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Original Research Paper

A Study on Environmental Quality of Manakudy Mangroves, Kanyakumari District, Tamilnadu Southwest Coast of India

Biochemistry

KEYWORDS : Mangrove, environmental quality, water, soil

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ABSTRACT

The present survey was made to study the some physico-chemical parameters in the water and soil of Manakudy mangroves during the year 2014-2015 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 and organic matter were maximum in the monsoon and minimum in summer season. The micronutrients such as zinc, copper and iron also present in moderate level in all the season. More hardness and alkalinity with sufficient amount of oxidizable organic matter, limited dissolved oxygen content and alkaline pH were probably the factors favouring the growth of living organisms. The study exemplified the fact that the Manakudy mangrove ecosystem is in a good state of health.

INTRODUCTION

Mangrove-forest is a vegetation community formed by a variety of mangrove vegetation species growing in the intertidal areas and estuary mouths between land and sea. Mangroves can provide critical habitat for a diverse marine and terrestrial flora and fauna. Mangrove forest beaches have an abundant nutrition and a good ecological environment for the marine creatures. Mangrove forests are one of the most productive and biodiversity wetlands on the earth. Thereby, this condition has formed the mangrove ecosystem. The large area mangrove forest is very important to protect the ecological balance of sea and coastline. Healthy mangrove forests are a key to a healthy marine ecology. Yet, these unique coastal tropical forests are among the most threatened habitats in the world (Ramamurthy, 2010).

Wetlands are vital to the health of environment due to their immense ecological and socioeconomic value. India has $7.6x10^{-4}$ km^2 of wetland comprising estuaries, bays, lagoons, brackish waters, lakes and saltpans. The various tidal zones, with characteristic substratum sustain a variety of specialized habitats of productive and complex nature. Mangroves, influenced by marine as well as fresh water are the most predominant and ecologically fragile habitats of coastal wetlands. About 8 % of India's coastline mangroves have occupied admeasuring 3760 km2 areas. These habitats have been to harbour varieties of biota of ecological and commercial importance. However, being easily accessible, mangrove ecosystems from the country have been over-exploited in the recent past leaving them in the most degraded stage (Ramamurthy et al., 2012).

*The mangrove forest at Manakudy is located on the southern extremity of Indian Peninsula (Lat 8*02'N Long 77030'E) along the south west coast of India, about 10 km from Kanyakumari. Manakudy estuary which has an area of about 150 ha is situated about 8 kilometers northwest of Cape Comorin in Kanyakumari District. It is the confluence of river pazhayar, which has its origin from the Western Ghats. The Manakudy mangroves is abound with varied habitats that include shallow open waters, sandy beaches, muddy flats, mangrove forest, river delta and sea grass. Mangroves are a significant ecosystem in the estuary with a luxuriant growth on the mud flats. The litters on the mangrove floor undergo humification and mineralisation and the nutrients are leached into the mangrove water due to surface run-off adding to the productivity of the estuary. There is luxuriant growth of mangroves on the mud flats of Manakudy mangroves.

Mangroves are coastal wetland forests established at the intertidal zones of estuaries, backwaters, deltas, creeks, lagoons, marshes and mudflats of tropical and subtropical latitudes. Approximately one fourth of the world's coastline is dominated by mangroves that are distributed in 112 countries and territories comprising a total area of about 181,000 km2 (Saravanan, 2005). Among the marine ecosystems, mangroves constitute the second most important ecosystem in productivity and sustained tertiary yield after coral reefs. Productivity in mangrove waters depends on the extent of mangrove canopy cover that supplies carbon, nitrogen and phosphorous (Ramamurthy et al., 2009). 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. So, the present study has been undertaken to know the some physico-chemical parameters of soil and water of Manakudy mangrove forest.

MATERIAL AND METHODS

The water was collected from Manakudy mangroves situated at Kanyakumari district, Tamil Nadu, India. A sampling programme consisting of a series of monthly water and soil quality survey was conducted for one year (2014 - 2015).

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The Physico-chemical characteristics of water were done according to the Standard Methods (APHA, 1998). The Physico-chemical characteristics of soil were done according to the standard methods Organic matter (Wlakley and Black, 1934), Avilable of phosphorus (Olsen et al., 1954), Avilable Nitragen and Potassium (Sankaram, 1996). Sodium was recorded by the method of Aitken (1984). Some moles like Ca and Mg were determined by according to the International pipette method describe by Piper (1942) and also Hydrometer method (Bouyoucos, 1962). The temperature and pH of the water and soil were measured at the station itself. All the determinations were replicated thrice and the mean values were used to obtain representation of samples.

RESULTS AND DISCUSSION

The environmental parameters showed variations in different seasons in the study region depending on the topography. Atmospheric temperature varied between 30.9 and 32.1°C in post monsoon and pre monsoon respectively. The minimum (28.5°C) was recorded during monsoon season in November and the maximum (34.2°C) was observed during summer in May. Surface water temperature ranged from 28.3 to 31.3°C in post monsoon and pre monsoon respectively. The minimum (27.4°C) was recorded during monsoon season in November while the maximum (33.4°C) was during summer in May. The environmental parameters showed variations in different seasons in the study region depending on the topography. Salinity showed the highest values (29.1 ppt) in summer nearer to the coastal environment associated with low phosphorus (0.901 mg/l) concentrations. The lowest value of salinity (23.8 ppt) was noticed in monsoon seasons, accompanying high phosphorus (1.655 mg/l) concentration due to the freshwater zone of this aquatic environment. Low DO (5.1 mg/l) values in summer season may be due to the stagnant not conditions of the water with increasing waste load in the mangrove environment. This in turn enhances the concentrations of ammonia (7.3 mg/l) and nitrite (5.7 mg/l) at these monsoon periods. High nitrate (17 mg/l), inorganic phosphorus (1.091 mg/l) and organic phosphorus (0.620 mg/l) concentration observed in the monsoon periods indicates the impact of terrestrial runoff.

Estuarine mangrove waters in general have relatively low stocks of inorganic phosphorus and nitrogen (Alongi et al 1992). In some cases, the degree of human impact seems to control nutrient profiles (Nedwell 1975), while in others the degree of upland influence and the hydrology of the system appear to be of greater importance (Boto & Wellington 1988; Ovalle et al 1990). In the present study, the ecosystem was found to be nutrient rich and the ratios of N: P (9: 1) as well as TN: TP (7: 1) were low. The water pH, temperature and salinity fluctuations in the Manakudy mangrove are consistent with seasonal cycles. However, the influence of the Manakudy mangrove 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 pre monsoon.

The salinity 23.8 ppt was recorded in monsoon season and the maximum 29.1 ppt in summer. Salinity is the prime factor of the environmental changes by the freshwater inflow and the prevailing temperature of the mangrove and coastal waters. In the present study salinity becomes high in mouth bar. Salinity distribution is the major factor, which governs the invasion of marine and freshwater organisms into the estuary (Nair and Tranter, 1971).

Free carbon-di-oxide was reported as higher 1.91mg/l in summer season during March-May and low 1.45 mg/l in monsoon season. CO_2 is released during respiration by organisms. Its increased level may affect the pH of the water. Maximum CO2 content was found in the polluted zone due to the disposal of wastages. Verma Pradeep et al. (2012) reported the same throughout the investigation.

The higher nitrate level (17 mg/l) was recorded in the monsoon season and lower level (9.1 mg/l) was recorded in summer season. Higher values of nitrate recorded during monsoon season might be due to the influx of nitrogen rich flood water. Inorganic nitrogen is present in an aquatic biotope as oxidized nitrate, nitrite an intermediate state in the nitrogen cycle. Increasing amount of nitrate will leads to the high growth of aquatic plant, which may affected the mangrove water environments leading to eutrophication. This causes sickness and death of marine organisms. The organic materials received from the fisheries leads to increase in nitrate level (Prabhu et al., 2008).

Total phosphorus was maximum (1.655 mg/l) during the monsoon season and minimum (0.901 mg/l) in summer season. Total phosphorus content was found to be high may be due the impact of industrial effluents. Similar conditions were observed by Sundararaj and Krishnamurthy (1975) from Pitchavaram mangrove waters. The environmental changes of phosphate due to the processes like surface assimilation and buffering action of sediment (Govindasamy et al., 2000). Total Phosphate concentrations ranged from 0.901 to 1.655 mgl-1. Values were also higher in the monsoon season and the lowest concentration of summer was recorded. Phosphate concentrations reported for Vedharanyam mangroves are higher in rainy than other seasons those reported (Ramamurthy et al., 2012).

Total alkalinity values ranged from 15.9 to 26.1 mg/l. 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. 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 by Ramamurthy *et al. (2009).*

The 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 Manakudy mangroves. 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 and iron also present in moderate level in all the season. Among the soil samples, all the micronutrients were maximum in monsoon and minimum in summer season.

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 Manakudy mangroves reported the average percentage of clay at Sharankhola, Chandpai, Nalianala and Burigoalini

respectively for Sundraban mangrove in Bangladesh. So it is found that the soil texture of the Sundarban is likely silty clay. Choudhury (1962) found that the soil of Sundraban is finely textured and the sub soil is stratified and at greater depth is compacted. Zafer *et al*. (2001) reported that the percentage composition of soil in the chakaria mangrove areas were always found to be sand>clay>silt. Given that these mangroves were not located in the geographic areas, the variability in the properties of the soils underlying these mangroves is not unexpected.

The average pH values were determined by 9.6 to 10.2 in the study periods. Hassan and Razzaque (1981) found that the pH value of soil in Sundarban is neutral to mildly alkaline under field conditions but in some localities the pH value of dried up sub soil samples drops to 6.5. Mohamood and Saikat (1995) reported the acidic pH values in the soil of Chakaria mangrove area and consequently, this area have a rich reserve of pyrite in its soil. Muhibbullah *et al*. (2005) 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. Organic mater values in monsoon, post monsoon, pre monsoon and summer were 12.2, 13.7, 14.6 and 13.6 % respectively. Organic matter concentrations were greatest in the summer in the mangrove (14.6%). Five percent organic matter is ideal for the proper composition of soil. Choudhury (1962) mentioned that the organic matter in mangrove soil belong over 5%. 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. Zafar et al. (1999) stated that organic matter varied between 0.86 and 1.9% in the intertidal muddy beach. Escourt (1967); Anderson (1977); Mayer et al. (1985) reported that organic carbon is related to mud percentage in the soil. Mud percentage in the study areas were higher than sand and that is why organic matter was higher in the Sundaraban areas (Muhibbullah et al., 2005).

The chemical properties of the soils varied considerably among samples particularly in nutrient level. Phosphorus concentrations present in the Manakudy mangrove ware analyzed in four seasons such as monsoon, post monsoon, pre monsoon and summer were 11.8, 10.5, 10.1 and 8.6 mg kg–1 respectively. The extractable phosphorus values reported by Karim (1994) were similar to the results presented here; the range from the lower and upper profiles was between 20 and 120 mg kg–1. The total amount of potassium was maximum in the monsoon and minimum in summer season. The potassium content is observed in the range of 27.5 to 56.1 mg/g in mangroves. Muhibbullah *et al*. (2005) reported 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. 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. Karim (1994) reported the sodium content is varied from 450-1850 μg/g, Calcium 2350 to 3950 μg/g and magnesium content 1000 to 1500 μg/g in the mangrove soils. Muhibbullah *et al*. (2005) reported 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.

Sheela and Sugirtha Kumar (2014) studied that the soil samples from Manakudy mangrove sediments had pronounced peaks in the clay fraction in March, April, May and June. Variation in the kurtosis values is a reflection of the flow characteristics of the depositing medium, the dominance of finer size of very platykurtic nature of the sediments reflecting the maturity of the sand. This may due to the aggregation of sediment particle size by compaction and the variation in the sorting values are likely due to continuous addition of finer/coarse materials in varying proportions. The Manakudy mangrove sediments are under pressure from the anthropogenic sources like sewage and domestic waste has resulted in initiation of organic load build up in it. Manakudy mangrove sediments, sand is the major fraction and it is coarsely skewed and planty to extremly leptokurtic in nature. Soil samples from Manakudy mangrove sediments had pronounced peaks in the clay fraction.

The present information of physico-chemical properties of water and soil samples from Manakudy mangroves shows relatively high content of salinity than the riverside. Salinity level is the main factor responsible for variation in the hydrobiology. The quality of water and soil in the mangroves is deteriorated by ret liquor of the retting industry adjacent to the estuary, domestic sewage and agricultural runoff along natural and artificial sources. The quality of water is not stable and it may be changed due to seasonal variations. Water nutrients shows variations among mangroves and revering side because the accumulation of artificial and natural calamities. It is concluded that the necessessity of monitoring the water resource of Manakudy mangroves.

Table : 1 . Physico-chemicalanalysis of Manakudy mangrove water (October 2014 to September 2015)

S. No	Parameters	Monsoon	Post-monsoon	Summer	Pre-monsoon
1	pH	7.6 ± 1.26	8.2 ± 1.84	8.7 ± 2.16	7.9 ± 1.54
2	Atmospheric Temp. (^{0}C)	28.5 ± 2.57	30.9 ± 2.18	34.2 ± 2.97	32.1 ± 2.14
3	Surface water Temp. (^{0}C)	27.4 ± 2.06	28.3 ± 2.11	33.4 ± 2.56	31.1 ± 2.17
4	EC (dsm^{-1})	288 ± 5.14	313 ± 5.06	392 ± 6.17	306 ± 5.84
5	Turbidity (NTU)	5.25 ± 3.08	6.12 ± 3.17	7.87 ± 2.87	6.51 ± 3.31
6	Total dissolved solids	854 ± 1.21	883 ± 1.81	910 ± 1.12	892 ± 1.65
7	Alkalinity	15.9 ± 1.28	20.8 ± 1.33	26.1 ± 1.18	21.7 ± 1.87
8	Free carbon dioxide	1.45 ± 2.14	1.69 ± 2.18	1.91 ± 2.45	1.58 ± 2.22
9	Dissolved Oxygen	6.5 ± 0.12	6.1 ± 0.65	5.0 ± 0.98	5.9 ± 0.87
10	Ammonia	7.3 ± 6.71	6.5 ± 6.12	5.8 ± 6.17	6.2 ± 6.42
11	Nitrate	17 ± 4.19	12 ± 4.67	9.1 ± 4.81	10 ± 4.27
12	Nitrite	5.7 ± 5.17	4.9 ± 5.26	3.4 ± 5.81	4.7 ± 5.28
13	Total hardness	1050 ±0.11	1125 ± 0.34	1210 ± 0.81	1150 ±0.22
14	Calcium	675 ± 0.47	697 ± 0.22	794 ± 0.84	710 ± 0.35
15	Magnesium	324 ± 0.18	345 ± 0.14	372 ± 0.31	354 ± 0.15

Volume : 5 | Issue : 8 | August 2016 • ISSN No 2277 - 8179 | IF : 3.508 | IC Value : 69.48

16	Chloride	124 ± 1.51	151 ± 1.87	195 ± 1.34	167 ± 1.28
17	Sulphate	15.7 ± 1.22	17.2 ± 1.42	18.7 ± 1.46	17.9 ± 1.85
18	Salinity (ppt)	23.8 ± 1.44	25.9 ± 1.31	29.1 ± 1.25	26.7 ± 1.13
19	Silicate	3.87 ± 1.17	4.13 ± 1.28	5.18 ± 1.54	4.54 ± 1.11
20	Total Phosphorus	1.655±0.15	1.340±0.28	0.901±0.84	1.420±0.24
21	Inorganic phosphorus	1.091±0.24	0.926±0.86	0.605±0.22	0.978±0.29
22	Organic phosphorus	0.620±0.33	0.480±0.14	0.301±0.56	0.495±0.41
23	Sodium (ppm)	115 ± 1.24	119 ± 1.37	141 ± 1.82	117 ± 1.22
24	Potassium (ppm)	2.72 ± 0.17	3.13 ± 0.22	4.71 ± 0.36	3.24 ± 0.15
25	BOD	8.8 ± 1.11	11.8 ± 1.42	14.2 ± 1.27	12.3 ± 1.38
26	COD	59.7 ± 1.63	66.8 ± 1.44	73.2 ± 1.64	67.4 ± 1.85

Monsoon (Oct-Dec); Post-monsoon (Jan-Mar); Summer (Apr-June); Pre-monsoon (July-Sep)

* Except pH and temperature all values expressed in mg^{-1}.

Table. 2. Physico-chemical analysis of Manakudy mangrove soil (October 2014 to September 2015)

S. No	Parameters	Monsoon	Post-monsoon	Summer	Pre-monsoon
1	Soils texture	Clay	Clay	Clay	Clay
2	pH	8.6 ± 1.15	8.9 ± 1.24	9.6 ± 1.64	9.1 ± 1.31
3	EC (dsm^{-1})	1.25 ± 1.23	1.29 ± 1.15	1.38 ± 1.10	1.30 ± 1.22
4	Organic matter (%)	14.5 ± 0.22	15.2 ± 0.31	17.3 ± 0.14	15.8 ± 0.12
5	Nitrogen (mg/g)	7.5 ± 0.14	6.7 ± 0.19	5.7 ± 0.25	6.3 ± 0.17
6	Potassium (mg/g)	56.2 ± 1.23	34.5 ± 1.42	27.5 ± 1.31	36.3 ± 1.33
7	Phosphorus (mg/g)	11.8 ± 1.18	10.5 ± 1.25	8.6 ± 1.27	10.1 ± 1.15
8	Sodium (mg/g)	1.5 ± 1.22	1.0 ± 1.17	0.85 ± 1.21	1.1 ± 1.17
9	Calcium (mg/g)	30 ± 1.29	25 ± 1.34	19 ± 1.31	24 ± 1.64
10	Magnesium (mg/g)	1.8 ± 1.31	1.2 ± 1.15	1.0 ± 1.27	1.4 ± 1.12
11	Zinc (ppm)	2.28 ± 0.28	2.19 ± 0.17	1.59 ± 0.19	2.12 ± 0.13
12	Copper (ppm)	0.51 ± 1.31	0.41 ± 1.12	0.34 ± 1.64	0.42 ± 1.08
13	Iron (ppm)	5.70 ± 2.13	6.15 ± 2.33	6.92 ± 2.94	6.25 ± 2.15

Monsoon (Oct-Dec); Post-monsoon (Jan-Mar); Summer (Apr-June); Pre-monsoon (July-Sep)

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