



Characterization and Classification of Soils of Madahalli Micro-watershed of Karnataka

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Abstract: Detailed soil survey was carried out to characterize and classify the soils of Madahalli watershed, Chamrajnagar district, Karnataka using cadastral map overlaid on Cartosat-1(ortho corrected) image as a base. Three landform units were identified based on elevation and slope *i.e.* gently sloping lands (3-5%), very gently sloping lands (1-3%) and nearly level lands (0-1%) and mapped into 6 soil series and 30 phases of soil series. These soils were classified as Alfisols (Typic Rhodustalfs, Rhodic Paleustalfs) and Inceptisols (Typic Haplustepts). Alfisols are slightly deep to deep, dark reddish brown to strong brown in hue 2.5YR 3/4 to 2.5YR 4/6, sandy loam to sandy clay in texture with >35 per cent gravel. Inceptisols are very deep, yellowish brown to dark brown with hue 10YR 4/6 to 10YR 3/3, sandy clay loam to clay in texture. These soils are moderately acidic to moderately alkaline (pH 5.26 to 8.17). The organic carbon content varied from low to high (0.21 to 1.16%) and CEC of the soils ranged from 4.1 to 19.9 cmol (p+) kg⁻¹.

Keywords: Soil survey and mapping, remote sensing, Alfisols, Inceptisols, Taxonomy

Introduction

Land and water are the most vital natural resources of the country and these are under tremendous stress due to ever increasing biotic pressure. Characterization of soils is fundamental to all soil studies, as it is an important tool for soil classification, which is done based on soil properties. It also provides information for understanding of the physical, chemical and mineralogical properties of the soils and an insight into the potentials and limitations of the soils for management. The soil and land resource inventories made so far in Karnataka had limited utility because the surveys were of different types, scales and intensities at different times with specific objectives. Hence, there is need to generate detailed site-specific farm level database on different land resources for all the

village/watersheds in a time bound manner that would help to protect the valuable land resources and also to stabilize the farm production and characterization of Madahalli micro-watershed of Gundlupet taluk, Chamrajnagar district is one of the case study in this direction.

Materials and Methods

Madahalli micro-watershed is located in Kodosogegramma panchayath, Terakanambi Hobli, Gundlupet taluk of Chamrajnagar district (Fig.1). The micro-watershed with total area of 698 hectares (76°46'15.16" and 76°48'15" N latitude) and 11°43' 05.91" and 11°44'43.13" E longitude) is located at about 30 kms southeast from Gundlupet. The watershed covers Karkla Madahalli (298 ha), Thodipura (172 ha), Vaddagere (49 ha) Alwadi (178 ha) and Kodosoge (4 ha) villages.

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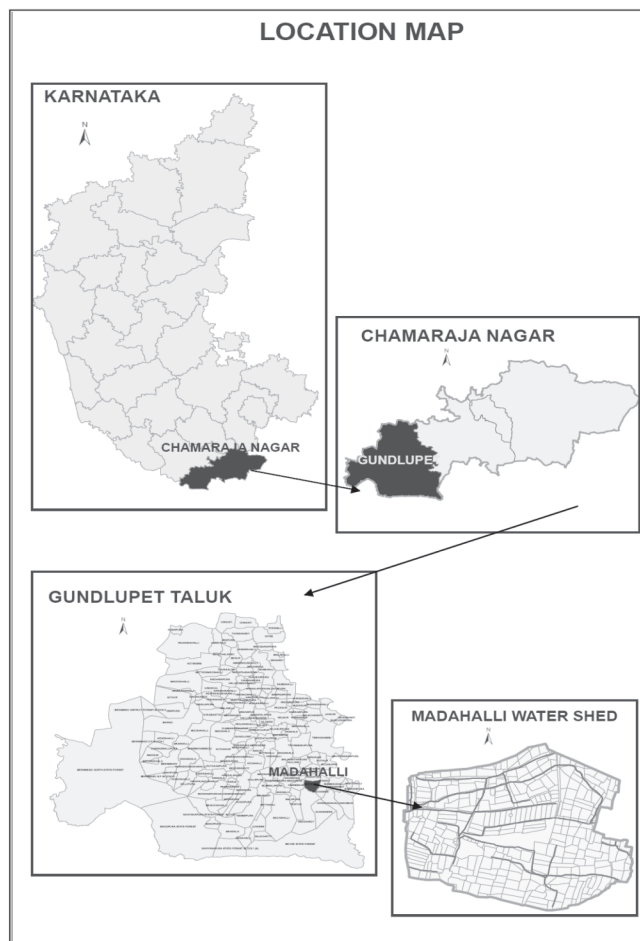


Fig. 1. Location map of study area

Granite and granite-gneiss are the major rock types in the watershed. The elevation of the area ranges from 868 to 919 m above mean sea level (MSL). The area is very gently sloping to gently sloping uplands with slope ranging from 1 per cent to 5 per cent. The area can be broadly divided into three landform units based on elevation and slope and they are gently sloping lands (3-5%), very gently sloping lands (1-3%) and nearly level lands (0-1%). Very gently to gently sloping land cover about 67 per cent and nearly level land occupies 30 per cent of the watershed. The climate of the area is semi-arid transition characterized by hot and dry summer with mild winter. The annual precipitation is 734.5 mm and the annual temperature is 23.7 °C. Length of growing period (LGP) ranges from 90 to 120 days. Soil moisture regime is ustic and soil temperature regime is isohyperthermic. Pongamia (*Pongamia*

pinnata), Neem (*Azadirachta indica*), Lantana (*Lantana camera*), Tamarind (*Tamarindus indica*), Soapnut tree (*Acacia concinna*), Pipal (*Ficus religiosa*). are the natural vegetation. The major crops grown are ragi (*Eleusine coracana*), groundnut (*Arachis hypogaea*), pigeonpea (*Cajanus cajan*), castor (*Ricinus communis*), mango (*Mangifera indica*) etc.

Detailed survey of the watershed was carried out by using Cartosat-1 image in conjunction with cadastral map as a base. A total of six pedons were exposed and studied from each landform for describing morphological characteristics (Soil Survey Staff 2010). Horizon-wise soil samples were collected, processed and analysed for particle size distribution, pH, EC, organic carbon and cation exchange capacity following the procedure outlined by Black (1965).

Results and Discussion

Soil morphology

The pedons were slightly deep to very deep. The colour is in the hue of 7.5YR, 5YR and 2.5YR with value 3 to 4 and chroma 4 and 6. In general, pedons had dark brown, dark reddish brown surface and dark reddish brown to reddish brown sub-surface horizons except pedon 6. These pedons have thin patchy cutans in sub-surface soils except P₆. Structure of the soils are weak fine to medium weak subangular blocky in surface to moderate medium subangular blocky in sub-surface soils. (Table 1)

Physical characteristics

The particle size data (Table 2) indicated that the clay content varied from 13.4 to 41.4 per cent and gradually increased in the sub-surface layers and then decreased. Meena *et al.* (2014) also recorded similar trend of clay illuviation in lowland soils in Mandya District of Karnataka. Silt content varied from 2.7 to 19.8 per cent and it was irregularly distributed in all the pedons. Sand content varied from 44.0 to 83.2 per cent being high in surface layers. Coarse fragments varied from 5 to 70 per cent with irregular distribution with depth.

Chemical characteristics

The pH of the soils varied from 5.26 to 8.20 (moderately acid to moderately alkaline). In some pedons, pH increased with depth which could be due to the leaching of exchangeable bases from the surface horizon. Electrical conductivity varied from 0.027 to 0.129 mSm⁻¹ indicating that the soils are non-saline. Organic carbon content varied from low to high (0.21 to 1.23 per cent) and in few pedons it increased with depth and then decreased in lower layers. Cation exchange capacity of the soils varied from 4.1 to 19.9 cmol

(p+)kg⁻¹ and in general increased with depth. (Table 2) Among exchangeable bases, exchangeable Ca²⁺ was higher (1.88 to 10.05 cmol(p+)kg⁻¹) and the exchangeable cations followed in the order as Ca>Mg>Na>K. Exchangeable calcium had positive correlation with clay and pH. Base saturation of the soils is more than 35 per cent and pedon 6 had base saturation ≈ 100 per cent. The exchangeable Ca²⁺ and Mg²⁺ contributed for higher base saturation in these soils. Similar results were also reported by Srinivasan *et al.* (2013) and Meena *et al.* (2014).

Table 1. Morphological features of typical pedons of Madahalli micro-watershed

Pedons	Horizon	Depth cm	Colour (moist)	Structure	Consistence	Coarse fragments	Special features
Pedon 1	Ap	0-18	7.5YR 4/4	m1sbk	fr, so, po	10	-
	AB	18-29	2.5YR 4/4	m2sbk	fr, ss, sp	5	T tn p
	Bt1	29-48	2.5YR 3/4	m2sbk	fr, ss, sp	60	T tn p
	Bt2	48-69	2.5YR 3/6	m1sbk	fr, ss, sp	25	T tn p
	Cr	69+	Weathered granite gneiss				
Pedon 2	Ap	0-22	5YR 3/4	m1sbk	fr, ss, sp	-	-
	Bt1	22-46	2.5YR 3/6	m2sbk	fr, ms, mp	50	T tn p
	Bt2	46-74	2.5YR 3/6	m2sbk	fr, ms, mp	45	T tn p
	Bt3	74-96	2.5YR 3/4	m1sbk	fr, ss, sp	20	T tn p
	Cr	96+	Weathered granite gneiss				
Pedon 3	Ap	0-13	7.5YR 3/4	f1sbk	fr, s0, p0	5	
	Bt1	13-41	2.5YR 3/4	m2sbk	fr, ms, mp	10	T tn p
	Bt2	41-83	2.5YR 3/4	m2sbk	fr, ms, mp	60	T tn p
	Cr	83+	Weathered granite gneiss				
Pedon 4	Ap	0-13	7.5YR 4/4	f1sbk	l, so, po	10	-
	Bt1	13-36	2.5YR 3/6	m1sbk	f, ms, mp	70	T tn p
	Bt2	36-61	2.5YR 3/6	m1sbk	f, ms, mp	65	T tn p
	Bt3	61-83	2.5YR 3/4	m1sbk	f, ms, mp	60	T tn p
	Cr	83+	Weathered granite gneiss				
Pedon 5	Ap	0-20	5YR 3/4	m1sbk	fr, ss, sp	-	-
	Bt1	20-38	5YR 4/4	m1sbk	fr, ss, sp	-	T tn p
	Bt2	38-69	2.5YR 3/6	m2sbk	fr, ms, mp	-	T tn p
	Bt3	69-98	2.5YR 3/4	m2sbk	fr, ms, mp	40	T tn p
	Bt3	98-134	2.5YR 3/4	m1sbk	fr, s, p	50	T tn p
	Cr	134-188	Weathered granite gneiss				
Pedon 6	Ap	0-26	10YR 4/4	f1sbk	l, ss, sp	-	
	2A21	26-51	10YR 4/6	f1sbk	l, so, po	-	
	3Bw1	51-72	10YR 4/6	m1sbk	l, so, po	-	Pressure faces
	4Bw2	72-104	10YR 4/4	m2sbk	h, vs, vp	-	Pressure faces
	5Bw3	104-138	10YR 4/3	m2sbk	h, vs, vp	-	Pressure faces
	6Bw4	138-170	10YR 3/3	m2sbk	h, vs, vp	-	Pressure faces

Table 2. Physical and chemical properties of the soils of Madahalli micro-watershed

Horizon	Depth cm	Particle size distribution (% of <2 mm)			Organic carbon (gkg ⁻¹)	pH	EC (dSm ⁻¹)	Exchangeable bases (cmol (p+) kg ⁻¹)				CEC	Base saturati on (%)
		Sand (2.0-0.05 mm)	Silt (0.05- 0.002mm)	Clay (<0.00 2mm)				Ca	Mg	Na	K		
Pedon 1													
Ap	0-18	82.5	4.5	13.4	11.6	6.14	0.45	4.36	0.61	0.45	0.59	4.1	100
Bw	18-29	80.5	5.8	13.5	10.6	6.21	0.27	2.72	0.64	0.27	0.65	4.7	91
Bt1	29-48	51.5	12.0	36.3	8.8	5.88	0.46	5.35	0.97	0.22	0.55	12.3	58
Bt2	48-69	55.0	19.8	35.2	8.1	6.41	0.49	4.11	1.0	0.13	0.51	12.7	45
Pedon 2													
Ap	0-22	58.8	11.9	33.3	12.3	7.57	0.97	10.05	1.34	0.65	0.49	10.3	100
Bt1	22-46	50.1	11.3	38.6	5.3	7.67	0.47	2.88	1.02	0.26	0.73	12.8	38
Bt2	46-74	57.0	13.0	32.0	7.4	7.64	0.37	3.4	1.07	0.15	0.84	14.5	38
Bt3	74-96	50.2	14.80	35.0	4.2	7.44	0.34	3.96	1.11	0.19	0.86	19.1	32
Pedon 3													
Ap	0-13	83.2	2.7	15.1	9.5	6.28	0.38	3.61	0.99	0.35	0.63	6.7	83
Bt1	13-41	57.9	6.2	35.6	7.4	5.86	0.32	3.48	0.71	0.24	0.56	9.7	51
Bt2	41-83	54.5	9.7	35.8	7.7	5.89	0.33	3.36	0.76	0.19	0.55	10.7	45
Pedon 4													
Ap	0-13	65.0	13.9	20.1	6.3	5.26	0.95	4.71	0.41	0.29	0.36	6.2	93
Bt1	13-36	62.5	6.2	31.5	5.3	5.75	1.29	4.9	0.83	0.28	0.55	12.9	51
Bt2	36-61	49.8	9.8	41.4	4.6	6.19	0.90	4.67	1.14	0.36	0.97	19.9	36
Bt3	61-83	52.8	11.7	35.5	4.2	6.24	0.71	5.1	0.82	0.31	0.73	18.2	38
Bt4	83-106	76.5	2.9	21.6	4.8	6.78	0.79	2.95	0.7	0.15	0.63	7.4	60
Pedon 5													
Ap	0-20	71.0	8.7	23.3	6.3	7.02	0.31	1.97	0.64	0.41	0.08	4.3	72
Bw	20-38	72.1	7.4	20.5	12.3	7.15	0.43	1.9	0.61	0.19	0.58	9.1	36
Bt1	38-69	44.0	15.1	40.1	8.1	7.17	0.52	3.97	0.72	0.13	0.82	10.8	52
Bt2	69-98	59.4	5.6	36.0	8.8	6.68	0.44	2.8	0.82	0.12	0.96	9.6	49
Bt3	98-134	57.6	7.4	36.2	5.6	7.02	0.25	1.88	0.51	0.14	0.93	8.9	39
Pedon 6													
Ap	0-26	74.1	7.3	20.6	7.0	7.96	0.52	6.19	1.35	0.24	0.72	8.5	100
2A2	26-51	82.2	2.3	12.5	6.3	7.93	0.53	5.4	0.09	0.45	0.58	7.3	89.3
3Bw1	51-72	72.0	6.6	22.4	2.1	8.17	0.47	3.53	0.7	0.15	0.78	4.7	100
4Bw2	72-104	58.0	8.2	30.8	6.0	7.79	0.64	3.63	1.13	0.19	0.79	10.1	56.8
5Bw3	104-138	26.7	30.3	40.0	2.8	7.85	0.72	6.06	1.79	0.23	0.92	12.7	70.9
6Bw4	138-170	55.5	9.5	35.0	4.2	8.06	0.66	5.37	1.5	0.22	0.65	13.2	58.6

Soil classification

Based on the morphological characteristics, physical and chemical properties of the typifying pedons, all the upland soils are grouped under Alfisols and the lowland soils under Inceptisols (Fig. 2). Six soil series were identified and mapped with 30 mapping units (phases of

soil series). Moderately deep, well drained red gravelly sandy loam soils (M1 and M4 series); occupy nearly 47 per cent of the watershed area (330 ha). Series M5, which is very deep dark red sandy clay loam soils, cover an area of 326 ha. Other soils cover less than 5 per cent of the area in the watershed.

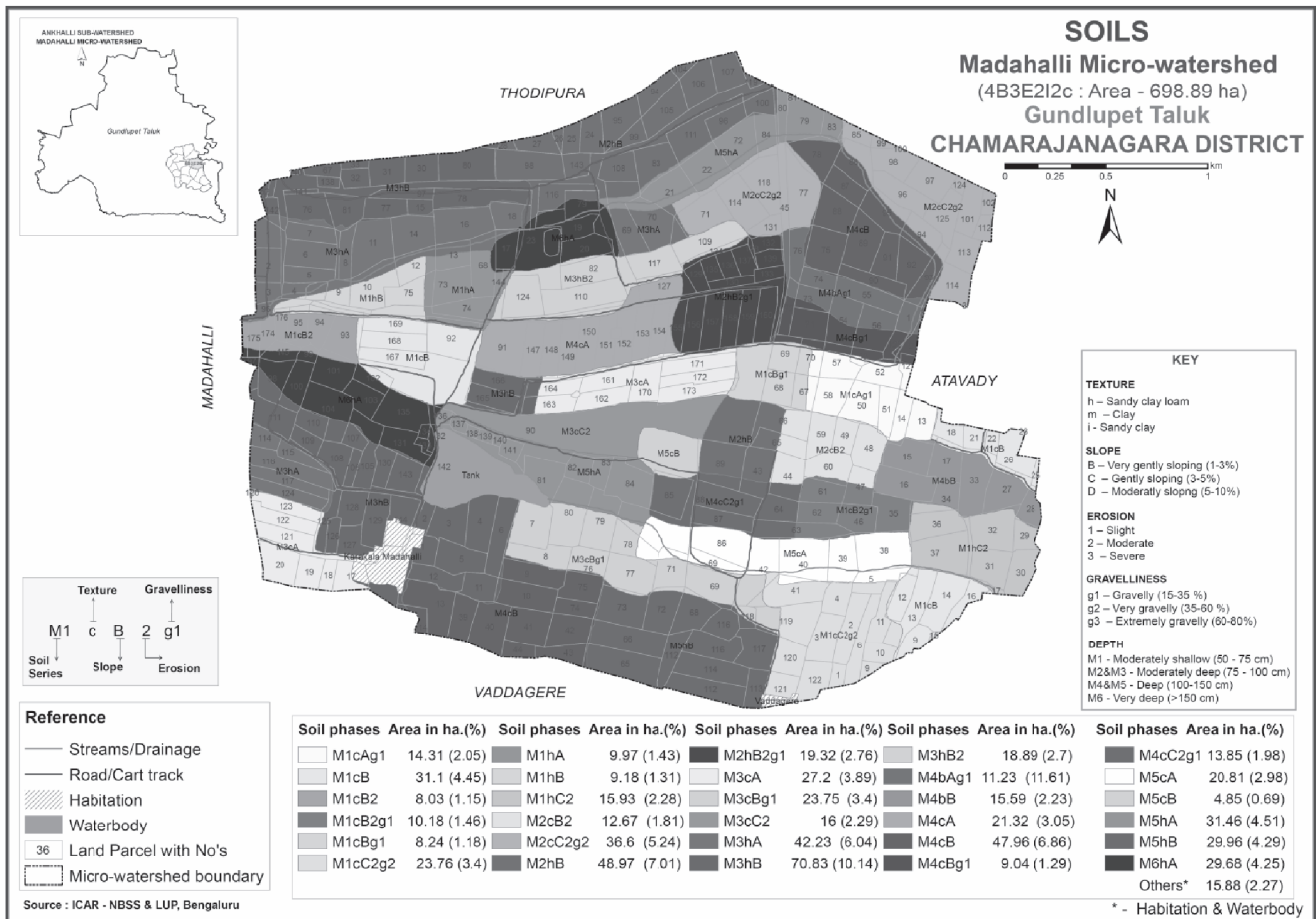


Fig.2. Soils of Madahalli microwatershed

Description of soil series

Series M1 (Madahalli-1)

The soils of Series M1 belonging to clayey-skeletal, mixed isohyperthermic Rhodic Paleustalfs are slightly deep, well drained with gravelly sandy loam texture. The clay content varied from 13.4 to 35.2 per cent in the sub-soil. The pH of the surface layer is 6.14 and it increased with depth. The EC of surface soil is 0.45 dS m⁻¹. The organic carbon content of surface soil is 11.6 g kg⁻¹ and it decreased with depth.

Series M2 (Madahalli-2)

Soil series M2 representing clayey-skeletal, mixed isohyperthermic Typic Rhodustalfs had relatively higher clay content (38.6%) in sub-soil than the surface layer (33.3%). The surface soil had pH 7.57 but it decreased in sub soil. Electrical conductivity was higher

in surface layer than sub-soil. Organic carbon content of surface soil is 12.3 g kg⁻¹ and it decreased with depth.

Series M3 (Madahalli-3)

Clayey-skeletal, mixed isohyperthermic Rhodic Paleustalfs representing M3 series had higher clay accumulation in sub soil (35.8%) than overlying horizon (15.1%)

The pH of the surface soil is 6.28 and in the sub soil it varies from 5.86 to 5.89. EC is less and varies from 0.38 in the surface to 0.33 dS m⁻¹ in the sub-soil. Organic carbon content of surface soil is 9.5 g kg⁻¹ and it decreases with depth to 7.7 g kg⁻¹.

Series M4 (Madahalli-4)

Soils were classified as clayey-skeletal, mixed isohyperthermic Typic Rhodustalfs. The clay content

increases from the surface (20.1%) to the sub-soil (35.5 per cent). The pH of the surface soil is 5.6 and it increases in the sub-soil to 6.78. Organic carbon content of surface soil is 6.3 g kg^{-1} and it decreases with depth to 4.8 g kg^{-1} . Base saturation of soil ranges from 36 to 93 per cent.

Series M5 (Madahalli-5)

The clayey-skeletal, mixed isohyperthermic Typic Rhodustalfs have sandy loam to sandy clay loam texture. Clay content varies from 20.5 to 40.1 per cent. Soil pH of surface and sub-surface layers are 7.02. EC in surface soil layer is 0.31 dS m^{-1} whereas in sub-surface layer it varies from 0.9 to 0.18 dS m^{-1} . Organic carbon content of surface soil is 6.3 g kg^{-1} and it increases with depth to 12.3 g kg^{-1} . Base saturation of soil ranges from 36 to 72 per cent.

Series M6 (Madahalli-6)

In the soils of M6 series (Fine, mixed isohyperthermic Typic Haplustepts), clay content increases from the surface (26.4%) to the sub-soil (40.0%). The pH of soil increased in the sub-soil to 7.9

from 7.0 (surface soil). The Ap horizon had low EC than the sub-soils (5.2 to 0.66 dS m^{-1}). Organic carbon content of surface soil is 7.0 g kg^{-1} and it decreased with depth to 2.1 g kg^{-1} . Base saturation of soil ranged from 56.8 to 100 per cent.

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