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Physico-Chemical Analysis of Mangrove Soil, Kundapura, Karnataka, India

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Abstract

The present study was carried out to determine the periodic variation in physico-chemical characteristics of mangrove soil samples. The soil samples had been accrued from four distinctive places of Kundapura mangrove areas in three seasons, monsoon, pre-monsoon and post-monsoon. Soil analysis pertaining to various variables such as total Nitrogen, Phosphorus, Potassium, pH and Electrical conductivity. Soil pH is assorted from 3.84 to 6.66. Electrical conductivity is assorted from 0.02 dSm^{-1} to 9.60 dSm^{-1}. Available nitrogen is assorted from 30.7 kg/ha to 323 kg/ha. Available phosphorus concentration has ranged between 1.37 kg/ha and 47.27 kg/ha. Available potassium is differed from 117.43 kg/ha to 537.63 kg/ha. The results confirmed variations in all of the analyzed parameters of the soils amassed from four stations.

Article History

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Keywords

Monsoon;
Nitrogen;
Phosphorus;
Pre-monsoon;
Post-monsoon;
Potassium.

Introduction

Mangroves are tropical plants which grow along the tropical coastlines of the world. They are found growing along shallow sheltered coasts. Mangroves are responsible for several economic as well as ecological services.[1]

Mangroves are the most productive and biologically important ecosystems of the world, as they offer ecological balance, goods and offerings to humans; performs an essential position in nature with the aid of using nurturing ecological, safety and social services.[2] Like any other ecosystem mangrove ecosystem is likewise a cradle and predominant bioresource for plenty beneficial bioingredients together with many different species which are directly or indirectly depending on the sustenance of mangrove ecosystem.[3] Marine

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ecosystems are numerous habitats, endowed with physical, chemical, and geographical versions in the ecosystems, wherein the gradation from relatively productive organisms to especially specialised organisms exists.[4] Mangrove wetlands are one of the world's most threatened ecosystems and are vital wetlands alongside tropical and subtropical coasts, mainly along deltas and bays in which rivers discharge freshwater and sediment to the sea that offer ecological security, environmental sustainability and economic prosperity.[5]

Mangroves are salt lenient forest ecosystems of tropical as well as subtropical intertidal areas of the arena. There may be no additional group of plants with such relatively advanced morphological as well as physiological adaptations to severe situations.[6] Mangrove soils arise in coastal environments of tropical and subtropical regions and they will be originated from sedimentary material deposited via river as well as marine actions or from the amendment of the sedimentary substrate. The sediments are similarly reformed by means of organisms amended to flood, anaerobic as well as salt conditions. Soils of mangrove ecosystems are the end result of complicated interactions amongst abiotic elements, along with tidal oscillations and biotic factors. Soils offer vital nutrients for mangrove species growth and bodily structure for plant anchorage and balance.[7]

Mangrove habitat is the breeding floor to fishes, crabs, shrimp species and mollusks. The trees are home to an array of nesting, breeding as well as migratory birds. When mangrove forests are vacant precious habitat is gone astray, intimidating the survival of myriad species. Hence there is a requirement of studying mangrove soil which supports the vegetation.

Table 1: Study sites

Study sites	Latitude	Longitude	Elevation (Feet)
Herikudru	13°38'28"N	74°42'01"E	28'
Uppinakudru	13°39'21"N	74°41'59"E	25'
Jaladi	13°39'41"N	74°42'16"E	16'
Hemmadi	13°40'46"N	74°41'20"E	32'

Materials and Methods

The domain of study is located at Kundapura, 440 km from Bangalore and 37 km from Udupi, at 13°37'24" N latitude and 74°41'30" E longitude and maximum elevation of 18 meters above sea level. Four study sites (Table: 1) have been selected beside the backwaters of the Haladi River.

Herikudru

This region is a small island wherein the trees are planted through the local people to protect their agricultural fields from erosion.

Uppinakudru

This location is completely under the tidal influx with numerous mangrove patches.

Jalady

This area is absolutely under tidal influence with dense growth of mangroves.

Hemmady

This region lies along the back waters of the river Haladi and the vicinity is absolutely under the tidal influence with good formations of mangroves.

Sample collection and Processing

Soil samples were collected in three seasons, monsoon, post-monsoon, and pre-monsoon, starting monsoon-2010 to pre-monsoon-2012 in four selected mangrove sites. The soil samples have been collected from the surface at a depth within 10-15 cm. The collected soil trials were fetched to the laboratory in a sterilized plastic bag, spread in a tray, air-dried at laboratory temperature, powdered, sieved at 2 mm size and stored in containers for further analysis.

Analysis of soil samples

Physico-chemical analysis of soil like pH, Electrical conductivity, Nitrogen, Phosphorus, Potassium was

performed as per standard methods mentioned as follows:

Soil pH

Soil pH was determined at 1:2.5 ratio soil: water suspension by potentiometric method via glass electrode, the H^+ ion concentration was calculated using soil pH and expressed in moles H^+ 1^{-1}.[8]

Electrical Conductivity

Electrical conductivity which is a measure of soluble salts in soil was measured in the soil: water (1:2) extract using conductivity bridge.[8]

Available Nitrogen

20 grams of soil was distilled with 100 ml of 0.32N $KMnO_4$ and 100 ml of 2.5% NaOH. The ammonia released during distillation was trapped in 4% boric acid solution comprehending mixed indicator and titrated against standard H_2SO_4.[9]

Available Phosphorous

Available Phosphorus in the soil samples of acidic pH range was estimated by Bray's method using 0.03N NH_4F + 0.25N HCl for extraction of phosphorus. The extracted Phosphorus was then appraised by chlorostannous reduced molybdophosphoric blue colour method. The intensity of blue color was measured using spectrophotometer at 660 nm.[8]

Available Potassium

5 grams of soil was extracted with 1N ammonium acetate extractant. Potassium content in the extract was determined by flame photometric method.[8]

Table 2: Physico-chemical parameters of Herikudru mangrove soil

Soil parameters	Monsoon 2010	Monsoon 2011	Post-monsoon 2010	Post-monsoon 2011	Pre-monsoon 2011	Pre-monsoon 2012	Min	Max	Mean	STD
Soil pH	6.51	6.66	5.93	4.76	5. 91	5.68	4.76	6.66	5.9	0.75
Electrical Conductivity	1.85	4.83	2.51	4.02	8.08	8.08	1.85	8.08	4.89	2.68
Nitrogen	61.2	116	102	323	210	210	61.2	323	170.36	95.90
Phosphorus	32.30	36.41	30.29	25.27	2.37	1.37	1.37	36.41	21.33	15.50
Potassium	476.69	194.25	318.55	294.68	341.36	331.36	194.25	476.69	326.14	90.95

Table 3: Physico-chemical parameters of Uppinakudru mangrove soil

Soil parameters	Monsoon 2010	Monsoon 2011	Post-monsoon 2010	Post-monsoon 2011	Pre-monsoon 2011	Pre-monsoon 2012	Min	Max	Mean	STD
Soil pH	5.30	6.34	5.91	4.76	6.43	6.43	5.30	6.43	5.86	0.69
Electrical Conductivity	1.92	7.49	5.40	4.02	4.25	3.25	1.92	7.49	4.38	1.90
Nitrogen	185.5	250	101	323	282	282	101	323	237.25	80.94
Phosphorus	9.48	47.27	22.82	25.27	15.46	17.46	15.46	47.27	22.96	13.14
Potassium	284.12	318.55	320	294.68	435.59	439.59	284.12	439.59	348.75	70.18

Results and Discussion

Mangrove soils are generally acidic in nature; mainly in those regions which get flooded occasionally and are positioned within the upper regions of the intertidal area. The soil will become loose due to the presence of fine sediment and decaying organic matter. In such situations, the soil turns into black and emits foul odor of H_2S due to anaerobic microbial activity within the soil. In the present investigation, pH, Electrical conductivity, Nitrogen, Phosphorus

and Potassium of the mangrove sediment are analyzed and their values have been recorded.

The most essential factor of the mangrove sediment is soil pH that ranged between 3.84 (pre-monsoon-2012 on site-4) to 6.66 (monsoon-2011 on site-1). The soil pH is differed in all seasons and is slightly acidic in all the selected sites. The present study has documented the low pH value during summer season and high pH value during the rainy season. Acidity or alkalinity of the sediment is always dependent on the presence of Hydrogen ion concentration in the soil. Acidity and alkalinity level of mangrove soil has been reported by many scientists. The high value of pH throughout the rainy season is because of the inflow of rain water.[10] The soil acidity of south-eastern Brazil mangrove is because of the decomposition of mangrove litter.[11] The soil pH of Sundarbans is neutral to slightly alkaline condition of the field, however in a few localities the pH value of dried up soil samples drop to acidic.[12] Acidic nature of soil was also reported in Chakaria of Sundarban region.[13]

Table 4: Physico-chemical parameters of Jaladi mangrove soil

Soil parameters	Monsoon 2010	Monsoon 2011	Post-monsoon 2010	Post-monsoon 2011	Pre-monsoon 2011	Pre-monsoon 2012	Min	Max	Mean	STD
Soil pH	6.10	6.36	6.23	5.45	4.83	4.83	4.83	6.36	5.63	0.69
Electrical Conductivity	0.02	5.54	7.92	4.89	9.60	9.60	0.02	9.60	6.26	3.64
Nitrogen	80.0	173	130	229	168	168	80.0	229	158	49.66
Phosphorus	2.03	28.62	14.83	24.00	3.48	3.48	2.03	28.62	12.74	11.57
Potassium	537.63	117.43	307.41	468.33	292.79	294.79	117.43	537.63	336.39	148.53

Table 5: Physico-chemical parameters of Hemmadi mangrove soil

Soil parameters	Monsoon 2010	Monsoon 2011	Post-monsoon 2010	Post-monsoon 2011	Pre-monsoon 2011	Pre-monsoon 2012	Min	Max	Mean	STD
Soil pH	6.12	6.07	6.03	5.72	4.84	3.84	3.84	6.12	5.43	0.91
Electrical Conductivity	0.30	9.35	8.44	3.58	6.63	6.63	0.30	9.35	5.82	3.35
Nitrogen	30.7	261	130	243	229	229	30.7	261	187.11	89.23
Phosphorus	7.37	27.62	4.01	24.32	6.88	6.88	4.01	24.32	12.84	10.28
Potassium	450.57	215	287	425.44	446.29	441.29	215	450.57	377.59	101.02

Notes: Monsoon (June to September); post-monsoon (October to January); pre-monsoon (February to May); Kg/ha: Kilogram per hectare; dS m^{-1}: deciSiemens per meter; Min: Minimum; Max: Maximum; STD: Standard Deviation.

Electrical conductivity is differed from 0.02 dSm^{-1} (Monsoon-2010 in site-3) to 9.60 dSm^{-1} (Pre-monsoon-2012 in site-3). The present study documented higher value throughout pre-monsoon and minimal value throughout monsoon season. Similar results were reported in the mangroves of southeast coast of India which ranged between 5.6 to 6.2 dSm^{-1}.[14] Electrical conductivity of the soil has a tendency to lower in the direction of the inland, however normally the salinity of the soils employed by every forest community deliberated became low plus the adsorption site of the soils became

subjugated through cations in the order of Ca > Mg > Na >K.[15] The electrical conductivity of a soil solution will increase with the increased concentration of ions.[16] High soil conductivity is because of the permeation of seawater throughout high tides, the evaporation of water as well as capillary rise of floor water in the course of low tides.[17] Electrical conductivity values of the mangrove soils were marginally lower because the soils under mangrove zones were subjected to regular inundation by tidal water and eventually maintained equilibrium, with the salinity of the estuarine water.[18]

Available Nitrogen varied from 30.7 kg/ha (Monsoon-2010 in site-4) to 323 kg/ha (Post-monsoon-2011 in site-2). In the present study, a Nitrogen value in soil changed in all the seasons. High Nitrogen value is because of trapping of detritus by means of finer particles, resulting in a boom in bacterial population which will also become a cause for the excessive level of Nitrogen.[19] Excessive values of Nitrogen release from the decay of a huge quantity of phytoplankton.[20] Rich source of Nitrogen in sediment detritus due to activities of crab is also recorded and reported.[21] The present study revealed that the excessive value of Nitrogen is because of the greater amount of organic matter and low value of Nitrogen is because of the less amount of organic matter.

Available Phosphorus concentration ranged between 1.37 kg/ha (Pre-monsoon-2012 in site-1) and 47.27 kg/ha (Monsoon-2011 in site-2). The maximum value was recorded throughout the monsoon and post-monsoon season and minimum value was recorded in the course of pre-monsoon season. The varied quantity of Phosphorus between 53.16 to 62.56 kg/ha in Sundarbans forest was recorded.[22] High concentration of inorganic Phosphates observed throughout the monsoon season was probably due to the encroachment of upwelling seawater into the bay, which increased the level of Phosphate.[23] Recorded low Phosphate value throughout summer season may be attributed to the limited flow of freshwater, excessive salinity and usage of Phosphate by Phytoplankton.[24]

Available Potassium differed from 117.43 kg/ha (Monsoon-2011 in site-3) to 537.63 kg/ha (Monsoon-2010 in site-3). Reported the average Potassium values between 250 to 750 kg/ha in Sundarban mangroves in Bangladesh.[25] Potassium content within the soil becomes varied from soils significantly amongst samples especially in nutrient level. Potassium performs an important role within the regulation of photosynthesis and production of plant sugars which might be used for diverse plant metabolic desires.[16] All plants necessitate Potassium for keeping intracellular electric neutrality, osmotic regulation, enzyme activation, protein synthesis as well as photosynthetic metabolism.[26] In this research study, maximum amount of Potassium was recorded in all the study sites during all the seasons.

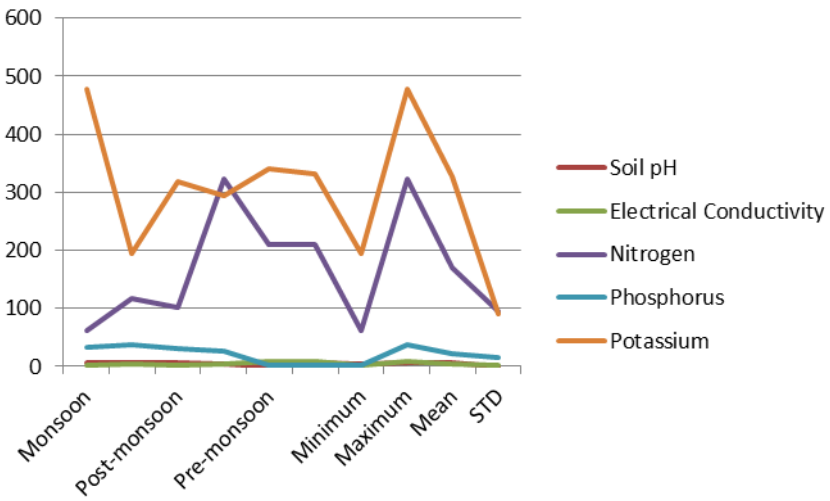

Fig. 1: Graph showing Physico-chemical parameters of Herikudru mangrove soil

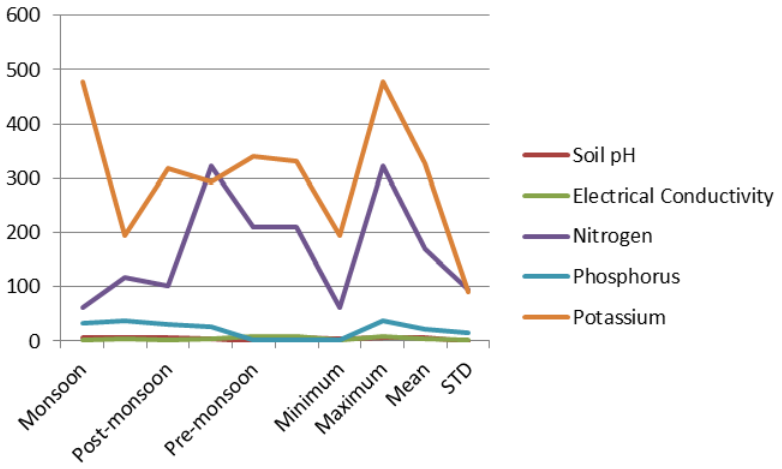

Fig. 2: Graph showing Physico-chemical parameters of Uppinakudru mangrove soil

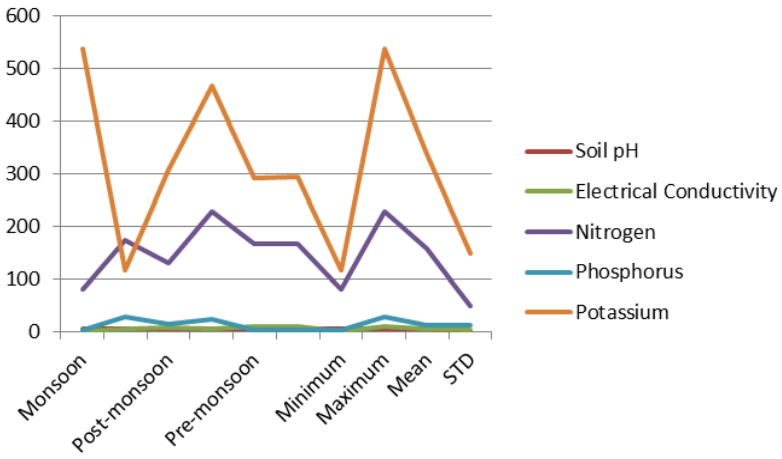

Fig. 3: Graph showing Physico-chemical parameters of Jaladi mangrove soil

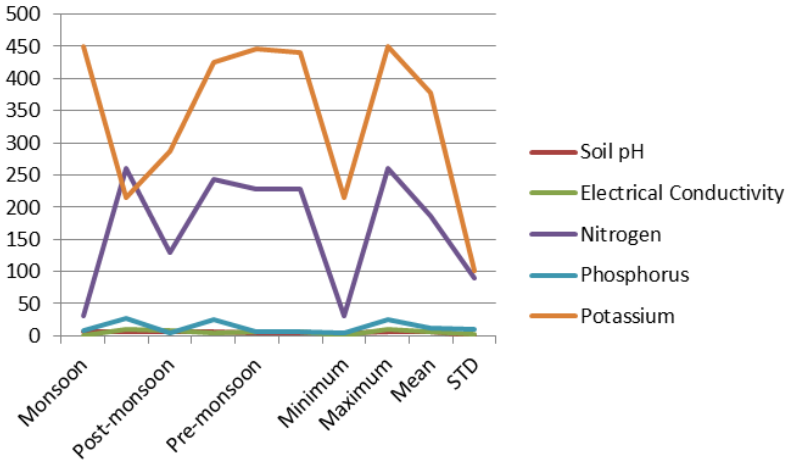

Fig. 4: Graph showing Physico-chemical parameters of Hemmadi mangrove soil

Conclusion

The present study documented the physico-chemical parameters of soil such as pH, Electrical conductivity and available Nitrogen, Phosphorus and Potassium. All the study fields have acidic in nature that is due to inflow of freshwater, confined Electrical conductivity is due to regular inundation by tidal water and rich source of available Nitrogen is because of massive amount of organic matter, Phosphorus is due to the runoff from agricultural and aquaculture fields and Potassium is due to influx of sea water. The findings of the present study provide baseline data of mangrove soil, which might be beneficial for further ecological evaluation, plantation activities and tracking of mangrove ecosystem.

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Conflict of Interest

The authors do not have any conflict of interest.

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