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Characteristics and classification of coastal soils of North Karnataka

India has a coastline of 8129 km and the coastal ecosystem of the country supports the food and livelihood security of several million rural poor. Out of the total coastline of India, 310 km coastline is in Karnataka and its coastal region accounts for 6.09 percent of the area of the state. The problem of resource evaluation and management in the coastal region is strikingly different from those of hinterland. For the planned development of coastal areas reliable information on soils with respect to their nature, potential and limitation is very essential. In the present study an attempt was made to characterize and classify some coastal soils of North Karnataka.

The study area lies in Kumta *taluk* of Uttara Kannada district of Karnataka and lies between 14° 20' to 14° 36' N latitudes and 74° 17' to 74° 41' E longitudes with a total area of 582 sq. km. The area receives a mean annual rainfall of 3522 mm. The mean annual temperature is 27.6°C with an average annual maximum and minimum temperatures of 31.7°C and 23.5°C, respectively. The soil temperature regime is isohyperthermic and moisture regime is ustic.

Reconnaissance survey was carried out using survey of India toposheets and IRS-ID imageries. Sample strip was selected, pedons were examined and morphological characteristics were studied (Soil Survey Staff, 1951). Three typical pedons were selected for the detailed study. Particle size analysis of the soil samples was carried out by international pipette method as described by Jackson (1979). pH, electrical conductivity, organic carbon, cation exchange capacity, exchangeable bases and exchangeable acidity were determined following standard methods (Black, 1965). The soils were classified as per Soil Taxonomy (Soil Survey Staff, 1992).

The pedons were deep and developed on coarse textured alluvium. The colour of the surface horizons of the pedons was dark brown for Kadekode and Honehalli pedons and it was dark yellowish brown for Aghanashini pedon (Table 1). Hue remained same for all the pedons (10 YR) except in lower solum of Aghanashini pedon (5 GY) due to the presence of deposited marine materials. The texture ranged from sandy to sandy loam. These soils exhibited single grained structure or a very weakly developed sub-angular blocky structure. The better developed structure of Aghanashini pedon in comparison to other pedons was due to high organic matter content accumulated by way of estuarine process. Yellowish brown to red coloured mottles were observed in Kadekode and Honehalli pedons. These soils lacked distinct horizonation.

In terms of physical characteristics the content of coarse fragments was very low (Table 2) and sand fraction dominated the particle size classes. These fractions were inert and were of no consequence in further weathering. The clay content was very less and irregularly distributed in Honehalli pedon whereas in Aghanashini pedon it was uniform. The particle size distribution data of pedons indicated that these pedons had uniform lithology (Kaswala *et al.*, 1999) with lack of the process of illuviation. The high clay content in Ap and A_2 horizon of Kadekode pedon may be due to depositional differences of coastal alluvium.

Table 1. Morphological characteristics of the soils

Horizon	Depth (m)	Soil colour (moist)	Tex-ture	Structure (moist)
Pedon 1 (Kadekode)				
Ap	0-0.13	10 YR 3/3	cl	m1sbk
A2	0.13-0.45	10 YR 5/6	scl	vf1sbk
C1	0.45-0.58	10 YR 6/3	s	sg
C2	0.58-0.74	10 YR 6/3	s	sg
Pedon 2 (Honchalli)				
Ap	0.0-0.12	10 YR 3/3	ls	vf1sbk
A1	0.12-0.26	10 YR 3/3	s	sg
C1	0.26-0.52	10 YR 5/3	s	sg
C2	0.52-0.74	10 YR 7/3	s	sg
C3	0.74-0.99	10 YR 6/6	s	sg
C4	0.99-1.25	10 YR 6/3	ls	vf1sbk
Pedon 3 (Aghanashini)				
Ap	0.0-0.9	10 YR 3/4	Sl	m2sbk
A1	0.09-0.14	10 YR 3/4	Sl	m1sbk
A2	0.14-0.23	10 YR 4/4	Sl	fisbk
A3	0.23-0.37	10 YR 4/6	Sl	vf1sbk
C1	0.37-0.56	10 YR 5/3	Sl	m1sbk
C2	0.56-0.73	5 GY 4/1	Sl	weak
C3	0.73-0.82	5 GY 4/1	[illegible]	[illegible]

The chemical properties show that the A horizons of Kadekode and Honehalli pedons and all the horizons of Aghanashini pedons were acidic in reaction (Table 2). Such acidic pH range was due to regeneration of the inherent acidity of these soils after washing off of the salinity by heavy rains (Varghese *et al.*, 1970). In the lower horizons of Kadekode and Honehalli pedons the pH shifted to neutral range. Electrical conductivity was less than 1.0 dSm^{-1} except in C_3 horizon of Aghanashini pedon. The irregular distribution of organic carbon content was due to estuarine processes and the high content of organic carbon at C_3 horizon of Aghanashini pedon was due to the presence of deposited materials there.

Cation exchange capacity was generally low and varied from 0.75 to 5.25 cmol (p+) kg^{-1}. The low EC was due to low clay content in these soils. In all the pedons calcium was the dominant cation followed by magnesium, sodium and potassium. The high $BaCl_2$-TEA extractable acidity indicated that these soils contained more proportion of pH dependent changes and the high $BaCl_2$-TEA acidity could be attributed to aluminium hydroxyl compounds that were held tenaciously on the exchange complex and due to non-exchangeable aluminium embedded between crystal lattice which came into the solution due to buffering and complexing nature of $BaCl_2$-TEA (De Alwis and Pluth, 1976). The base saturation percentage was very low in these soils.

Classification of the soils suggests that because of the absence of any diagnostic horizons these pedons could be classified under the order Entisol. The Kadekode and Aghanashini pedons were characterized as Aquents due to hue of 10 YR and chroma of 2 in case of Kadekode pedon and presence of gleyed horizon (5 GY) in case of Aghanashini pedon.

Both pedons were classified as Psammaquents at great group level due to loamy sand and sandy particle size classes. The Aghanashini pedon had an Ap horizon with a colour value moist of 3, dry value of 5, and a base saturation (by NH_4OAC) of less than 50 percent throughout the profile, and therefore classified as Humaqueptic Psammaquents and Kadekode pedon qualified for Typic Psammaquents due to absence of gradation in properties.

The Honehalli pedon qualified for Ustipsamments due to loamy sand to sandy textural class and ustic moisture regime. At subgroup level it may be classified as Typic Ustipsamments.

Limitations and management

To discuss on limitation and management these coastal soils pose severe physical constraints associated with their inherent site characteristics such as climate, texture and single grained structure. The coarse textured nature of these soils leads to high percolation resulting in loss of added nutrients to deeper depths.

The lifting of sand is intensified during heavy wind period and causes severe damage to the standing crops in coastal dune areas. Adopting erosion control and other ameliorative measures such as, stabilization of sand dunes, pasture development, moisture conservation practices, incorporation of organic manures, water harvesting, and control of surface crusting would enhances the productivity. Plantation of casuarinas on the sandy foreshore can minimize the problem of shifting sand.

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Table 2. Physicochemical properties of soils

Horizon	Particle size analysis[1]					pH (1:2.5 soil/ water)	EC dSm^{-1}	Organic carbon (%)	CEC	Ca	Mg	Na	K	1N KCl	$BaCl_2$-TEA acidity
	Depth (m)	Sand (%)	Silt (%)	Clay (%)	Coarse fragments %				cmol (p+) kg^{-1}						
Pedon 1 (Kadekode)															
Ap	0-0.13	30.6	33.4	35.9	0.2	5.5	0.57	0.45	4.8	1.9	0.75	0.79	0.04	0.50	11.8
A2	0.13-0.45	56.0	19.6	24.4	-	6.8	0.10	0.30	3.3	1.5	0.98	0.12	0.05	0.25	8.9
C1	0.45-0.58	87.5	10.8	1.6	-	7.6	0.10	0.12	2.1	0.80	0.30	0.09	0.03	0.16	9.9
C2	0.58-0.74	95.2	3.0	1.8	-	7.9	0.07	0.85	3.0	1.5	0.68	0.11	0.02	0.19	8.9
Pedon 2 (Honehalli)															
Ap	0.0-0.12	83.8	12.2	4.0	4.6	4.7	0.03	0.24	5.0	2.9	0.90	0.14	0.02	0.18	16.5
A1	0.12-0.26	90.6	6.5	2.5	2.8	5.4	0.03	0.03	3.2	2.0	0.45	0.08	0.02	0.12	14.5
C1	0.26-0.52	94.4	3.7	1.9	0.5	6.5	0.03	0.15	3.2	0.98	1.65	0.59	0.03	0.12	9.9
C2	0.52-0.74	95.5	2.7	1.7	-	6.9	0.04	0.60	2.5	0.75	0.60	0.59	0.03	0.07	9.4
C3	0.74-0.99	96.1	2.4	1.5	0.6	7.0	0.06	0.48	2.5	0.83	0.45	0.08	0.02	0.10	9.4
C4	0.99-1.25	89.5	7.1	3.5	-	7.0	0.08	0.24	2.1	0.90	0.75	0.09	0.03	0.17	8.5
Pedon 3 (Aghanashini)															
Ap	0.0-0.09	58.4	26.0	17.3	6.3	4.7	0.06	1.59	9.0	4.3	2.3	0.99	0.15	0.30	15.0
A1	0.09-0.14	54.5	30.1	15.3	7.5	5.1	0.83	1.23	8.6	3.5	2.0	1.1	0.77	0.30	14.1
A2	0.14-0.23	83.5	6.5	10.0	6.6	6.2	0.31	0.09	8.1	4.0	2.4	0.77	0.01	0.25	10.3
A3	0.23-0.37	76.8	13.8	9.5	1.1	6.0	0.42	0.45	7.9	2.5	2.9	0.89	0.07	0.30	13.6
C1	0.37-0.56	77.2	12.2	10.7	0.8	5.4	0.42	0.57	8.6	5.3	1.1	0.90	0.10	0.30	12.2
C2	0.56-0.73	73.3	14.6	12.1	0.9	6.7	0.40	0.58	6.6	2.1	1.1	0.81	0.01	0.23	16.9
C3	0.73-0.82	76.8	12.1	11.1	2.3	5.9	1.14	0.40	9.4	3.3		1.1	0.13	0.25	19.7

[1]Particle size analysis according to USDA classification

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