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Characterization and Classification of Soils of Bettadapura Micro-Watershed of Chamarajanagar District, Karnataka

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Abstract

Based on detailed soil survey, six typical representative soil pedons of Bettadapura micro watershed were studied for morphological and physico-chemical properties. Results indicated that soil depth of the entire micro watershed area varied from shallow to very deep and argillic sub-surface diagnostic horizon was dominant in the upper slope of the watershed. The texture of the soils ranged from sandy clay to clay. Soils were slightly neutral (7.8) to moderately alkaline (8.89). The electrical conductivity and organic carbon content of the pedons were medium to low, varied from 0.18 to 0.82 $dSm^{-1}$and 0.36-0.81 g kg^{-1}, respectively. The CEC of the pedons varied from 18.67 to 42.69cmol(p+) kg^{-1}. The exchangeable bases in most of the pedons were in the order of Ca^{2+}> Mg^{2+}> K^{+}> Na^{+}.

Indiscriminate use of finite soil resources coupled with lack of management has led to degradation causing concern to planners, researchers and farmers. This calls for a scientific approach for development and management of these resources at various levels. Soil resource inventory provides an insight into potentialities and limitations for its effective management. It also provides adequate information in terms of land form, natural vegetation as well as characteristics of soils which can be utilized for land resource management and development (Manchanda *et al.* 2002). Rational utilization of land resources can be achieved by optimizing its use, which demands evaluation of land for alternative land use. Characterization, classification and evaluation of soils under different land uses are the first milestone in developing sustainable and eco-friendly land use models. No information is available especially on characterization, classification and genesis of soils of Chamarajanagara district in general. Hence, present study was under taken for characterization and classification of soils of Bettadapura micro watershed of Chamarajanagara district, Karnataka.

The study area lies between 11°54'0.73" latitude and 76° 46' 15.9" longitude with an altitude ranging from 805 to 946 m (msl). The soils have developed from granite-gneiss, sandstone and alluvium parent materials. The area qualifies for semi-arid monsoon climate with distinct summer, winter and rainy seasons. It experiences mean annual precipitation of 799.3mm. The mean annual temperature is 31.5°C with a mean summer temperature of 35.33°C The soil moisture regime has been computed as ustic and temperature regime as *isohyperthermic*. The natural vegetation comprises of species like *Acacia spp, Tamarindus indica, Azadirachta indica, Pongamia pinnata, Eucalyptus* spp, *Partheniumhysterophorus, Lantana camera, Cyperus rotundus, Cynodon dactylon etc.*

The base map of Bettadapura micro-watershed showing permanent features like roads, settlements, rivers, streams and tanks etc. were delineated using Survey of India (SOI) toposheet and was updated using satellite imagery. Visual interpretation of FCC of IRS LISS IV + cartosat merged data on 1:7920 scale was carried out in conjunction with survey of India (SOI) toposheet to identify the physiographic units in the watershed. Traversing of the entire watershed area was undertaken in order to check the physiographic units. The transects were delineated in such a way that each transect should cut across at least three or more physiographic units. In each physiographic unit, profiles were studied for morphological characteristics to establish relation between physiography and soils depending on the length of slope. Based on soil characteristics nine soil series were identified. Soil samples collected from the typifying pedons were analyzed for physical and chemical properties as per standard procedure (Klute, 1986). The soils were classified as per USDA Soil Taxonomy (Soil Survey Anon, 2003).

Soil morphology : The soils were shallow to very deep moderately well to well-drained. The horizon boundaries were clear to gradual in distinctness and smooth to wavy in topography. The colour varied from5YR3/3 to 10YR 4/2 Table I. The soil colour appearsto be the function of chemical and mineralogical composition as well as textural make up of soils and conditioned by topographic position and moisture regime (Walia and Rao 1997). Textural class of the soils varied from sandy clay to clay. This textural variation might be due to differences in composition of parent material, topography, *in-situ* weathering and translocation of clay by eluviation and age of soils (GeethaSireesha and Naidu 2013). The structure of the soils was single grain, sub angularblocky and angular blocky. The blocky structure *i.e.,* angular and sub-angular blocky were attributed tothe presence of higher quantities of clay fraction (Sharma *et al.* 2004).

The consistence of the soils varied from soft to very hard (dry), loose to firm (moist) and non-sticky and non-plastic to very sticky and very plastic (wet). Presence of sticky and plastic to very sticky and very plastic, firm to very firm and slightly hard to very hard consistence in wet, moist and dry conditions, respectively may be due to high clay content of soil (Sarkar *et al.* 2001) and also due to dominance of smectite clay mineral (Leelavathi *et al*. 2010).

Soil physical characteristics : The data pertaining to particle size analysis (Table II) revealed that clay content varied from 29.25 to 85.75 per cent. Increase in clay content with depth in pedons might be due to downward translocation of finer particles from the surface layers (Murthy, 1988). The decrease in clay content with depth in pedon 4 might be due to variability of weathering in different horizons. Silt content in general,exhibited an irregular trend with depth, which might be due to variation in weathering of parent material or *insitu*formation (Satish Kumar and Naidu, 2012).

Physico-chemical characteristics: The soils are neutral to slightly alkaline in pH varying from7.8 to 8.89. This wide variation was attributed to the nature of the parent material, leaching, presence of calcium carbonate and exchangeable sodium (Shalima Devi and Anil Kumar, 2010). All the pedons showed low electrical conductivity values ranging from 0.18 to 0.82 dSm^{-1}indicating non saline nature. The low electrical conductivity may be due to free drainage conditions which favored the removal of released bases by percolation and drainage (Table II).

Organic carbon content of these soils was found to be low to medium and varied from 0.36-0.81 per cent (Table II). The organic carbon content decreased with depth in all the pedons. This is attributed to the addition of plant residues and farm yard manure to surface horizons (Ashok Kumar and Jagdish Prasad, 2010). The low carbon content in the soils might be attributed to the prevalence of tropical condition, where the degradationof organic matter occurs at a faster rate coupled with low vegetation cover, thereby leaving less organic carbon in the soils (Nayak *et al.,* 2002).

The CEC in all the pedons estimated by ammonium acetate extract varied from 18.67 to 42.69 cmol (p+) kg^{-1}soil which corresponds to clay content, organic carboncontent and also type of clay mineral present in these soils. Exchangeable bases in all pedons are in the order of $Ca^{2+} > Mg^{2+} > Na^{+} > K^{+}$ on the exchange complex.

The soils in Bettadapura micro watershed of chamarajanagaradistrict were shallow to very deep in depth, neutral to slightly alkaline in reaction, non-saline and low to medium in organic carbon and the exchangeable complex was dominated by Ca^{2+} followed by Mg^{2+}, Na^{+} and K^{+}.

TABLE I

Morphological characteristics of Bettadapura micro watershed, Chamarajanagar District

Horizon	Depth (cm)	Colour (moist)	Texture	Gravel (%)	Structure	Consistancy
Pedon 1:						
Ap	0-23	10YR2/1	c	5	3mcsbk	hfrmsmp
$Bwss_1$	23-47	10YR2/1	c	<5	3mcsbk	hfrvsvp
$Bwss_2$	47-70	10YR3/1	c	<5	3mcabk	hfrvsvp
$Bwss_3$	70-100	10YR3/1	c	<5	3mcabk	hfrvsvp
$Bwss_4$	100-125	10YR3/1	c	<5	3mcabk	hfrvsvp
Bck_1	125-157	-	c	<5	3mcabk	hfrmsmp
Bck_2	157-180	-	c	<5	3mcabk	hfrmsmp
C	Weathered parent material					
Pedon 2:						
Ap	0-18	10 YR 3/1	c	5	3mcsbk	hfrmsmp
Bw1	18-32	10 YR 3/1	c	<5	3mcsbk	vhfrvsmp
Bw2	32-60	10 YR 2/1	c	<5	3mcsbk	hfrvsmp
Bw3	60-90	10 YR 2/1	c	<5	3mcsbk	hfrvsvp
C	Weathered parent material					
Pedon 3:						
Ap	0-16	10YR 4/2	c	<5	3fmsbk	hvfrmsmp
Bw1	16-29	10YR3/2	c	<5	3fmsbk	hfrmsmp
Bw2	29-55	10YR4/2	c	<5	3mcsbk	hfimsmp
Bw3	55-72	10YR4/2	c	<5	3mcsbk	vhfimsmp
Bw4	72-93	10YR3/2	c	<5	3mcsbk	vhfimsmp
Bw5	93-113	10YR4/2	c	<5	3mcsbk	vhfimsmp
Bck1	113-133	10YR3/2	c	<5	3mcsbk	vhfimsmp
Bck2	133-145	10YR4/2	c	<5	3fmsbk	vhfimsmp
Bck3	145-190	10YR3/2	c	<5	3fmsbk	vhfimsmp
C	Weathered parent material					
Pedon 4:						
Ap	0-25	7.5YR 2.5/2	sc	10	2fmsbk	shvfmsmp
Bt1	25-40	7.5YR 2.5/2	sc	10	2fmsbk	shvfmsmp
Bt2	40-56	5YR 2.5/2	sc	5	2fmsbk	hfmsmp
Bt3	56-71	5YR3/3	sc	5	2fmsbk	hfimsmp
Bt4	71-82	7.5YR3/2	c	<5	2fmsbk	hfvsvp
Bt5	82-108	5YR3/2	scl	5	2fmsbk	shfmsmp
C	Weathered parent material					
Pedon 5:						
Ap	0-17	7.5YR 2.5/2	sc	5	1fmsbk	shvfrsssp
Bw	17-36	10YR3/2	c	<5	2fmsbk	hfimsmp
C.	Weathered parent material					
Pedon 6:						
Ap	0-20	10YR3/2	scl	10	3mcsbk	hvfrmsmp
Bw1	20-38	10YR3/1	sc	5	3mcsbk	hvfrmsmp
Bw2	38-63	10YR3/1	c	<5	3mcsbk	hvfrmsmp
Bw3	63-92	10YR3/1	c	<5	3mcsbk	hvfrmsmp

TABLE II

Physico chemical properties of typifying Pedons in Bettadapur micro watershed, Chamarajanagar District

Horizon	Depth (cm)	Send (%)	Silt (%)	Clay (%)	pH	Ec (dSm^{-1})	Oc (%)	Exchangeable Catoons				CEC (%)
								Ca	Mg	Na	K	
								cmol (p+)Kg^{-1}				cmol (p+)Kg^{-1}
Pedon 1:												
Ap	0-23	34	24.75	42.25	8.61	0.32	0.60	12.1	6.9	2.15	0.57	25.72
$Bwss_1$	23-47	15.5	11.25	63.25	8.38	0.35	0.76	18.5	7.9	1.87	0.26	29.54
$Bwss_2$	47-70	14.5	9.75	65.75	8.03	0.58	0.52	19.8	8.4	1.76	0.25	33.42
$Bwss_3$	70-100	15.75	23	60.25	7.69	0.49	0.54	23.4	10.6	2.13	0.28	36.42
$Bwss_4$	100-125	14.75	24.36	64.25	7.8	0.42	0.56	25.8	10.1	1.34	0.32	39.77
Bck_1	125-157	16	18.95	65.25	7.85	0.40	0.44	21.4	9.8	0.56	0.36	32.12
Bck_2	157-180	18.5	23.25	58.25	7.86	0.41	0.42	20.9	8.4	0.43	0.25	30.98
C	Weathered parent material											
Pedon 2:												
Ap	0-18	33.3	15.25	51.45	8.04	0.18	0.40	21.7	7.1	0.68	0.30	30.78
Bw_1	18-32	31	16.75	52.25	7.93	0.18	0.56	20.7	6.9	2.10	0.31	31.01
Bw_2	32-60	20.55	18.25	61.2	8.04	0.19	0.64	21.8	8.3	0.57	0.28	33.95
Bw_3	60-90	19.5	15.25	65.25	8.19	0.19	0.48	23.8	7.8	0.39	0.34	31.34
C	Weathered parent material											
Pedon 3:												
Ap	0-16	32.5	25.25	42.25	8.72	0.29	0.68	22.7	12.2	0.75	0.33	33.98
Bw_1	16-29	18.95	18.75	62.25	8.65	0.28	0.70	25.9	10.2	0.43	0.45	36.99
Bw_2	29-55	19.68	22.25	60.75	8.89	0.42	0.80	27.7	14.3	0.27	0.51	41.78
Bw_3	55-72	20.25	16.25	61.75	8.85	0.54	0.81	27.4	13.8	0.60	0.32	40.93

TABLE II Contd.

Horizon	Depth (cm)	Send (%)	Silt (%)	Clay (%)	pH	Ec (dSm^{-1})	Oc (%)	Exchangeable Catoons				CEC (%)
								Ca	Mg	Na	K	
								cmol (p+)Kg^{-1}				cmol (p+)Kg^{-1}
Bw_4	72-93	17.75	23.5	59.25	8.75	0.73	0.76	26.9	12.8	0.61	0.37	40.68
Bw_5	93-113	18.56	22.25	57.75	8.82	0.75	0.77	27.8	15.1	0.70	0.38	45.18
Bck_1	113-133	16	21.75	62.25	8.73	0.74	0.75	26.2	14.8	0.40	0.35	42.75
Bck_2	133-145	18.2	18.25	58.75	8.79	0.77	0.68	24.8	12.5	0.33	0.38	39.01
Bck_3	145-190	17.5	23.25	59.25	8.64	0.82	0.56	23.1	12.8	0.35	0.37	38.52
Pedon 4:												
Ap	0-25	14.25	21.5	30.25	7.92	0.25	0.64	11.5	4.3	0.48	0.39	18.67
Bt_1	25-40	43.25	22.25	34.5	7.87	0.20	0.72	16.5	5.5	0.57	0.31	29.88
Bt_2	40-56	38.5	25.25	36.25	8.03	0.20	0.36	19.8	6.5	0.43	0.24	32.97
Bt_3	56-71	14	24.5	35.5	8.05	0.19	0.69	20.4	7.7	0.57	0.31	34.99
Bt_4	71-82	4.25	30.25	65.5	8.09	0.21	0.71	21.6	10.2	0.44	0.35	35.60
Bt_5	82-108	43.5	27.25	29.25	8.16	0.19	0.40	19.5	8.4	0.40	0.24	30.55
C	Weathered parent material											
Pedon 5:												
Ap	0-17	48	22.25	29.75	8.2	0.23	0.44	21.6	12	0.49	0.53	36.62
Bw	17-36	9.5	30.25	60.25	8.08	0.18	0.60	24.3	10.8	0.55	0.34	42.69
C	Weathered parent material											
Pedon 6:												
Ap	0-20	11.5	15.25	73.25	7.99	0.13	0.40	20.3	8.2	0.76	0.40	29.66
Bw_1	20-38	45.75	22.75	31.5	7.97	0.24	0.78	21.5	10.8	0.56	0.38	36.94
Bw_2	38-63	12.5	19.25	68.25	7.99	0.24	0.81	20.9	11.9	0.39	0.63	35.83
Bw_3	63-92	17.25	15.75	67	8.12	0.20	0.42	22.3	12.7	1.00	0.47	36.48

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