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Characterization and Classifications of Soils of Eastern Ghats Region of Karnataka

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Abstract: Characterization and classification of soil resources is essential scientifically plan agricultural land use agroforestry, agri-horticulture and silvi-pastoral farming systems. In the present study, an attempt was made to characterize and classify the soils occurring on different topography in three villages of Ramanagara district of Karnataka. Out of forty five pedons, nine representative pedons (covering all the soil types) very shallow to deep, dark reddish brown to yellowish red (red soils), to very dark brown to very dark greyish-brown (black soils) in colour. With sub-angular blocky in structure, These soils were sandy clay to clay in texture, strongly acidic to slightly alkaline (4.5-8.02) in reaction (non-saline soils) and had medium to high (0.5-1.33%) organic carbon content. Calcium and magnesium were the dominant exchangeable cations followed by sodium and potassium. Soils were grouped under Alfisols, Inceptisols and Entisols orders.

Keywords: *Soil survey, soil characterization, soil classification, soil physical and chemical characteristics*

Introduction

Soil is recognized as a base for every production system and knowledge of their properties, extent and spatial distribution is extremely important to maintain soil resources to sustain the ecosystem (Sarmah *et al.* 2019) and site-specific soil management practices.

The systematic study of morphology, physic-chemical characteristics and taxonomy of soils provides information on the nature and type of soils, their constraints, potentials, capabilities and their suitability for various uses (Jagdish Prasad *et al.* 2009; Sashikala *et al.* 2019). The data generated through systematic soil resource inventory and characterization will help to formulate agro-interventions for management of these soils under existing delivery extension systems, agriculture schemes, and value chains, so that new technologies could be adopted for sustainable production.

Materials and Methods

Description of the study area

The study was carried out in Kanakapura Taluk (12° 26' 27" to 12° 23' 19" N; 77° 31' 36" to 77° 34' 53" E), Ramanagara district of Karnataka (Fig. 1) covering an area of 2123 ha at an altitude of 584 to 603 m above the mean sea level. The area a part of agro-ecological region 9 falls under the semi-arid tract of the state and receives an average annual rainfall of 790.6 mm. The temperature varies from 16 to 38°C. The average potential evapo-transpiration (PET) is 1496.9 mm and varies from a low

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of 98.4 mm in December to 158 mm in the month of April. The length of the crop growing period (LGP) is 150 days. Red sandy soil covers (60%) of the district (60%), while, red loamy soils cover the remaining part of the district percentage. In undulating land slopes, red sandy soil is mostly developed from granites and granitic-gneiss parent material.

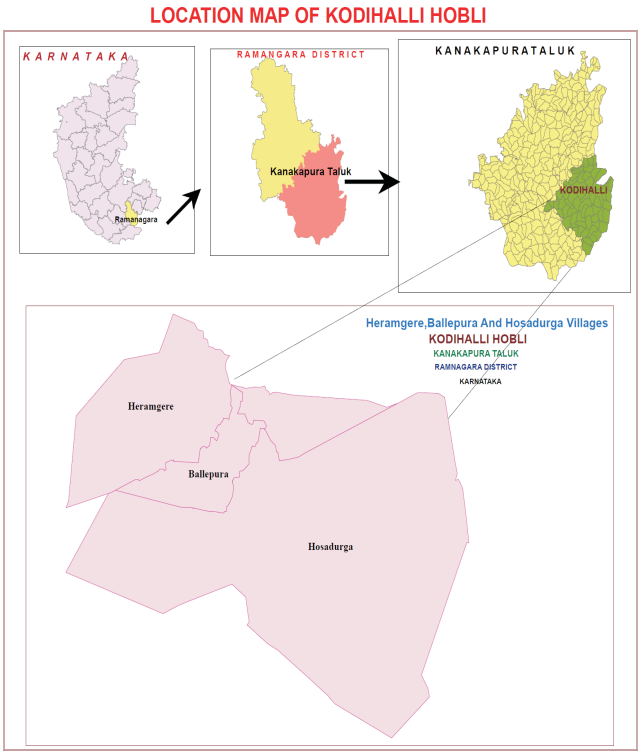

Fig. 1. Location map of Ramanagara district

Soil sampling methodology

A detailed soil survey was carried out (using toposheets on 1:7920 scale) in three villages adopted under Farmers First programme in Ramanagara district, Karnataka. Out of forty five pedons nine typical pedons were selected based on landform and their soil morphological properties (Table 2). The horizon-wise soil samples were collected, processed and analyzed using standard analytical methods and soils were classified (Soil Survey Staff 2022).

Results and Discussion

Morphological characteristics

The thickness of the solum varied from 17 to 160 (very shallow to very deep). The pedons occurring on the uplands (P1, P2, P3, P4, P5, P6, P7, P8) were shallow to deep in depth but low pedon (P9) area was very deep (Table 1). The upland pedons were well drained barring P8. The soil's hue ranged from 2.5YR to 10YR, with value 3 to 4 and chroma 2 to 6, respectively. The chemical, mineralogical, and textural constitution of soils, together with their topographic position and moisture regime, all appear to have a role in the variation in soil colour (Sireesha and Naidu 2013; Vasundhara *et al*. 2017). The red colour of the mottles in the lower layers may have resulted from alternate oxidation and reduction processes in the sub-surface soils (Jondhale and Jagdish Prasad 2006). The chroma 2 in the lower horizon of pedon-9 revealed gleying, which suggested the presence of water for a certain period (Bhattacharyya *et al.* 2009). The soils had textures of loamy sand to sandy clay. In surface and sub-surface horizons, the pedons exhibited weak to moderate, fine to medium, sub-angular

Table 1. Soil morphological characteristics of representative pedons

Horizon	Depth (cm)	Matrix color (Moist)	Structure			Consistency			Root		Pores	
			Grade	Size	Type	D	M	W	Q	S	Q	S
Pedon 1 (VPD-T4/P1)-Typic Usticpsaments												
Ap	0-8	7.5 YR 3/4	1	f	sbk	s	vfr	so po	f	vf	f	vf
A2	8-17	7.5 YR 3/4	1	m	sbk	s	vfr	so po	m	f	f	m
C	17-91	Weathered parent material										
Pedon-2 (CGD-BLP/R5)- Typic Haplusteps												
A	0-16	5 YR 3/4	2	m	sbk	sh	fr	ms mp	c	vf	c	f
Bt1	16-33	7.5 YR 3/4	1	m	sbk	-	fr	ms mp	c	vf	c	f
Cr	33-79	Weathered parent material										
Pedon-3 (BMH-BLP/R7)- Typic Rhodustalfs												
Ap	0-12	2.5 YR 3/4	2	m	sbk	sh	fr	ms mp	c	vf	f	c
Bt1	12-31	2.5 YR 3/3	2	m	sbk	-	fr	ms mp	f	vf	c	f
Bt2	31-46	2.5 YR 3/3	2	m	sbk	-	fr	ms mp	f	vf	c	f
Bt3	46-63	2.5 YR 3/4	2	m	sbk	-	fr	ms mp	f	f	m	f
cr	63-75	Weathered parent material										
Pedon-4 (RMD-U1/A)- Typic Rhodustalfs												
Ap	0-14	5 YR 3/4	1	m	sbk	l	vfr	ss sp	f	f	f	m
Bt1	14-37	2.5 YR 4/4	2	m	sbk	h	fr	ms mp	f	f	f	m
Bt2	37-96	2.5 YR 4/4	2	m	sbk	h	fr	ms mp	f	f	f	m
C	96-124	Weathered parent material										
Pedon-5 (BLP-HSD-R1) - Typic Rhodustalfs												
Ap	0-10	5 YR 3/3	1	f	sg	l	vfr	so po	c	vf	c	vf
Bt1	10-30	2.5 YR 3/4	2	m	sbk	-	fr	ms mp	f	f	f	c
Bt2	30-51	2.5 YR 3/4	2	m	sbk	-	fr	ms mp	f	f	f	c
BC	51-77	5 YR 3/4	1	m	sbk	-	fr	ss sp	f	f	f	c
Cr	Weathered parent material											
Pedon-6 (MBD- BLP /R1)- KanhaplicRhodustalfs												
Ap	0-10	2.5 YR 3/3	2	m	sbk	sh	fr	ms mp	f	vf	c	f
Bt1	10-24	2.5 YR 3/3	2	m	sbk	-	fr	ms mp	f	vf	c	f
Bt2	24-50	2.5 YR 3/4	1	m	sbk	-	fr	ms mp	f	f	c	f
Bt3	50-76	2.5 YR 3/4	1	m	sbk	-	fr	ms mp	f	f	c	f
BC	76-91	2.5 YR 3/4	1	m	sbk	-	fr	ms mp	-	-	c	f
cr	91-91+	Weathered parent material										
Pedon-7 (HRG- SR /P2)- Typic Rhodustalfs												

Ap	0-18	7.5 YR 3/4	2	m	sbk	l	vfr	ss sp	f	vf	m	f
Bt1	18-41	2.5 YR 3/4	2	m	sbk	l	fi	ss sp	f	vf	m	f
Bt2	41-68	2.5 YR 4/4	3	m	sbk	h	fi	ss sp	f	vf	-	-
Bt3	68-88	2.5 YR 3/6	3	m	sbk	vh	vfi	ss sp	f	vf	-	-
Bt4	88-110	5 YR 4/4	3	m	sbk	vh	vfi	ss sp	f	vf	-	-
Pedon-8 (HSD- BLP /R8)- UlticHaplusteps												
Ap	0-12	7.5 YR 3/3	1	m	sbk	sh	fr	ss sp	m	vf	c	f
Bt1	12-30	7.5 YR 3/4	2	m	sbk	-	fr	ms mp	m	vf	c	f
Bt2	30-58	5 YR 3/3	2	m	sbk	-	fr	ms mp	c	vf	c	f
Bt3	58-97	5 YR 3/3	2	m	sbk	-	fr	ms mp	f	vf	c	f
Bt4	97-125	5 YR 3/4	1	m	sbk	-	fr	ss sp	f	f	c	f
Bw	125-150	5 YR 3/4	1	f	sbk	l	vfr	so po	-	-	f	c
Pedon-9 (CHG- HSD/R7)- Typic Haplusteps												
Ap	0-15	10 YR 3/2	1	m	sbk	h	fr	ss sp	c	m	f	vf
Bw1	15-35	10 YR 3/2	2	m	sbk	-	fi	ms mp	f	m	c	f
Bw2	35-75	10 YR 3/2	2	m	sbk	-	fi	ms mp	f	f	c	f
Bw3	75-106	10 YR 3/3	2	m	sbk	-	fi	ms mp	f	f	-	-
Bw4	106-128	10 YR 3/3	2	m	sbk	-	fr	ms mp	f	f	-	-
Bw5	128-150	10 YR 3/3	2	m	sbk	-	fr	ms mp	f	f	-	-
Bw6	150-160	10 YR 3/2	2	m	sbk	-	fr	ms mp	f	f	-	-

Consistency: D – dry:l-loose, sh –slightly hard, h- hard, vh-very hard; M – moist:fi – firm, fr – friable, vfr -very friable; W – wet: ss – slightly sticky, sp –slightly plastic, ms – moderately sticky, mp –moderately plastic, so – non sticky, po –non plastic

Structure: Grade: 1- weak, 2 – moderate; Size: f-fine, m – medium: Type: sbk – sub angular blocky, sg-single grain

Root/ Pores: Q - quantity: f – few, c – common, m – many; S – size: vf – very fine, f-fine, c-coarse

blocky structures. Higher clay content and low organic carbon content may responsible for this kind of soil structure (Gurav *et al.* 2017). The soil's surface consistency ranged from loose to hard (dry), friable to very friable (wet), non-sticky, and non-plastic to moderately sticky but moderately plastic (wet). While, sub-surface had firm to extremely friable (moist), soft to very hard (dry), non-sticky, and non-plastic to moderately sticky and moderately plastic (wet) consistencies. The increase in stickiness and plasticity may be due to high clay content down the profile, in P2, P3, P4, P6 and P9 and *vice-versa.* Very fine to coarse, and few to many, roots/pores were found in both surface and sub-surface layers of the soil profiles in all the pedons. Pedons located in uplands had no diagnostic horizon (P1), argillic (Bt) horizon (P2 –P8), but P9 of lowland had cambic (Bw) horizon. These pedons were classified under Entisols, Alfisols, and Inceptisols orders.

Physical characteristics

The sand content of these pedons ranged from 45.2 to 83.3%, and it was uneven with depth in all the pedons. The silt content ranged from 8.54 to 22.7% and its distribution followed similar trends as sand distribution (Table 2). Clay content ranged from 6.4 to 43.6%. The higher concentration of clay in the lower horizon may be due to clay illuviation. In P1, P3, and P6, there was no wide textural class variation. This could be ascribed to increased compaction and decreased aggregation caused by decreased OC and clogging of pores by dispersed clay in sub-soil layers (Khan and Kamalakar 2012). The silt ratio varied from 2.19 to 9.76 in the pedons. The soil moisture content (SMC), which exhibits an erratic pattern with depth, ranged from 7.04 to 21.98% at 33kPa and 3.20 to 15.09% at1500 kPa. The heterogeneity of the parent material, variations in the clay and OC content could contribute to the difference in SMC. Nikam *et al.* (2006) reported that water retention at both the sections had positive correlation with clay content. The gradual increase in SMC with depth could be attributed to increased clay content and total pore space. Typically, coarse fragments ranged from 10 to 30%, but in some profiles, it was as high as 70% (P4, P6). All of the soil profiles had a sand.

Chemical characteristics

The pH of the soil ranged from 4.65 to 8.02 (slightly acidic to slightly alkaline). The leaching of bases is primarily responsible for lower pH in surface horizons. The EC of soils varied from 0.02 to 0.23 dS m^{-1} (Table 3) indicating that the soils are non-saline. The OC content ranged from 0.24 to 2.14%, and categorized as low to the medium. The surface horizons had higher than the sub-surface horizons because of more biomass addition (Vasundhara *et al.* 2020). The exchangeable bases in the majority of the pedons were in the order of Ca^{+2}> Mg^{+2}> K^{+} > Na^{+} barring P2 and P8. The cation exchange capacity of the soils varied from 3.50 to 24.23 c mol (+) kg^{-1} of soil through depth. The wide range of CEC is related to the amount and type of clay, and the of organic carbon content in these soils (Sekhar *et al.* 2017).

The $CaCO_3$ content of P7 and P9 ranged from 0.73 to 3.18 per cent and had an irregular distribution with depth, owing to different geological material and leaching of carbonates from the porous sandy layers (Singh and Agrawal 2005). The prevailing semi-arid environment leads to the depletion of Ca^{2+} ions in the soil solution in the form of calcretes and the concurrent increase in ESP with depth may be the cause of the high $CaCO_3$ in the soils (Balpande *et al.* 2007; Warhade *et al.* 2022). Except for P1 and P4, others pedons were highly base saturated, and base saturation in P2, P5, and P9 was found to increase with the depth indicated that the CEC: clay ratio of soils ranged from 0.12 to 0.96 which reflect the presence of kaolinte, mixed and semectitic mineralogy. The Ca: Mg ratio of soil profiles ranged from 1.11 to 4.63.

Soil classification

Based on the morphological, physical and chemical, properties of the the soils were classified up to sub group level (Soil Survey Staff 2022). Pedon represented VPD soil series had no diagnostic sub-surface horizon and these soils were placed in Entisols

Table 2. Soil physical characteristics of representative pedons of Ramanagara district, Karnataka

Horizon	Depth (cm)	Particle-size class (mm)										% Moisture		Sand/ Silt ratio
		Sand (2.0-0.05)	Silt (0.05-0.002)	Clay (<0.002)	Very coarse (2.0-1.0)	Coarse (1.0-0.5)	Medium (0.5-0.25)	Fine (0.25-0.1)	Very fine (0.1-0.05)	Coarse fragments v/v (%)	Textural Class (USDA)	1/3 Bar	15 Bar	
Pedon 1 (VPD-T4/P1)														
Ap	0-8	83.05*	10.57	6.38	22.60	19.27	11.91	16.35	12.92	15	ls	8.13	3.20	7.86
A2	8-17	81.18	10.63	8.19	17.40	16.17	11.80	21.16	14.65	15	ls	7.93	3.43	7.64
C	17-91	-												
Pedon-2 (CGD-BLP/R5)														
A	0-16	49.58	14.64	35.79	10.55	8.76	8.86	11.81	9.60	20	sc	21.80	13.68	3.39
Bt1	16-33	63.63	14.07	22.30	7.65	6.08	20.96	15.93	13.00	15	scl	20.30	11.86	4.52
Cr	33-79	-												
Pedon-3 (BMH-BLP/R7)														
Ap	0-12	62.50	12.17	25.33	14.34	13.52	11.17	14.65	8.81	15	scl	14.81	8.36	5.14
Bt1	12-31	56.71	10.61	32.67	14.26	13.95	8.99	3.31	16.22	15	scl	16.75	10.99	5.34
Bt2	31-46	62.14	13.61	24.25	14.51	12.04	11.21	16.77	7.61	25	scl	13.75	8.59	4.57
Bt3	46-63	47.56	19.66	32.77	8.29	11.92	8.08	10.88	8.39	30	scl	20.31	12.42	2.42
Cr	63-75	-												
Pedon-4 (RMD-U1/A)														
Ap	0-14	83.33	8.54	8.13	17.78	18.99	18.59	18.59	12.83	20	ls	7.04	3.76	9.76
Bt1	14-37	58.20	12.59	29.21	18.41	16.51	8.15	8.15	6.46	60	scl	16.36	11.76	4.62
Bt2	37-96	64.30	10.49	25.21	23.17	17.33	7.72	7.72	7.31	70	scl	15.84	9.85	6.13
C	96-124	-												
Pedon-5 (BLP-HSD-R1)														
Ap	0-10	74.72	12.39	12.90	19.67	12.23	10.60	19.57	12.64	15	sl	10.43	4.86	6.03
Bt1	10-30	60.89	12.22	26.89	17.85	16.37	8.18	9.99	8.50	15	scl	14.43	7.48	4.98
Bt2	30-51	63.34	13.10	23.56	18.17	11.55	14.29	9.77	9.56	10	scl	13.91	6.91	4.84
BC	51-77	65.19	14.13	20.69	16.83	14.92	10.05	12.59	10.79	20	scl	14.59	7.43	4.61
Cr	77-77+	-												
Pedon-6 (MBD- BLP/R1)														
Ap	0-10	49.48	13.31	37.21	12.53	9.81	8.14	10.44	8.56	15	sc	18.87	11.95	3.72
Bt1	10-24	52.33	10.73	36.94	16.06	10.05	7.56	9.74	8.91	15	sc	17.94	12.02	4.88

Bt2	24-50	45.32	11.04	43.63	18.50	8.94	5.82	6.34	5.72	50	sc	21.53	15.09	4.11
Bt3	50-76	48.65	13.02	38.33	18.33	9.79	6.04	8.12	6.35	45	sc	20.99	14.86	3.74
BC	76-91	53.25	11.19	35.56	16.04	9.75	7.44	9.01	11.01	40	sc	20.22	13.61	4.76
Cr	91-91+	-												
Pedon-7 (HRG- SR /P2)														
Ap	0-18	68.03	17.83	14.14	12.60	11.78	12.60	11.37	19.67	15	sl	14.91	6.98	3.82
Bt1	18-41	58.83	12.42	28.75	20.74	14.57	8.94	7.77	6.81	20	scl	17.46	11.52	4.74
Bt2	41-68	60.65	14.01	25.34	21.20	17.21	8.71	7.03	6.51	25	scl	20.23	11.94	4.33
Bt3	68-88	64.17	13.14	22.69	28.35	16.10	7.89	6.44	5.40	30	scl	18.13	11.67	4.88
Bt4	88-110	65.97	13.02	21.01	25.57	18.06	8.56	7.31	6.47	30	scl	18.27	10.71	5.07
Pedon-8 (HSD- BLP /R8)														
Ap	0-12	64.54	17.09	18.38	5.05	6.08	17.73	18.56	17.11	10	sl	13.12	6.18	3.78
Bt1	12-30	55.31	18.58	26.11	8.67	11.25	10.53	13.21	11.66	10	scl	17.84	9.10	2.98
Bt2	30-58	59.40	15.06	25.54	10.02	13.64	12.50	12.40	10.85	10	scl	16.00	8.73	3.94
Bt3	58-97	64.51	13.01	22.48	9.88	15.43	15.02	16.05	8.13	10	scl	17.36	7.52	4.96
Bt4	97-125	76.73	8.01	15.26	13.27	19.59	17.65	17.76	8.47	10	sl	10.89	5.33	9.58
Bw	125-150	75.08	12.00	12.92	15.22	19.82	17.26	3.58	19.20	10	sl	10.72	4.91	6.26
Pedon-9 (CHG- HSD/R7)														
Ap	0-15	45.17	17.38	37.45	7.56	10.29	8.82	9.56	8.93	-	sc	21.98	11.39	2.60
Bw1	15-35	49.79	22.74	27.47	7.22	7.01	15.07	10.72	9.77	-	scl	19.78	9.86	2.19
Bw2	35-75	59.65	19.37	20.99	13.03	15.02	12.62	11.16	7.82	-	scl	15.68	7.44	3.08
Bw3	75-106	56.46	19.58	23.96	12.50	13.23	12.29	11.15	7.29	-	scl	17.30	8.44	2.88
Bw4	106-128	54.41	19.62	25.97	15.97	12.61	9.98	8.30	7.56	-	scl	18.09	9.42	2.77
Bw5	128-150	57.05	20.11	22.83	12.43	13.58	12.12	6.79	12.12	-	scl	16.30	7.84	2.84
Bw6	150-160	54.86	17.50	27.64	10.76	13.27	11.49	10.76	8.57	-	scl	17.55	9.45	3.13

Table 3. Soil chemical characteristics of representative pedons of Ramanagara district, Karnataka

Horizon	Depth (cm)	pH	EC (dS m^{-1})	OC (%)	Exchangeable cations					CEC	Base Saturation	$CaCO_3$ equivalent	Exch. Ca/Mg ratio	CEC/ Clay ratio
					Ca	Mg	Na	K	Sum					
					----------[cmol(p+)kg^{-1}] ----------						(%)			
Pedon 1 (VPD-T4/P1)														
Ap	0-8	5.08	0.06	0.40	1.62	0.57	0.01	0.11	2.30	4.30	53.51	-	2.84	0.67
A2	8-17	4.70	0.02	0.60	1.76	0.55	0.01	0.05	2.37	4.00	59.21	-	3.20	0.49
C	17-91	-												
Pedon-2 (CGD-BLP/R5)														
A	0-16	6.45	0.06	0.45	14.47	5.33	0.14	0.08	20.02	24.23	82.62	-	2.71	0.68
Bt1	16-33	6.77	0.06	0.33	9.76	8.77	0.17	0.07	18.77	21.32	88.03	-	1.11	0.96
Cr	33-79	-												
Pedon-3 (BMH-BLP/R7)														
Ap	0-12	6.49	0.12	0.84	6.03	3.26	0.17	0.20	9.66	10.09	95.72	-	1.85	0.40
Bt1	12-31	6.84	0.11	0.66	7.31	4.27	0.12	0.12	11.82	11.54	100.00	-	1.71	0.35
Bt2	31-46	7.02	0.11	0.63	5.09	3.18	0.11	0.09	8.48	11.02	76.90	-	1.60	0.45
Bt3	46-63	7.11	0.10	0.45	7.73	3.84	0.28	0.09	11.95	12.20	97.90	-	2.01	0.37
Cr	63-75	-												
Pedon-4 (RMD-U1/A)														
Ap	0-14	4.65	0.04	0.68	1.39	0.52	0.01	0.10	2.02	3.50	57.62	-	2.67	0.43
Bt1	14-37	4.82	0.03	0.64	4.36	1.56	0.05	0.07	6.03	8.30	72.67	-	2.79	0.28
Bt2	37-96	5.1	0.02	0.4	3.85	1.25	0.06	0.06	5.22	7.80	66.91	-	3.08	0.31
C	96-124	-												
Pedon-5 (BLP-HSD-R1)														
Ap	0-10	5.42	0.07	0.68	3.22	1.45	0.01	0.10	4.78	5.70	83.85	-	2.22	0.44
Bt1	10-30	5.79	0.03	0.68	6.16	2.55	0.02	0.03	8.77	8.70	100.00	-	2.42	0.32
Bt2	30-51	6.14	0.03	0.36	6.54	2.48	0.04	0.04	9.10	9.00	100.00	-	2.64	0.38
BC	51-77	6.5	0.03	0.48	7.90	3.21	0.04	0.03	11.18	11.00	100.00	-	2.46	0.53
Cr	77-77+	-												
Pedon-6 (MBD- BLP/R1)														
Ap	0-10	6.80	0.23	1.33	4.06	3.00	0.20	0.77	8.03	9.78	82.15	-	1.35	0.26
Bt1	10-24	6.07	0.20	0.89	3.45	2.67	0.36	1.23	7.71	10.61	72.64	-	1.29	0.29
Bt2	24-50	6.44	0.07	0.46	2.96	1.92	0.49	1.19	6.55	10.61	61.74	-	1.54	0.24
Bt3	50-76	6.63	0.07	0.34	2.26	1.02	0.07	0.13	3.48	4.78	72.72	-	2.22	0.12
BC	76-91	6.77	0.08	0.22	4.69	1.74	0.06	0.09	6.58	8.53	77.22	-	2.70	0.24

Cr	91-91+	-											
Pedon-7 (HRG- SR /P2)													
Ap	0-18	7.88	0.13	0.76	9.67	2.09	0.03	0.13	11.92	9.80	100.00	0.98	4.63	0.69
Bt1	18-41	6.60	0.06	0.48	9.53	3.80	0.03	0.08	13.43	14.10	95.28	-	2.51	0.49
Bt2	41-68	6.41	0.04	0.56	8.24	2.85	0.16	0.06	11.31	12.00	94.23	-	2.89	0.47
Bt3	68-88	6.44	0.04	0.36	8.76	2.89	0.23	0.06	11.94	13.10	91.12	-	3.03	0.58
Bt4	88-110	6.45	0.04	0.32	8.38	2.45	0.20	0.05	11.07	12.80	86.52	-	3.42	0.61
Pedon-8 (HSD- BLP /R8)														
Ap	0-12	7.82	0.10	0.80	6.06	4.03	0.35	0.12	10.55	10.61	99.44	-	1.50	0.58
Bt1	12-30	6.89	0.08	0.53	6.84	4.48	0.12	0.07	11.50	13.10	87.78	-	1.53	0.50
Bt2	30-58	6.91	0.05	0.55	6.74	4.44	0.09	0.08	11.35	12.69	89.48	-	1.52	0.50
Bt3	58-97	6.94	0.05	0.49	5.45	3.50	0.10	0.07	9.11	10.92	83.46	-	1.56	0.49
Bt4	97-125	7.09	0.08	0.27	3.63	2.52	0.09	0.05	6.30	7.18	87.82	-	1.44	0.47
Bw	125-150	7.37	0.09	0.29	3.42	2.52	0.14	0.05	6.12	7.28	84.12	-	1.36	0.56
Pedon-9 (CHG- HSD/R7)														
Ap	0-15	8.02	0.20	2.14	17.16	7.55	0.15	0.45	25.00	21.90	100.00	3.18	2.27	0.58
Bw1	15-35	7.81	0.15	1.33	15.64	5.04	0.12	0.12	20.92	17.40	100.00	1.10	3.10	0.63
Bw2	35-75	7.62	0.06	0.6	9.08	4.41	0.11	0.09	13.68	12.20	100.00	0.73	2.06	0.58
Bw3	75-106	7.69	0.05	0.32	9.58	5.57	0.17	0.10	15.41	13.50	100.00	0.86	1.72	0.56
Bw4	106-128	7.86	0.05	0.36	9.56	5.54	0.29	0.12	15.50	14.60	100.00	1.22	1.73	0.56
Bw5	128-150	7.92	0.04	0.44	8.62	4.68	0.31	0.12	13.73	12.40	100.00	0.86	1.84	0.54
Bw6	150-160	7.94	0.07	0.4	9.76	5.53	0.39	0.13	15.81	14.00	100.00	1.35	1.76	0.51

order. VPD soils have less than 35% (by volume) rock fragments and texture of loamy fine sand or coarser in all layers within the particle-size control section have been in Psaments grouped as at sub-order level. Owing to ustic moisture regime, soils were classified as Ustipsaments at great group level. Except the soils of VPD series, other soils were placed under Alfisols at order level as these pedons have argilic sub-surface horizon. The presence of base saturation more than 35% throughout the depth of the soil horizons and ustic moisture regime, The soils of CGD HSD and CHG were classified as Haplustalfs at great group level, because these soils do not have either duripan or rhodic features. In addition to this, soils of HSD services exhibited the base saturation (by sum of cations) of less than 75 percent throughout and hence placed Ultic at sub group level where as typing pedons of CGD and CHG services did not exhibit any integration with other taxa or an extra gradation from the central concept and hence these have been placed as Typic Haplustalfs (Table 4).

The typifying pedons of BMH, RMD, BLP, MBD, HRG soil series were classified as Rhodustalfs because of occurrence of sub-horizons in the upper 100 cm of the argillic horizon or throughout the entire argillic horizon if less than 100 cm thick, more than 50 per cent colours that have hue of 2.5YR or redder and value, moist, of 3 or less. Similarly at sub group level, these soils did not exhibit any integration with other taxa nor deviated from central concept of Rhodustalfs are placed in Typic Rhodustalfs whereas soils of series MBD have been grouped as Kanhaplic Rhodustalfs (Table 4) because of CEC less than 24 c mol (p+) kg^{-1} clay.

The pedons representing VPD CGD, BLP, HRG, CHG series had the fine earth fraction less than 75 mm in diameter, 15 per cent or more (by weight) particles with a diameter of 0.1 to 75 mm in fine earth fraction, less than 18 per cent clay by weight are placed under coarse loamy particle-size class. The soils of MBD series possessed more than 35 per cent clay with 35 per cent or more (by volume) rock fragments so these were classified placed under the clayey-skeletal particle-size class.

The soils of BMH and HSD series had more than 18 per cent but less than 35 per cent clay (weighted average) in the control section, hence keyed out as fine-loamy, whereas soils of RMD series contained more than 18 percent and less than 35 per cent clay along with 35 percent or more (by volume) rock fragments are placed under loamy-skeletal.

The soils of VPD, MBD, HRG, HSD, and CHG series were classified as active at cation exchange activity classes because the ratio of CEC to per cent clay (by weight) was between 0.40 to 0.60. The pedons belonging to BMH, RMD, and BLP Soil series were classified as semi active because CEC to clay ratio was between 0.20 to 0.40, whereas soils of CGD series was classified as active because the CEC to clay ratio was more than 0.60. The temperature regime of the area was classified as isohyperthermic.

Conclusion

The soils of the area in Ramanara district, Karnataka were strongly acidic to slightly alkaline in reaction (non saline) and had medium to high OC content and low to medium CEC. These soils were classified as Typic Ustipsamments, Kanhaplic Rhodustalfs, Typic Rhodustalfs, Ultic Haplustepts and Typic Haplustepts, at sub-group level. The main constraints were depth, slope, excessive drainage and low water holding capacity in upland soils.

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