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RESEARCH PAPER

Characterization of soil pedons of Ukkund-1 micro-watershed of Ranebennur taluk, Haveri district

VIVEK V. PATIL*, C. VIJAY KUMAR, B. R. JAGADEESH, P. PRIYA AND H. M. SANTHOSHA

Department of Soil Science and Agricultural Chemistry, College of Agriculture, Dharwad
University of Agricultural Sciences, Dharwad - 580005, India

*E-mail: patilvivek132@gmail.com

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Abstract: A study was undertaken to characterize the soil pedons of Ukkund-1 micro-watershed of Ranebennur taluk, Haveri district of Karnataka. 12 profiles were studied for the morphological, physical and chemical properties. The soil depth of each pedon ranged between shallow to deep. In dry conditions, surface horizons were slightly hard, while sub-surface layers were very hard. Under wet and moist conditions, the surface horizons exhibited moderate stickiness, plasticity, and a friable nature, whereas the sub-surface horizons were very sticky, very plastic, and firm. Horizon wise soil samples were collected from 12 pedons based on soil heterogeneity and analyzedfor pedon morphology, physical and chemical properties. Soil texture varied from clay loam to clay and structure varied from sub-angular blocky to angular blocky. Bulk density increased with depth. The pH ranged from slightly acidic to slightly alkaline and EC was normal. Organic carbon (OC) content decreased with depth. Conversely, free $CaCO_3$ content increased with depth.

Key words: Soil characterization, Micro-watershed, Pedons, Soil survey

Introduction

Soil is a vital natural resource that supports ecosystems, agriculture and human life. Its characteristics shaped by interactions among environmental factors such as climate, topography, vegetation and parent material determine its ability to sustain plant growth and regulate water and nutrient cycles. Understanding the morphological, physical and chemical properties of soils is essential for assessing their quality and managing them for agricultural productivity and environmental sustainability.

Micro-watersheds, which are smaller divisions of larger hydrological units, serve as important sites for soil studies because of their unique topographical and hydrological features. These factors strongly affect the distribution of soils and their properties across the landscape. Examining soil morphology helps in understanding horizon development, structure and other visible traits that reflect soil genesis. Physical properties such as texture, bulk density and porosity regulate the movement of air and water in the soil, influencing plant growth and ecosystem functioning. Chemical properties including soil pH, electrical conductivity (EC), organic carbon (OC) and nutrient status play a direct role in soil fertility and its capacity to support agricultural productivity.

Within a micro-watershed, the interaction of landforms, vegetation and hydrology often produces a wide range of soil types and conditions. Recognizing these variations is essential for developing suitable soil management strategies. Building on this background, the present study focuses on the morphological, physical and chemical properties of soils in the Ukkund-1 micro-watershed, offering a detailed assessment of soil behaviour and fertility under different land uses. The outcomes of this study are expected to contribute to sustainable agricultural practices, improvement of soil health and better conservation planning in micro-watershed areas.

Materials and methods

The Ukkund-1 micro-watershed, located in Ranebennur taluk, Haveri district, Karnataka, spans 685.17 ha and lies between $14^0$35’ 30" N latitude and $75^0$30’ 47" E longitude. The region, part of the northern transition zone, is characterized by black and red soils and receives seasonal rainfall during the kharif period, with an average annual rainfall of 700-800 mm. The landscape is nearly level to gently sloping with moderate drainage and its geology is dominated by Dharwar schist. The climate is tropical, experiencing hot, dry summers (March-May), monsoonal rains (June-September), a pleasant post-monsoon season (October-November) and mild winters (December-February). Natural vegetation includes species like *Prosopis Juliflora, Cassia auriculata* and neem (*Azadirachta indica*), with agriculture being the main economic activity. Crops such as maize, bajra, sorghum, sunflower, bengal gram, tur and cotton are cultivated.

A detailed soil survey was conducted using IRS P6 LISS-IV imagery and cadastral maps, with 12 pedons examined in the field for their morphological features as per soil survey manual. Horizon-wise soil samples were collected, air dried and passed through 2 mm sieve and analyzed for particle size distribution following international pipette method (Piper, 2002), bulk density by clod method (Black, 1965), pH and EC by 1:2.5 soil water suspension (Jackson, 1973). Organic carbon was estimated by Walkley and Black wet oxidation method (Jackson, 1973), free calcium carbonate by rapid acid titration method (Piper, 2002).

Table 1. Morphological characteristics of pedons in Ukkund-1 micro-watershed

Pedon No.	Horizon	Depth	Colour		Structure	Consistence			
			Dry	Mst		Dry	Mst	Stk	Pls
1	Ap	0-18	10 YR 3/1	10 YR 2/1	2 m sbk	sh	fr	vs	vp
	BA	18-39	10 YR 3/1	10 YR 2/1	2 m sbk	sh	fr	vs	vp
	Bss1	39-54	10 YR 3/1	10 YR 2/1	3 m sbk	h	fi	vs	vp
	Bss2	54-105	10 YR 3/1	10 YR 2/2	3 m sbk	h	fi	vs	vp
	Bss3	105-136	10 YR 3/1	10 YR 2/3	3 m sbk	h	fi	vs	vp
	Bssk1	136-165	10 YR 3/2	10 YR 4/2	2 m abk	sh	fr	vs	vp
	Bssk2	165-190	10 YR 3/1	10 YR 4/2	2 m abk	sh	fr	vs	vp
2	Ap	0-16	10 YR 4/4	10 YR 3/4	1 m sbk	sh	fr	ms	mp
	BA1	16-40	10 YR 4/4	10 YR 3/3	1 m sbk	vh	fr	ms	mp
	BA2	40-64	10 YR 4/3	10 YR 3/4	2 m abk	vh	fr	ms	mp
	BA3	64-89	10 YR 4/3	10 YR 3/4	2 m abk	vh	fr	ms	mp
	Bss1	89-130	10 YR 4/1	10 YR 3/1	1 m abk	vh	fr	vs	vp
	Bss2	130-170	10 YR 4/1	10 YR 3/2	1 m abk	vh	fr	vs	vp
3	Ap	0-19	7.5 YR 3/4	10 YR 3/3	1 m sbk	sh	fr	ms	mp
	Bw	19-31	7.5 YR 4/3	7.5 YR 3/4	1 m sbk	sh	fr	ms	mp
	BC1	31-59	7.5 YR 4/4	7.5 YR 4/3	1 m sbk	sh	fr	ms	mp
	BC2	59-90	7.5 YR 4/4	7.5 YR 4/4	1 m sbk	sh	fr	ms	mp
4	Ap	0-15	7.5 YR 4/4	7.5 YR 3/4	1 m sbk	sh	fr	ms	mp
	Bw1	15-31	7.5 YR 3/4	7.5 YR 3/3	2 m sbk	sh	fr	ms	mp
	BC1	31-60	7.5 YR 3/4	7.5 YR 3/3	1 m sbk	sh	fr	ms	mp
	BC2	60-80	7.5 YR 4/3	7.5YR 3/4	1 m sbk	sh	fr	ms	mp
5	Ap	0-20	7.5 YR 4/3	7.5 YR 3/3	1 m sbk	sh	fr	ms	mp
	Bw1	20-38	7.5 YR 3/4	7.5 YR 2.5/3	1 m sbk	sh	fr	ms	mp
	BC1	38-60	7.5 YR 3/4	7.5 YR 3/3	1 m sbk	sh	fr	ms	mp
	BC2	60-89	7.5 YR 3/4	7.5 YR 3/3	1 m sbk	sh	fr	ms	mp
6	Ap	0-12	7.5 YR 3/4	7.5YR 3/3	1 m sbk	sh	fr	ms	mp
	Bw	12-22	7.5 YR 4/3	7.5 YR 3/4	1 m sbk	sh	fr	ms	mp
	BC	22-49	7.5 YR 3/4	7.5 YR 3/3	1 m sbk	sh	fr	ms	mp
7	Ap	0-15	10 YR 4/3	10 YR 3/3	1 m sbk	sh	fr	ms	mp
	Bw1	15-33	10 YR 3/2	10 YR 2/2	1 m sbk	h	fi	ms	mp
	Bw2	33-60	10 YR 3/2	10 YR 2/2	1 m sbk	h	fi	ms	mp
	BC	60-75	10 YR 4/3	10 YR 3/4	1 m sbk	sh	fr	ms	mp
8	Ap	0-23	5 YR 3/4	5 YR 3/3	2 m abk	sh	fr	ms	mp
	Bw1	23-49	5 YR 4/3	5 YR 3/4	2 m abk	h	fi	ms	mp
	Bw2	49-77	5 YR 4/4	5 YR 3/4	1 m abk	sh	fr	ms	mp
	Bw3	77-102	7.5 YR 4/4	7.5 YR 3/4	1 m abk	sh	fr	ms	mp
	BC	102-120	7.5 YR 5/6	7.5 YR 4/6	1 m abk	sh	fr	ms	mp
9	Ap	0-19	5 YR 3/4	5 YR 3/3	2 m sbk	sh	fr	ms	mp
	Bw1	19-48	5 YR 4/3	5 YR 3/4	2 m sbk	sh	fr	ms	mp
	Bw2	48-76	5 YR 4/4	5 YR 3/4	1 m abk	sh	fr	ms	mp
	Bw3	76-103	7.5 YR 4/4	7.5 YR 3/4	1 m abk	sh	fr	ms	mp
	BC	103-120	7.5 YR 5/6	7.5 YR 4/6	1 m abk	sh	fr	ms	mp
10	Ap	0-19	10 YR 3/2	10 YR 2/2	2 m sbk	sh	fr	ms	mp
	Bw1	19-55	10 YR 3/1	10 YR 2/2	2 m sbk	h	fi	vs	vp
	Bw2	55-101	10 YR 3/3	10 YR 3/2	2 m sbk	sh	fr	vs	vp
	BC	101-125	10 YR 5/4	10 YR 5/4	1 m sbk	sh	fr	vs	vp
11	Ap	0-12	10 YR 3/6	10 YR 3/4	1 m sbk	sh	fr	ms	mp
	Bw1	12-29	10 YR 3/4	10 YR 3/3	1 m sbk	sh	fr	ms	mp
	Bw2	29-55	10 YR 3/4	10 YR 3/3	1 m sbk	sh	fr	ms	mp
	BC	55-90	10 YR 3/6	10 YR 3/4	1 m sbk	sh	fr	ms	mp
12	Ap	0-19	10 YR 4/4	10 YR 3/4	1 m sbk	sh	fr	ms	mp
	Bw	19-32	10 YR 3/6	10 YR 3/4	2 m sbk	sh	fr	ms	mp
	BC	32-70	10 YR 5/4	10 YR 5/4	1 m sbk	sh	fr	ms	mp

1. Structure: Size: f-fine, m-medium, c-coarse. Grade: 1-weak, 2-moderate, 3-strong; Type: pl-platy, abk-angular blocky, sbk- subangular blocky. 2. Consistency: Dry: s-soft, sh-slightly hard, h-hard, vh-very hard. Moist: vfr-very friable, fr-friable, fi- firm, vfi-very firm. Stickiness: so-non sticky, ss-slightly sticky, ms-moderately sticky, vs-very sticky, Plasticity: po-non-plastic, sp-slightly plastic, mp-moderately plastic, vp-very plastic.

Results and discussion

Soil morphology

Morphological characteristics *viz.,* soil colour, soil structure, soil consistence of all the pedon are presented in Table 1.

Soil colour

In Ukkund-1 micro-watershed, the soil color differed consistently as surface horizons were darker. This darker color in the surface layers suggested a higher content of organic

matter (Thangasamy *et al*., 2005), which is typical of top soil where plant and microbial activity were most concentrated.

As the profiles extended deeper into the subsoil, the color slightly. This change in color indicated a decrease in organic matter content as the depth increased as well as the possible presence of iron oxides Sidhu *et al*. (1994).

Soil structure

Soil structure refers to the arrangement and organization of soil particles (sand, silt, and clay) into aggregates or clusters. In Ukkund-1 micro-watershed the surface horizons exhibited a medium sub angular blocky structure while the sub-surface horizons exhibited a medium angular blocky and medium sub

Table 2: Physical properties of soil pedons in Ukkund-1 micro-watershed

Pedon No	Horizon	Depth	Texture (%)			Textural class	BD(Mg m^{-3})
			Sand	Silt	Clay		
1	Ap	0-18	33.50	18.00	48.50	clay	1.23
	BA	18-39	32.70	17.80	49.50	clay	1.25
	Bss1	39-54	31.00	17.50	51.50	clay	1.29
	Bss2	54-105	29.60	17.30	53.10	clay	1.33
	Bss3	105-136	27.50	17.10	55.40	clay	1.35
	Bssk1	136-165	31.10	16.80	52.10	clay	1.38
	Bssk2	165-190	30.90	16.60	52.50	clay	1.41
2	Ap	0-16	36.50	22.30	41.20	clay	1.12
	BA1	16-40	36.40	21.40	42.20	clay	1.17
	BA2	40-64	37.40	18.40	44.20	clay	1.23
	BA3	64-89	36.60	16.70	46.70	clay	1.39
	Bss1	89-130	35.10	16.20	48.70	clay	1.50
	Bss2	130-170	33.70	15.20	51.10	clay	1.53
3	Ap	0-19	34.20	25.30	40.50	clay	1.21
	Bw	19-31	35.40	23.40	41.20	clay	1.23
	BC1	31-59	28.60	38.20	33.20	clay loam	1.27
	BC2	59-90	31.10	39.40	29.50	clay loam	1.36
4	Ap	0-15	28.40	25.40	46.20	clay	1.19
	Bw1	15-31	29.90	23.30	46.80	clay	1.26
	BC1	31-60	31.00	21.30	47.70	clay	1.27
	BC2	60-80	31.60	20.50	47.90	clay	1.43
5	Ap	0-20	29.40	26.30	44.30	clay	1.19
	Bw1	20-38	30.30	25.30	44.40	clay	1.22
	BC1	38-60	32.20	22.30	45.50	clay	1.29
	BC2	60-89	32.30	21.20	46.50	clay	1.39
6	Ap	0-12	28.90	27.30	43.80	clay	1.27
	Bw	12-22	28.00	25.30	46.70	clay	1.31
	BC	22-49	26.90	23.30	49.80	clay	1.35
7	Ap	0-15	28.30	26.50	45.20	clay	1.29
	Bw1	15-33	30.70	22.10	47.20	clay	1.31
	Bw2	33-60	31.00	20.10	48.90	clay	1.35
	BC	60-75	32.60	18.30	49.10	clay	1.43
8	Ap	0-15	36.30	23.40	40.30	clay	1.12
	Bw1	15-30	36.50	21.40	42.10	clay	1.23
	Bw2	30-61	36.50	20.70	42.80	clay	1.37
	Bw3	61-92	36.30	19.80	43.90	clay	1.41
	Bw4	92-120	38.00	17.70	44.30	clay	1.43
9	Ap	0-19	33.50	25.30	41.20	clay	1.23
	Bw1	19-48	34.40	23.30	42.30	clay	1.34
	Bw2	48-76	34.30	21.20	44.50	clay	1.39
	Bw3	76-103	35.30	19.20	45.50	clay	1.41
	BC	103-120	38.80	18.50	42.70	clay	1.49
10	Ap	0-19	33.30	24.30	42.40	clay	1.18
	Bw1	19-55	36.50	20.20	43.30	clay	1.23
	Bw2	55-101	36.30	19.30	44.40	clay	1.37
	BC	101-125	35.60	36.10	28.30	clay loam	1.23
11	Ap	0-12	34.20	25.30	40.50	clay	1.17
	Bw1	12-29	33.80	23.90	42.30	clay	1.25
	Bw2	29-55	35.70	21.20	43.10	clay	1.29
	BC	55-90	36.56	19.34	44.10	clay	1.35
12	Ap	0-19	24.60	44.20	31.20	clay loam	1.33
	Bw	19-32	27.20	43.10	29.70	clay loam	1.43
	BC	32-70	31.70	40.60	27.70	clay loam	1.52

angular blocky this is due to the accumulation of clay (Sharma *et al.,* 2004) and the influence of downward-moving water carrying fine particles that cemented the aggregates more tightly.

Soil consistence

The pedons of this area exhibited a slightly hard consistency when dry, friable when moist and moderate sticky and plasticity when wet in the surface horizons. As the profile extended, the consistency in the dry state ranged from slightly hard to very hard, firm to very firm in the moist state and very plastic and very sticky in the wet condition due to higher clay content and compaction.

Soil physical and chemical properties

The particle size distribution of the studied pedons (Table 2) indicated that the soils were predominantly clay to clay loam in

Table 3. Chemical properties of soil pedons in Ukkund-1 micro-watershed

Pedon No	Horizon	Depth	pH (1:2.5)	EC (dS m^{-1})	OC (g kg^{-1})	Free $CaCO_3$ (%)
1	Ap	0-18	6.96	0.15	4.70	2.10
	BA	18-39	7.02	0.17	4.20	2.20
	Bss1	39-54	7.29	0.21	2.20	2.30
	Bss2	54-105	7.95	0.24	1.70	3.20
	Bss3	105-136	8.08	0.29	1.40	4.30
	Bssk1	136-165	8.27	0.33	1.10	10.70
	Bssk2	165-190	8.48	0.41	0.90	11.40
2	Ap	0-16	7.45	0.27	8.20	2.90
	BA1	16-40	7.86	0.35	4.50	3.10
	BA2	40-64	8.07	0.43	3.40	3.70
	BA3	64-89	8.12	0.45	2.20	3.90
	Bss1	89-130	8.22	0.38	1.70	4.40
	Bss2	130-170	8.42	0.36	1.70	4.80
3	Ap	0-19	6.35	0.17	7.70	3.10
	Bw	19-31	6.49	0.13	4.50	3.00
	BC1	31-59	6.78	0.17	3.80	2.70
	BC2	59-90	6.98	0.21	1.90	1.20
4	Ap	0-15	6.25	0.18	7.50	3.20
	Bw1	15-31	6.43	0.19	4.80	2.90
	BC1	31-60	6.87	0.14	3.30	2.20
	BC2	60-80	7.01	0.24	1.80	2.00
5	Ap	0-20	6.33	0.18	7.30	2.90
	Bw1	20-38	6.63	0.23	4.30	3.00
	BC1	38-60	7.19	0.27	2.90	2.50
	BC2	60-89	7.56	0.29	1.10	1.70
6	Ap	0-12	7.08	0.31	4.50	2.20
	Bw	12-22	7.19	0.33	2.90	3.20
	BC	22-49	7.55	0.29	1.30	3.50
7	Ap	0-15	6.78	0.19	6.60	2.80
	Bw1	15-33	7.03	0.15	2.90	3.00
	Bw2	33-60	7.12	0.17	1.90	2.50
	BC	60-75	7.19	0.23	1.10	1.00
8	Ap	0-15	6.11	0.22	5.30	1.90
	Bw1	15-30	6.43	0.26	2.70	2.30
	Bw2	30-61	6.98	0.29	1.50	2.50
	Bw3	61-92	7.02	0.31	1.10	2.70
	Bw4	92-120	7.21	0.28	1.00	1.10
9	Ap	0-19	6.02	0.18	5.10	2.00
	Bw1	19-48	6.17	0.22	2.80	2.20
	Bw2	48-76	6.67	0.25	1.30	2.50
	Bw3	76-103	7.43	0.29	1.00	2.90
	BC	103-120	7.54	0.21	0.70	1.50
10	Ap	0-19	7.14	0.27	7.80	3.90
	Bw1	19-55	7.29	0.24	5.00	4.80
	Bw2	55-101	7.35	0.26	3.90	6.20
	BC	101-125	7.99	0.29	2.50	11.20
11	Ap	0-12	6.22	0.18	8.10	1.50
	Bw1	12-29	6.43	0.17	3.80	1.00
	Bw2	29-55	6.56	0.22	2.40	1.00
	BC	55-90	6.78	0.14	1.90	1.00
12	Ap	0-19	6.63	0.16	5.40	2.30
	Bw	19-32	7.21	0.14	2.70	2.80
	BC	32-70	7.52	0.21	2.10	3.00

texture. Sand content varied irregularly among horizons, silt content did not exhibit a uniform trend across the pedons, fluctuating between horizons. Such variability is likely influenced by differences in the degree of weathering of the parent material, as observed by Denis *et al*. (2015). Clay content, in contrast, generally increased with depth in most pedons, suggesting the downward movement and accumulation of finer particles through illuviation during soil formation (Pulakeshi *et al*., 2014).

Bulk density of surface horizons ranged from 1.12 Mg m^{-3} to 1.29 Mg m^{-3}, while in sub-surface horizons, it increased up to 1.53 Mg m^{-3}. The surface Ap horizons generally recorded the lowest bulk density values, which can be attributed to higher organic matter content and better aggregation.With increasing depth, bulk density values rose steadily. This rise is largely due to greater compaction and a denser soil matrix (Tumbal and Patil, 2015).

The pH values of the studied pedons (Table 3) ranged from 6.02 to 8.48, indicated that the soils varied from slightly acidic to slightly alkalinein reaction.The relatively lower pH in surface layers can be attributed to the presence of organic matter and the leaching of basic cations.In some pedons, the deepest horizons recorded pH values above 8.0, coinciding with higher free CaCO*f* content. These results are in line with findings of Sharma *et al*. (2004).

The electrical conductivity of the studied pedons ranged from 0.13 to 0.45 dS m^{-1}, indicated that the soils are non-saline and generally free from any salinity hazards. The EC values were relatively low across all horizons.

The organic carbon (OC) content ranged from 0.70 to 8.20 g kg^{-1}. The maximum OC content was found in the pedon 2 (8.20g kg^{-1}) followed by pedon 11 (8.10g kg^{-1}) of Ap horizon, while the minimum was recorded in the sub surface horizons of the pedon 9 (0.70 g kg^{-1}). In almost all cases, OC values were higher in the surface horizons than in the underlying layers. This can be attributed to the greater accumulation of plant residues, fine roots and higher microbial activity at the surface (Pinki *et al*., 2017). The sub soil horizons, in contrast, exhibited lower OC levels due limited biological activity at depth further restricts organic matter accumulation (More *et al*., 1988).

In the studied pedons, free $CaCO_3$ content showed a general increase with soil depth.This enrichment in subsoil horizons is primarily attributed to the influence of the parent material, Dharwar schist, which upon weathering releases calcium carbonate that subsequently accumulates within the pedons (Pinki *et al*., 2017).

Conclusion

A study was conducted to characterize the soils of Ukkund-1 micro-watershed in Ranebennur taluk of Haveri district. Twelve profiles analyzed for their morphological, physical, and chemical properties. The twelve soil pedons showed considerable variation in depth, from shallow to deep. Pedon colours ranged from reddish brown to very dark gray. Texturally, they varied from clay to clay loam, becoming harder in the sub-surface layers. In wet conditions, surface horizons were moderately sticky and plastic, while sub-surface layers exhibited very sticky and plastic properties. Clay content increased with depth, ranging from 27.70 to 55.40 per cent. Silt varied between 15.20 and 44.20 per cent. Total sand content also exhibited an irregular pattern across the profiles. Bulk density consistently increased with depth, from 1.12 to 1.53 Mg m^{-3}.The pH of the soil pedons, indicated slightly acidic to moderately alkaline conditions. Organic carbon (OC) content decreased with depth. Conversely, free $CaCO_3$ content increased with depth.

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