DYNAMICS OF SOIL SODICITY IN BRAHMANI-BAITARANI ESTUARY AREA UNDER THE INFLUENCE OF SEA LEVEL RISE

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ABSTRACT:

Field study was conducted in Brahmani-Baitarani estuary area to know about the soil sodicity dynamics in monsoon and post-monsoon season. The study area is covered in between Latitude 20° 39' 00''N – 20 ° 47' 00'' N and 86 ° 49' 00'E'- 87 ° 00' 00'' E. Chanrakolha, Birbhanjpur and Naltapatia village were selected for study purpose. Agricultural field soil samples (surface and sub-surface) were collected at 100 m, 200 m and 500 m distance from saline river embankment and were analyzed for its texture, pH, organic matter and sodium absorption ration (SAR). Soil textural analysis with particle size analyzer revealed that soil is Silty Loam. Proportion of sand, silt and clay varied from 9.53 - 15.3, 67.11 - 83.7 and 2.97 - 23.36 % respectively. Soil organic matter was higher in post monsoon season as compared to observed in monsoon season. Despite of the location of agricultural field near to estuary area, soil pH was found to be acidic (<7) both in monsoon and post-monsoon season. The soil pH was even more acidic in post-monsoon as compared to observed in monsoon season. In monsoon season SAR value in surface soil was lower than sub-surface soil. Whereas, reverse trend was observed in post-monsoon season. The SAR value in soil was found to be higher in post-monsoon than that of monsoon season. SAR value in post-monsoon season in surface and sub-surface soil varied from 4.1 to 8.3 and 2.9 to 5.6, respectively. In all the villages SAR value of soil was observed to be highest at 100 m distance from saline river embankment.

1. INTRODUCTION

India has long coastline where major rivers drain into Indian Ocean. The mouth of the rivers i.e. estuary zone is low lying area with alluvial soil having high potential for agriculture. Brahmani-Baitarani estuary area in Orissa has vast stretch of land used for agricultural purpose fringing Bhitarkanika mangrove forest. The estuary area is under constant influence of tidal movement of saline sea water. Climate change induced sea level rise will strengthen the tidal force and shall affect the low lying fertile alluvial soil in estuary area. Agriculture in estuary area is dominated by mono-cropping rainfed kharif paddy crop. Being closer to Bay of Bengal, soil salinity is one of the constraints for paddy cultivation. The main factor affecting crop yield is known to be sodicity (the relative Na concentration in soil paste water), which prevents the plants from uptaking essential elements such as calcium and potassium (Baize, 1993). In India, very little baseline information is available of coastal estuarine agricultural soil resources. A study regarding physico-chemical characteristics of soil in Brahmani-Baitarani estuary area will not only help in providing baseline data of the area but also help in understanding the sodicity dynamics due to the influence of sea level rise. This will also help in formulating adaptation measures to manage the soil salinity. In this regard, research on dynamics of soil sodicity in Brahmani-Baitarani estuary area under the influence of sea level rise was relevant. The objective of the research study was to know about the soil characteristics in terms of sodicity (SAR) under the influence of sea level rise. Average global sea-level rise over the second half of the 20th century was 1.8±0.3 mm/year, and sea level rise of the order of 2-3 mm/year is considered likely during the early 21st century as a consequences of global warming (Woodroffe et al., 2006). Saltwater intrusion in estuaries due to decreasing river runoff can be pushed 10 to 20 km further inland by the rising sea level (Shen et al., 2003; Yin et al., 2003; Thanh et al;2004).

2. MATERIALS AND METHODS

2.1 Description of the Study Area

The study area is located in Rajnagar block of Kendrapara district in Orissa and lies within 20° 39' 00''N – 20 ° 47' 00'' N latitude and 86 ° 49' 00''E - 87 ° 00' 00'' E longitude. The area is surrounded by tributaries of river Brahmani-Baitarani draining into Bay of Bengal. Three selected village i.e. Birbhanjpur, Chanrakolha and Naltapatia are located in Brahmani-Baitarani estuary area at a distance of about 2.5, 4.5 and 7 kilometer respectively from the river mouth. (Fig. 1)

2.2 Sample Collection and Analysis

At each location (100 m, 200 m and 500 m distance from saline river embankment) five agricultural fields were selected and from each field about 5-10 soil samples were collected both in monsoon (August, 2008) and post-monsoon (December, 2008) season from surface (10 - 15 cm) and subsurface (20 -30 cm) with the help of screw augur. Collected soil samples were analysed for its texture, pH, organic matter and sodium absorption ratio (SAR). Texture: Soil texture was determined with the help of particle size analyser (model CILAS 1064 Liquid).

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pH: pH of Soil solution extract (1:2.5 soil: water ratio) was measured with the help of pH meter (Systronic, micro pH meter 361).

Organic matter of soil (%): Organic carbon in soil was determined by Walkley and Black method (1934). Multiplying organic carbon content with 1.72 factor gives organic matter content in soil.

Sodium absorption ratio (SAR): SAR can be calculated from the formula given below.

$$SAR = \frac{[Na^+]}{\sqrt{\frac{1}{2}([Ca^{2+}]+[Mg^{2+}])}}$$

Sodium (Na+) content in soil was estimated with the help of flame photo meter method (Elico Cl 361). The calcium content in soil was determined with the help of AAS (Perkin Elmer).

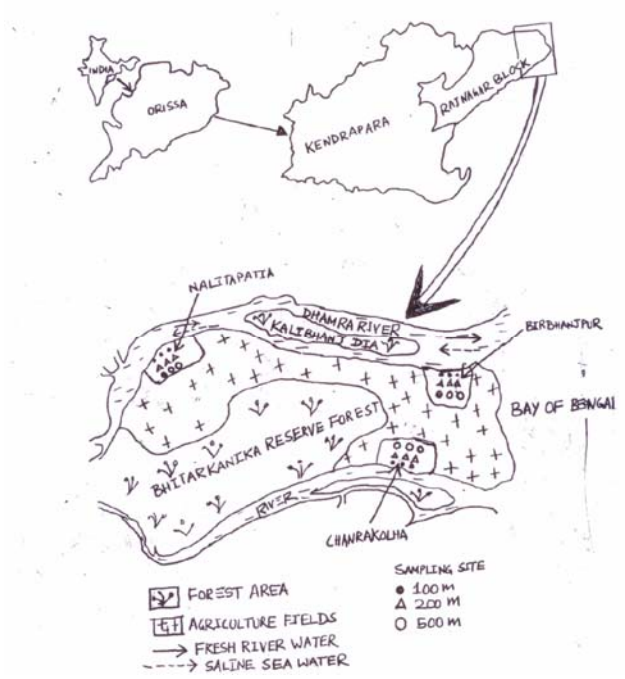

Figure 1. Sampling Site

3. RESULT AND DISCUSSSION

3.1 Soil Texture

Soil texture is most stable physical characteristics of soil which influences almost all physico-chemical parameters of soil. Majority of the soil sample analysed were in Silty Loam textural class. The variation of sand, silt and clay at 100 m, 200 m and 500 m distance from saline river embankment in Chanarkhola, Naltapatia and Birbhanjpur showed very little variation. Overall it varied from 9.53 - 15.23, 67.11 – 83.7 and 2.97 – 23.36 %. The silt content was recorded to be highest at Birbhanjpur (77.06 - 81.63 %) (Fig 2). This may be due to the proximity of the village to the river mouth having greater influence of tidal ingress.

3.2 pH

Irrespective of the location, season and depth (surface and subsurface), soil pH was observed to be in acidic range (<7) (Table1). In monsoon season, pH of subsurface soil showed higher value than surface soil. This may be due to illuviation of basic cations to subsurface soil. pH in post monsoon season showed decreasing trend in comparison with monsoon season. Leaching of the basic cations and decomposition of paddy based organic residue in the agricultural field can be the reason behind it. Average pH of the surface soil during monsoon season varied from 5.43 - 6.57. During post-monsoon season it ranged from 4.97 -5.57. In monsoon and post-monsoon season, the soil pH in subsurface was recorded to be 5.66 – 6.86 and 5.41 - 5.91 respectively (Table 1). Although the agricultural fields are located near to estuarine area, but there is very little influence of saline water intrusion, as revealed by acidic soil reaction.

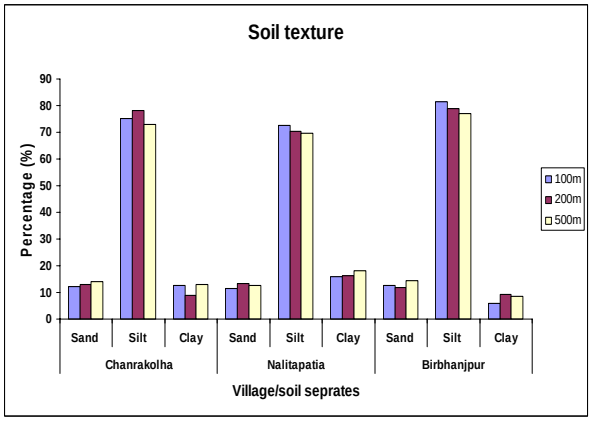

Figure 2. Soil Texture of Different Village

3.3 Soil Organic Matter

Among different villages, soil organic matter showed very little variation at 100 m, 200 m and 500 m distance from saline river embankment. In surface soil it ranged from 0.76 – 0.97 % and 0.92 – 1.05 % in monsoon and post monsoon respectively. In sub-surface soil it ranged from 0.68 – 0.81 % and 0.81 – 0.97 % respectively (Table 1). The organic matter content showed increasing trend from monsoon to post-monsoon season. Surface soil also showed higher organic matter content than sub-surface soil. This is due to the incorporation of paddy residue and use of organic manure while cultivation of kharif paddy.

3.4 Sodium Absorption Ratio (SAR)

In all the villages maximum SAR was observed at 100 m distance from saline river embankment. The maximum and minimum SAR value was observed in Birbhanjpur and Naltapatia respectively. This may be due to the proximity of Birbhanjpur from mouth of river draing into Bay of Bengal. Naltapatia being farthest from the mouth of river may have very little influence of sea water tidal ingression. In monsoon season SAR was observed to be higher in sub-surface soil than surface soil and vice versa in post monsoon season. At Nalitapatia in monsoon season average SAR value in surface soil at 100 m, 200 m and 500 m was 4.0, 3.79 and 3.45 respectively. At Birbhanjpur it was 5.28, 5.11 and 4.98 (Table 1).

Distance (m)	Depth	Place								
		Chanrakolha			Nalitapatia			Birbhanjpur		
		pH	Organic Matter (%)	Sodium absorption ratio	pH	Organic Matter (%)	Sodium absorption ratio	pH	Organic Matter (%)	Sodium absorption ratio
100	Sm	5.65 *(0.46)	0.97 (0.05)	5.08 (0.07)	5.782 (0.57)	0.83 (0.06)	4.0 (0.21)	6.57 (0.43)	0.95 (0.06)	5.28 (0.12)
	SSm	6.25 (0.60)	0.81 (0.10)	6.01 (0.15)	5.87 (0.10)	0.74 (0.05)	5.13 (0.24)	6.86 (0.08)	0.80 (0.01)	6.29 (0.07)
	Spm	5.11 (0.07)	1.05 (0.09)	7.15 (0.35)	5.20 (0.14)	0.94 (0.06)	5.36 (0.25)	5.57 (0.08)	1.03 (0.03)	7.74 (0.37)
	SSpm	5.50 (0.31)	0.97 (0.02)	4.97 (0.12)	5.69 (0.15)	0.86 (0.05)	4.21 (0.25)	5.91 (0.08)	0.96 (0.05)	5.42 (0.14)
200	Sm	5.51 (0.38)	0.94 (0.09)	4.79 (016)	5.438 (0.35)	0.79 (0.05)	3.79 (0.27)	6.33 (0.26)	0.84 (0.04)	5.11 (0.11)
	SSm	6.03 (0.58)	0.77 (0.11)	5.77 (0.09)	5.87 (0.37)	0.71 (0.04)	4.68 (0.23)	6.74 (0.07)	0.75 (0.02)	6.10 (0.04)
	Spm	5.13 (0.16)	1.02 (0.01)	6.91 (0.30)	5.06 (0.07)	0.93 (0.06)	5.07 (0.42)	5.43 (0.09)	1.01 (0.01)	7.49 (0.17)
	SSpm	5.63 (0.10)	0.96 (0.03)	4.79 (0.15)	5.68 (0.48)	0.84 (0.06)	3.99 (0.28)	5.74 (0.07)	0.92 (0.04)	5.32 (0.14)
500	Sm	5.75 (0.43)	0.87 (0.08)	4.61 (0.17)	5.45 (0.7)	0.76 (0.05)	3.45 (0.39)	6.02 (0.36)	0.84 (0.04)	4.98 (0.06)
	SSm	6.00 (0.62)	0.73 (0.10)	5.55 (0.06)	5.66 (0.38)	0.68 (0.03)	4.50 (0.26)	6.60 (0.09)	0.71 (0.04)	5.91 (0.08)
	Spm	5.12 (0.08)	1.01 (0.00)	6.69 (0.31)	4.97 (0.08)	0.92 (0.06)	4.88 (0.44)	5.29 (0.09)	1.01 (0.01)	7.32 (0.16)
	SSpm	5.61 (0.48)	0.94 (0.04)	4.51 (0.19)	5.41 (0.40)	0.81 (0.05)	3.75 (0.48)	5.60 (0.09)	0.90 (0.04)	5.15 (0.11)

Table 1: Physico-chemical parameters of soil (average) in different villages in Brahmani-Baitarani estuary area

** Value in parenthesis indicate the standard deviation (SD); Sm = Surface soil in monsoon season, Spm = Surface soil in post-monsoon season, SSm = Sub-surface soil in monsoon season , SSpm = Sub-surface soil in post-monsoon season*

CONCLUSION

Sea level rise is one of the important environmental challenges arising due to global warming. It will affect the coast most. In our study we observed that although the sodicity level (SAR) level was not exceeded the critical value for agriculture i.e 15. But the sodicity in the Birbhanjpur, especially in post monsoon is approaching the critical harmful value. The study has its relevance in its baseline data generation for the Brahmani-Baitarani estuary area which may be indicator of impact of sea level rise in Bay of Bengal. Apart from this it also can help in formulating mitigation option for the potential harmful impact due to sea level rise of the region.

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