues in mangrove area the percentage of organic matter is higher than other soil tract. For this reason the biological activity in mangrove forest area is highly active. The organic matter varied between 0.86 and 1.9% in the intertidal muddy beach[21].The organic carbon is related to mud percentage in the soil[22]. Mud percentage in the study areas were higher than sand and that is why organic matter was higher in the Sundaraban areas[20].

The chemical properties of the soils varied considerably among samples particularly in nutrient level. Phosphorus concentrations present in the Keezhathottam mangrove ware analyzed in four seasons such as monsoon, post monsoon, pre monsoon and summer were 13.5, 11.2, 12.2 and 10.5 mg/kg respectively.The extractable phosphorus values reportedwere similar to the results presented here; the range from thelower and upper profiles was between 20 and 120 mg/kg[23]. The total amount of potassium was maximum in the monsoon and minimum in summer season.

The potassium content is observed in the range of 4.5 to 7.7 mg/g in Keezhathottam mangroves (Fig.8).The average potassium values is found 450-750, 250-450, 350-500 and 350-570 µg/g in Sharankhola, Chandpai, Nalianala and Burigoalini, respectively for Sundraban mangrove in Bangladesh[20]. Sodium and potassium content in the soil were varied from soils varied considerably among samples particularly in nutrient level. The total amount of nutrients was maximum in the monsoon and minimum in summer season. The average sodium content is varied from 250-750 µg/g, Calcium content 1900 to 4500 µg/g and magnesium content 420 to 1500 µg/g in the Sundraban mangrove in Bangladesh[20].

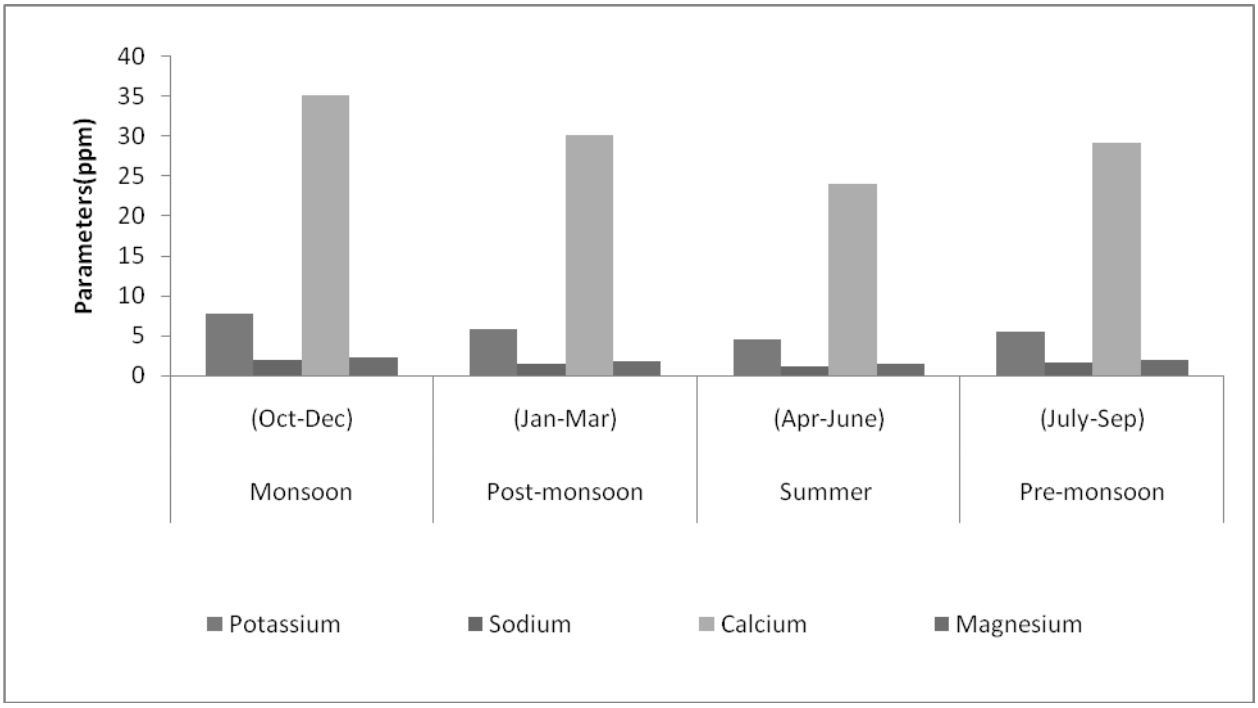

Figure 8.Physico-chemical analysis of Keezhathottam mangrove soil (October 2013 to September 2014)

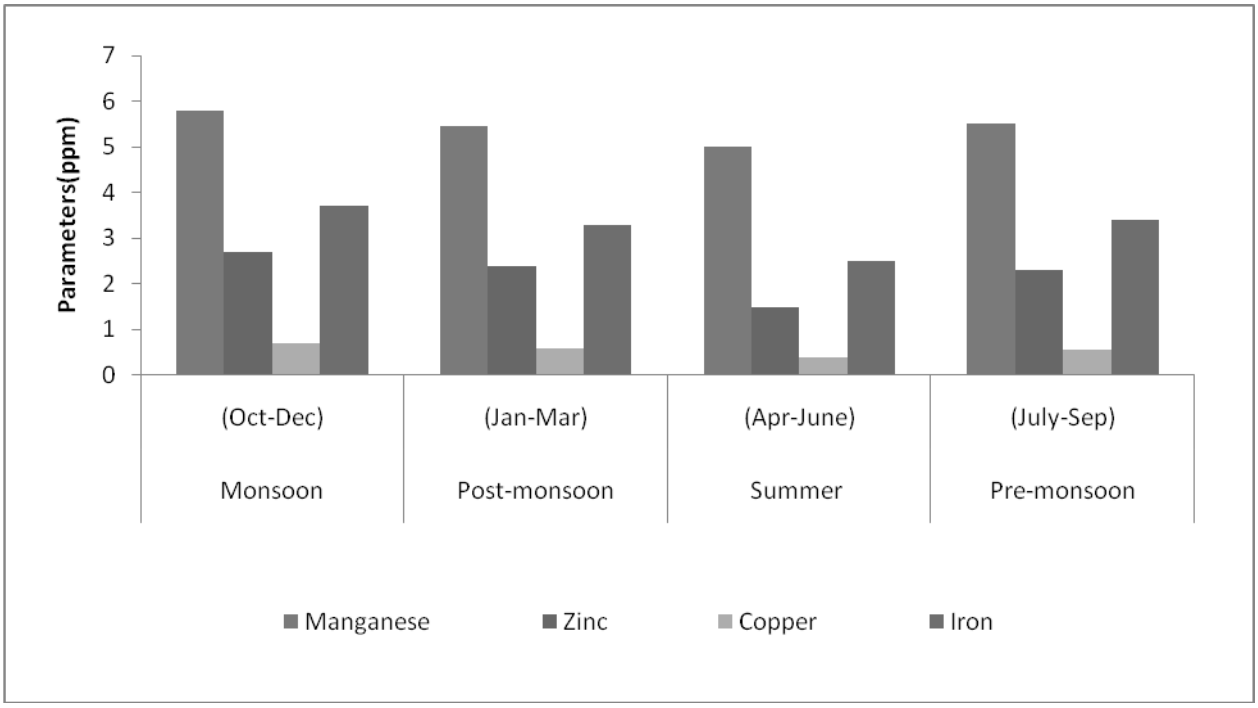

Figure 9. Physico-chemical analysis of Keezhathottam mangrove soil (October 2013 to September 2014)

The micronutrients such as zinc, copper, iron and manganese also present in moderate level in all the season (Fig.9). Among the soil samples, all the micronutrients were maximum in monsoon and minimum in summer season.

Conclusions

Mangroves are some of the most productive, complex, and beneficial natural wonders of our planet. Today mangrove forests are one of the most threatened habitats in the world. Public awareness and education about the mangrove forests may help protect them. It is necessary to involve all agencies include thelocal communities play an important role and should bemore effective to prevent the destruction of themangrove forest ecosystem and the aquaticenvironment of the mangrove forest. The present baseline information of the physico-chemical characteristics of water and soil texture would form an useful tool for further ecological assessment and monitoring of thesecoastal ecosystems of Keezhathottam mangroves.

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