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Characterisation and classification of soils of parts of Alur, Khairat, Matki and Padasavli subwatersheds, Aland Taluk, Kalaburagi district, Karnataka

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Abstract
Land Resource Inventory was undertaken to characterize and classify the soils of parts of Alur, Khairat, Matki and Padasavli subwatersheds covering an area of 5509 ha in Aland Taluk, Kalaburagi district of Karnataka. Two hundred fifteen soil profiles were studied for the morphological, physical and chemical properties and 10 soil series were identified. Representative pedons covering all the soil series were selected and their properties and classification is discussed in this paper. The soils were very shallow to very deep in depth, very dark grayish brown to dark yellowish brown and very dark gray in black soils and dark reddish-brown colour in red soils. They are predominantly sub- angular blocky in structure, clay in texture, neutral to alkaline in soil reaction and organic carbon content is high. Soils studied were classified up to series level according to Soil Taxonomy using morphological, physical and chemical properties. Inceptisols cover a maximum area of 2299 ha (42%) followed by Entisols 1845 ha (34%) and Vertisols 1214 ha (22%) in these subwatersheds.

Keywords: Land resource inventory, soil series, soil characterisation and soil classification

Introduction
Land is a scarce resource and basic unit for any material production. It can support the needs of the growing population, provided they use the land in a rational and judicious manner. But what is happening in many areas of the state is a cause for concern to everyone involved in the management of land resources at the grassroots level. Hence, there is an urgent need to generate detailed site-specific farm level database on various land resources for all the villages/watersheds in a time bound manner that would help to protect the valuable soil and land resources and also to stabilize the farm production. Therefore, the land resource inventory required for farm level planning is the one which investigates all the parameters which are critical for productivity *viz.*, soils, site characteristics like slope, erosion, gravelliness and stoniness, climate, water, topography, geology and various schemes and developmental works of the government etc. No information is available on the characterization, classification and genesis of soils of Kalaburagi district. Hence, the present study was taken up to characterize, classify and evaluate the soils of parts of Khairat, Matki, Alur and Padasavli subwatersheds in Aland taluk of Kalaburagi district.

Materials and Methods
The study area forms a part of Khairat, Matki, Alur and Padasavli subwatersheds in the northeastern part of Karnataka in Aland Taluk, Kalaburagi District, Karnataka State (Fig 1.). It lies between 76°23'14'' and 76° 31' 24'' East longitudes and 17° 31' 22'' and 17° 40' 0.05'' North latitudes with an elevation of 600 m above MSL and covers an area of 5509 ha. It is about 15 km from Aland town and the subwatersheds comprise 9 microwatersheds namely, Nirgudi-1, Nirgudi-2, Nirgudi West, Chincholi Khurd-1, Chincholi Khurd-2, Padasavli-1, Padasavli-2, Padasavli-3 and Matki-3 covering parts of Nirgudi, Matki and Padasavli villages. The study area falls under semiarid tract of the state and is categorized as drought prone with average annual rainfall of 785 mm.

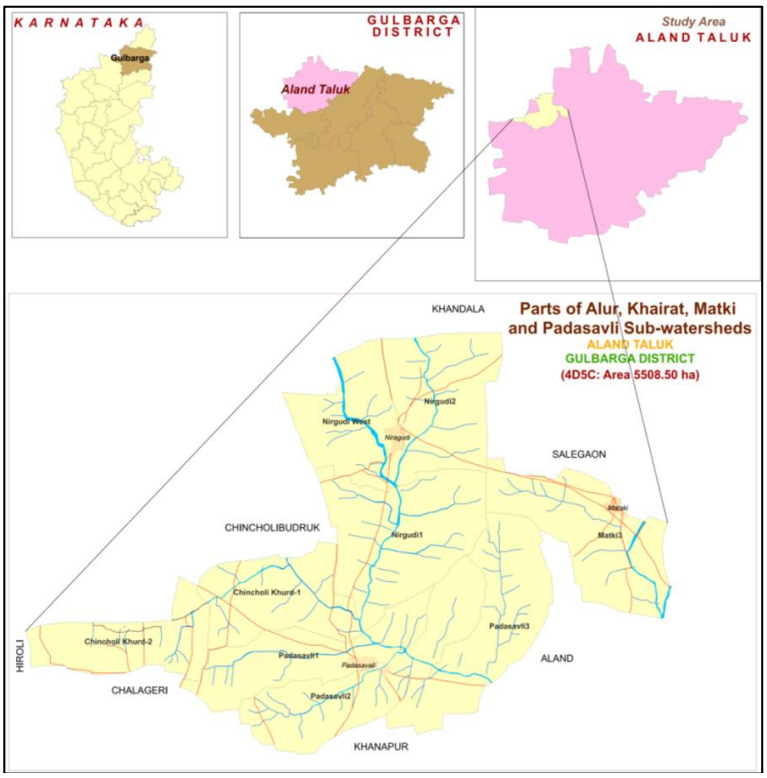

Fig 1: Location map of parts of Khairat, Matki, Alur and Padasavli subwatersheds

The land resource inventory was conducted using village cadastral maps and IRS satellite imagery on 1:7920 scale (Fig. 2). Physiographycally the area has been identified as basalt and laterite landscape. The false colour composites of IRS imagery were interpreted for physiography and the physiographic delineations were used as base for mapping soils. The soils were studied in several transects by locating soil profiles at closely spaced intervals to take care of any change in the land features like break in slope, erosion, gravel, stones etc.

In the selected sites, profiles (vertical cut showing the soil layers from surface to the rock) were opened up to 200 cm or to the depth limited by rock or hard substratum and studied in detail for all their morphological and physical characteristics. The soil and site characteristics were recorded for all profile sites on a standard proforma as per the guidelines given in USDA Soil Survey Manual (Soil Survey Staff, 2012). In all, about 215 profiles were studied.

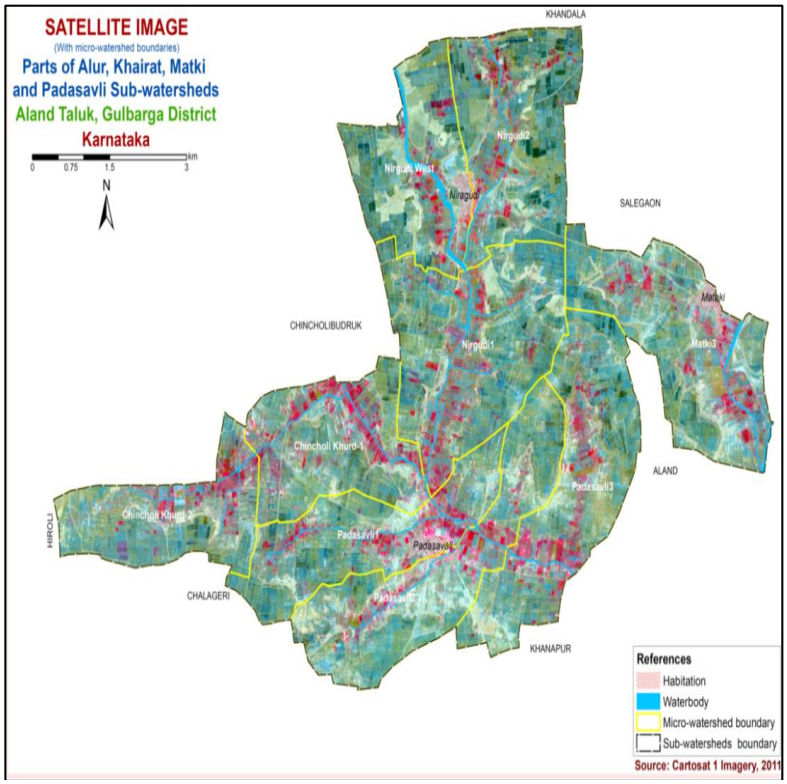

Fig 2: Satellite Image of parts of Khairat, Matki, Alur and Padasavli subwatersheds

Based on the soil characteristics, the soils were grouped into different soil series. Soil series is the most homogeneous unit having similar horizons and properties and behaves similarly for a given level of management. Soil depth, texture, colour, kind of horizon and horizon sequence, amount and nature of gravel present, calcareousness, nature of substratum etc, were used as the major differentiating characteristics for identifying soil series occurring in the area. The differentiating characteristics used for identifying the soil series are given in Table 1. Ten soil series were identified and mapped as phases of soil series (management units) and a soil map was prepared with phases of soil series as mapping units. Random checks were made all over the area outside the transects to confirm and validate the soil map unit boundaries. The soil map shows the geographic distribution and extent, characteristics, classification, behavior and use potentials of the soils in the Subwatershed. The soil map prepared with phases of soil series was categorically and cartographically generalised and a soil series was prepared (Fig.3). Soil samples for each series were collected from representative master profiles for laboratory characterization by following the methods outlined in the Laboratory Manual (Sarma *et al*. 1987) [6].

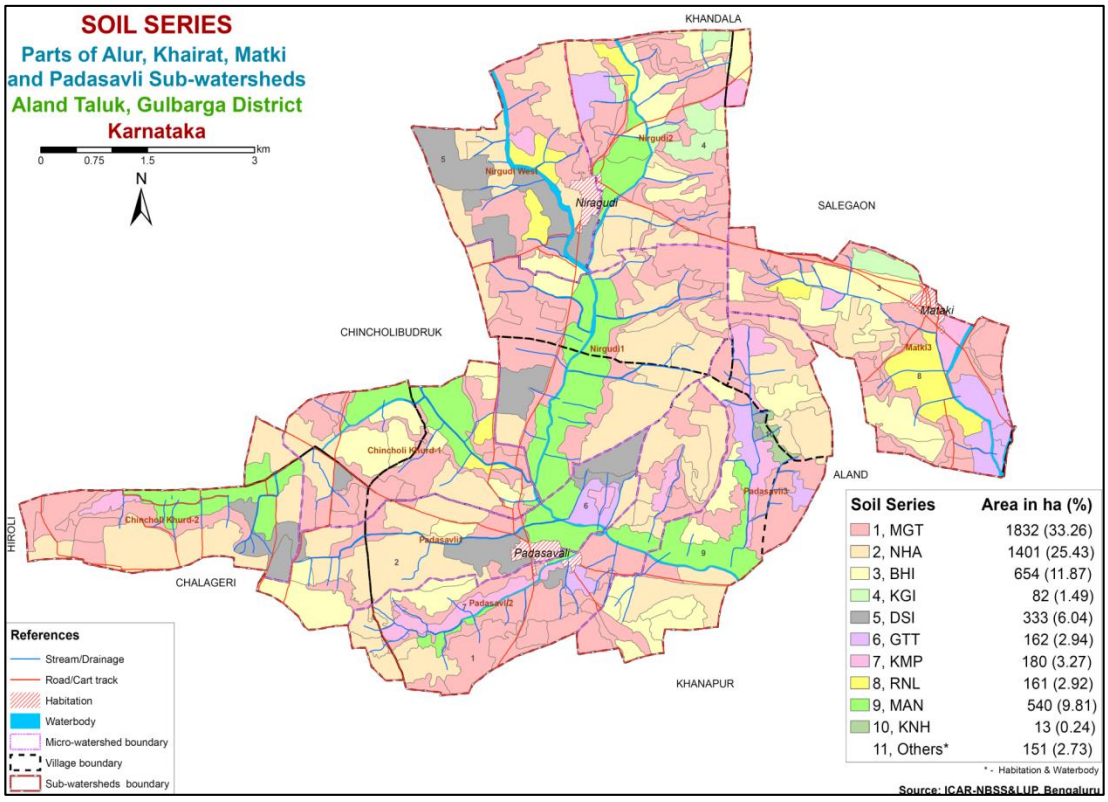

Fig 3: Soil Series map of parts of Khairat, Matki, Alur and Padasavli Subwatersheds

Table 1: Differentiating Characteristics used for Identifying soil series (Characteristics are of series control section)

Sl No.	Series	Depth (cm)	Colour (moist)	Texture	Gravel (%)	Horizon Sequence	Effervescence
Soils of Basalt landscape							
1	Margutti (MGT)	<25	10YR3/3,4/3,5/4 7.5YR4/3	gc	15-35	Ap-Ac	-
2	Novinihala (NHA)	25-50	10YR3/2,3/1,4/2 7.5YR3/4	gcl	15-35	Ap-Bw	-
3	Bhimanahalli (BHI)	25-50	10YR3/2,3/3,3/1 7.5YR3/2,4/2	gc	15-35	Ap-Bw-CB	-
4	Kalamundargi (KGI)	25-50	10YR4/3,4/2 7.5YR3/3,3/4,4/3	gcl	35-60	Ap-Bw	-
5	Dinsi (DSI)	50-75	10YR3/2,3/3,4/3, 3/2	c	<15	Ap-Bss	-
6	Gutti (GTT)	50-75	10YR3/2,3/ 7.5YR3/3,4/3	gc	15-35	Ap-Bw-Bc	-
7	Kamalapur (KMP)	75-100	10YR3/2,3/1	c	<15	Ap-AB-Bss	-
8	Rajanala (RNL)	100-150	10YR3/2,3/1,4/2, 4/3	c	<15	Ap-A1-Bss	es
9	Mahagaon (MAN)	>150	10YR3/2,3/1	c	<15	Ap-A1-Bss	es
Soils of Laterite landscape							
10	Kinhi (KNH)	<25	2.5YR3/3 5YR4/6	gcl	35-60	Ap	-

Results and Discussion

Morphological Characteristics of Soils

Of the, 10 soil series, 9 soil series were identified under basalt landscape and one soil series in laterite landscape. The brief morphological characteristics of the soil series are presented in Table 2.

The soils are very shallow to very deep have, very dark grayish brown (10 YR 3/2) to dark brown (10 YR 3/3, 7.5 YR3/3) in surface horizons and dark yellowish brown (10 YR 3/4) to very dark gray (10 YR 3/1) in subsurface horizons of all the soil series, except Kinhi (KNH) series that belongs to the lateritic landscape that is dark reddish brown (2.5 YR 3/3) in colour. There was not much variation in the soil colour with depth in all the series. The dominant colour in the black soil pedons vary from very dark grayish brown to very dark gray due to the clay-humus complex in the presence of lime. The dark matrix colour was due to the presence of high organic matter content in the surface horizons (Tripathi et al. 2006) [10]. In the kinhi soil series, hue was (2.5 YR). The soil colour appears to 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) [11].

The texture of the Margutti (MGT), Bhimanahalli (BHI), Dinsi (DSI), Gutti (GTT), Kamalapur (KMP), Rajnala (RNL) and Mahagaon (MAN) soil series were found to be clayey, whereas, Novinihala (NHA), Kakamundargi (KGI) and Kinhi (KNH) were found to be loamy. This textural variation might be due to differences in composition of parent material, topography, in-situ weathering and translocation of clay by eluviations and age of soils (Geetha Sireesha and Naidu 2013) [2].

Table 2: Morphological Characteristics of soils of Parts of Alur, Khairat, Matki and Padasavli subwatersheds

Horizon	Depth (cm)	Diagnostic horizon	Colour (moist)	Texture[1] Class (USDA)	Coarse [2] fragments w/w (%)	Structure[3]			Consistence[4]				Boundary[5]	
						Grade	Size	Type	Dry	Moist	Stickyness	plasticity	D	T
Soils of Basalt landscape														
Margutti (MGT) series														
Ap	0-15	Ochric	10YR3/2	c	20	2	m	sbk	sh	fr	ss	sp	c	s
AC	15-25		10YR4/4	c	80	2	m	sbk	sh	fr	ss	sp	c	s
Novinihala (NHA) series														
Ap	0-15	Ochric	10YR3/3	scl	10	2	m	sbk	sh	fr	ss	sp	c	s
Bw	15-40	Cambic	10YR3/3	cl	20	2	m	sbk	sh	fr	ss	sp	c	s
Bhimanahalli (BHI) series														
Ap	0-6	Ochric	10YR4/3	c	-	2	m	sbk	sh	fr	ss	sp	c	s
Bw1	6-25	Cambic	10YR4/4	c	-	2	m	sbk	sh	fr	ss	sp	c	s
CB	25-45		10YR4/4	sl	-	2	m	sbk	sh	fr	ss	sp	c	s
Kalamundargi (KGI) series														
Ap	0-10	Ochric	10YR3/2	cl	20	2	m	sbk	sh	fr	ss	sp	c	s
Bw	10-28	Cambic	10YR3/4	cl	50	2	m	sbk	sh	fr	ss	sp	c	s
Dinsi (DSI) series														
Ap	0-10	Ochric	10YR3/2	c	05	2	m	sbk	sh	fr	ss	sp	c	s
Bss1	10-30	Vertic	10YR3/1	c	-	2	m	abk	sh	fi	vs	vp	c	s
Bss2	30-50	Vertic	10YR3/1	c	-	2	m	abk	sh	fi	vs	vp	c	s
Bss3	50-75	Vertic	10YR3/1	c	05	2	m	abk	sh	fi	vs	vp	c	s
Gutti (GTT) series														
Ap	0-15	Ochric	7.5YR3/3	c	05	2	m	sbk	sh	fr	ss	sp	c	s
Bw1	15-40	Cambic	7.5YR3/4	c	20	2	m	sbk	sh	fr	ss	sp	c	s
BC	40-75		7.5YR3/4	c	50	2	m	sbk	sh	fr	ss	sp	c	s
Kamalapur (KMP) series														
Ap	0-10	Ochric	10YR3/2	c	-	2	m	sbk	sh	fr	ss	sp	c	s
AB	10-30	Ochric	10YR3/2	c	-	2	m	sbk	sh	fr	ss	sp	c	s
Bss1	30-43	Vertic	10YR3/2	c	-	2	m	abk	sh	fi	ms	sp	c	s
Bss2	43-60	Vertic	10YR3/2	c	-	2	m	abk	sh	fi	ms	sp	c	s
BC	60-85		10YR4/4	c	-	2	m	sbk	sh	fr	ss	sp	c	s
Rajanala (RNL) series														
Ap	0-18	Ochric	10YR3/2	c	05	2	m	sbk	sh	fr	ss	sp	c	s
A1	18-40	Ochric	10YR3/2	c	05	2	m	sbk	sh	fr	ss	sp	c	s
Bss1	40-60	Vertic	10YR3/2	c	-	2	m	abk	sh	fi	vs	vp	c	s
Bss2	60-105	Vertic	10YR3/2	c	-	2	m	abk	sh	fi	vs	vp	c	s
Bss3	105-150	Vertic	10YR3/2	c	-	2	m	abk	sh	fi	vs	vp	c	s
Mahagaon (MAN) series														
Ap	0-20	Ochric	10YR3/2	c	-	2	m	sbk	sh	fr	ss	sp	c	s
A1	20-45	Ochric	10YR3/2	c	-	2	m	sbk	sh	fr	ss	sp	c	s
Bss1	45-75	Vertic	10YR3/2	c	-	2	m	abk	sh	fi	vs	vp	c	s
Bss2	75-110	Vertic	10YR3/2	c	-	2	m	abk	sh	fi	vs	vp	c	s
Bss3	110-140	Vertic	10YR4/3	c	-	2	m	abk	sh	fi	vs	vp	c	s
Soils of Laterite landscape														
Kinhi (KNH) series														
Ap	0-18	Ochric	2.5YR3/3	cl	55	2	m	sbk	sh	fr	ss	sp	c	s

Note: 1. Texture: sl-sandy loam, scl-sandy clay loam, cl-clay loam, sc-sandy clay, c -clay.
2. Size: fg- fine gravel (<2cm), cg-coarse gravel (2-7.5cm), cb-cobbles (7.5-25cm), st-stones (25-60cm), b-boulders (>60cm).
3. Grade: 0-structureless, 1-weak, 2- moderate, 3-strong; Size: vf-very fine, f-fine, m-medium, c-coarse, vc-very coarse Type: gr-granular, cr-crumb, clr-columnar, pr-prismatic, pl-platy, abk-angular blocky, sbk-subangular blocky, sg-single grain, m-massive, c-cloddy.
4. Dry: l-loose, s-soft, sh-slightly hard, h-hard, vh-very hard, eh-extremely hard, Moist: l-loose, vfr-very friable, fr-friable, fi-firm, vfi-very firm, efi-extremely firm, Stickyness: 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.
5. D-Distinctness: a-abrupt, c-clear, g-gradual, d-diffuse, T-topography: s-smooth, w-wavy, i -irregular, b-broken

The structure indicates the mode of arrangement of soil particles and their aggregation, therefore the structural variation in soils was useful to differentiate the horizons. The structure of the MGT, NHA, BHI, KGI, GTT and KNH soil series were found to be subangular blocky throughout the soil profile, whereas in DSI, KMP, RNL and MAN series varied ie., sub angular blocky at the surface and angular blocky in the subsurface horizons. The blocky structure i.e., angular and

sub-angular blocky were attributed to the presence of higher quantities of clay fraction (Sharma *et al*. 2004) [8].

The dry consistence of all the soil series is slightly hard in surface and subsurface horizons. Moist consistence of surface and subsurface horizons are friable in all the soil series. Slightly sticky and slightly plastic consistence was observed in most of the soil series except in DSI, RNL and KMP series where the subsurface horizons found to be very sticky and very plastic and in KMP series it was found to be moderately sticky to slightly plastic. Presence of sticky and plastic to very sticky and very plastic, firm to very firm and slightly hard to very hard consistence in wet, most and dry conditions, respectively may be due to high clay content of soil (Sarkar *et al*. 2001) and also due to dominance of smectitic clay mineral (Leelavathi *et al*. 2010) [5, 3].

Physical and Chemical Properties of Soils

The physico - chemical properties of soils are given in Table 3. All the soils are clayey in texture both in surface and subsurface horizons except in NHA, KGI and KNH series and increase in clay content with depth in MAN (69 to 76%) and DSI (67 to 72%) series. This might be due to downward translocation of finer particles from the surface layers (Murthy 1988) [4].

In all the soil series, pH ranged from neutral to strongly alkaline. The soil pH was found to be strongly alkaline in RNL (8.42 to 8.63) and MAN (8.39 to 8.49) series both in surface and subsurface horizons. The high pH in black soils was due to calcareous nature and the accumulation of bases in the solum as they were poorly leached. 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) [7].

The organic carbon content was high (>0.75%) in surface and subsurface horizons of all the soil series. The $CaCO_3$ content was higher in RNL (8.22 to 9.3%) and MAN (5.7 to 8.7%) series and the higher CaCO3 content might be due to semi-arid climate which is responsible for the pedogenic processes resulting in the depletion of Ca^{+2} ions from the soil solution in the form of calcretes (Ashok Kumar and Jagdish Prasad 2010) [1].

The CEC was found to be high in DSI [58.46 to 62.40 cmol (p+) kg-^{1}] and RNL [60.0 to 63 cmol(p+) kg-^{1}**]** series. The ratio between CEC and clay ranged from 0.41 to 2.04 and the CEC: Clay ratio was used to identify the clay mineralogy (Ashok Kumar and Jagdish Prasad 2010) [1].

Table 3: Physico- chemical properties of soils of the parts of Alur, Khairat, Matki and Padasavli subwatersheds

Horizon	Depth (cm)	Particle- size distribution (%)			pH (1:2.5)	EC (dSm^{-1})	OC (%)	$CaCO_3$ (%)	Exchangeable bases (cmol(p+) kg^{-1})				CEC (cmol(p+) kg^{-1})	CEC/ Clay ratio	BS (%)	ESP (%)
		Sand (2.00.05)	Silt (0.05 0.002)	Clay (<0.002)					Ca	Mg	K	Na				
Soils of Basalt landscape																
Margutti (MGT) series																
Ap	0-15	10.68	31.06	58.26	6.83	0.27	0.85	3.72	-	-	0.66	0.09	46.27	0.79	100	0.18
AC	15-25	38.07	20.72	41.21	7.41	0.11	0.42	3.42	-	-	0.27	0.24	46.37	1.13	100	0.52
Mean		24.38	25.89	49.73	7.12	0.19	0.64	3.57	-	-	0.46	0.16	46.32	0.96	100.00	0.35
Novinihala (NHA) series																
Ap	0-15	52.62	26.66	20.72	7.09	0.11	0.70	0.00	18.96	9.75	0.08	0.06	30.55	1.47	94	0.20
Bw	15-40	41.84	21.29	36.87	7.79	0.05	0.66	0.00	27.56	14.20	0.09	0.32	48.11	1.30	88	0.67
Mean		47.23	23.98	28.79	7.44	0.08	0.68	0.00	23.26	11.98	0.09	0.19	39.33	1.39	91.06	0.44
Bhimanahalli (BHI) series																
Ap	0-6	41.40	17.80	40.81	6.81	0.10	0.73	2.46	-	-	0.15	0.05	28.03	0.69	100	0.18
Bw1	6-25	33.44	15.82	50.74	7.37	0.07	0.77	2.70	-	-	0.05	0.10	34.27	0.68	100	0.29
CB	25-45	80.17	5.12	14.71	7.70	0.06	0.54	3.66	-	-	0.02	0.51	29.95	2.04	100	1.71
Mean		51.67	12.91	35.42	7.29	0.08	0.68	2.94	-	-	0.07	0.22	30.75	1.13	100.00	0.72
Kalamundargi (KGI) series																
Ap	0-10	40.04	23.67	36.29	7.15	0.12	1.05	3.90	-	-	0.28	0.11	40.32	1.11	100	0.27
Bw	10-28	38.51	23.28	38.20	7.42	0.16	1.17	3.66	-	-	0.17	0.35	59.81	1.57	100	0.58
Mean		39.28	23.47	37.25	7.29	0.14	1.11	3.78			0.22	0.23	50.06	1.34	100.00	0.43
Dinsi (DSI) series																
Ap	0-10	12.90	20.53	66.57	7.00	0.11	1.13	4.32	-	-	0.18	0.17	61.92	0.93	100	0.27
Bw1	10-30	3.25	23.91	72.84	7.24	0.08	1.13	4.86	-	-	0.12	0.15	61.34	0.84	100	0.25
Bw2	30-50	2.72	24.91	72.36	7.50	0.10	1.09	4.14	-	-	0.14	0.19	58.46	0.81	100	0.32
Bw3	50-75	3.37	24.35	72.28	7.56	0.10	1.13	4.08	-	-	0.17	0.17	62.40	0.86	100	0.27
Mean		5.56	23.43	71.01	7.33	0.09	1.12	4.35	-	-	0.15	0.17	61.03	0.86	100.00	0.28
Gutti (GTT) series																
Ap	0-15	3.40	25.23	71.37	6.46	0.08	1.10	0.00	23.46	10.89	0.18	0.22	38.19	0.54	91	0.57
Bw1	15-40	3.51	18.85	77.63	6.55	0.05	1.06	0.00	18.69	8.35	0.09	0.21	36.14	0.47	76	0.57
BC	40-75	33.48	19.34	47.18	6.80	0.10	0.90	0.00	29.94	12.22	0.15	0.27	42.75	0.91	100	0.64
Mean		13.46	21.14	65.40	6.60	0.08	1.02	0.00	24.03	10.49	0.14	0.23	34.89	39.03	0.64	0.59
Kamalapur (KMP) series																
Ap	0-10	8.31	18.80	72.90	6.69	0.18	0.81	3.24	-	-	0.35	0.11	43.49	0.60	100	0.25
AB	10-30	8.29	19.28	72.43	7.05	0.07	0.73	3.42	-	-	0.17	0.08	40.13	0.55	100	0.20
Bw1	30-43	11.70	16.58	71.72	7.15	0.10	0.54	4.32	-	-	0.17	0.10	43.78	0.61	100	0.24
Bw2	43-60	11.45	21.46	67.09	7.00	0.10	0.50	2.34	-	-	0.32	0.04	44.10	0.66	100	0.08
BC	60-85	40.34	13.27	46.39	7.80	0.09	0.38	2.85	-	-	0.13	0.20	48.48	1.05	100	0.42
Mean		16.02	17.88	66.11	7.14	0.11	0.59	3.23	-	-	0.23	0.11	43.99	0.69	100	0.24

Rajanala (RNL) series																
Ap	0-18	10.17	28.16	61.68	8.42	0.22	0.97	9.36	-	-	0.50	0.13	60.00	0.97	100	0.21
A1	18-40	9.83	24.55	65.62	8.63	0.18	0.58	8.70	-	-	0.37	0.12	61.82	0.94	100	0.20
Bss1	40-60	6.59	22.19	71.22	8.55	0.20	0.50	8.64	-	-	0.28	0.21	63.26	0.89	100	0.32
Bss2	60-105	6.13	16.86	77.01	8.57	0.20	0.62	9.06	-	-	0.27	0.18	61.44	0.80	100	0.30
Bss3	105-150	12.37	20.36	67.27	8.62	0.22	0.55	8.22	-	-	0.47	0.13	60.86	0.90	100	0.22
Mean		9.02	22.42	68.56	8.56	0.20	0.64	8.80			0.38	0.15	61.48	0.90	100.00	0.25
Mahagaon (MAN) series																
Ap	0-20	3.87	26.80	69.33	8.35	0.20	0.87	5.70	-	-	0.53	0.08	58.46	0.84	100	0.14
A1	20-45	6.05	24.97	68.97	8.49	0.17	0.63	6.84	-	-	0.25	0.10	56.54	0.82	100	0.17
Bss1	45-75	5.08	17.69	77.23	8.43	0.19	0.66	7.38	-	-	0.22	0.11	58.66	0.76	100	0.18
Bss2	75-110	4.74	24.52	70.74	8.46	0.23	0.58	6.00	-	-	0.30	0.13	59.04	0.83	100	0.22
Bss3	110-140	5.44	18.28	76.28	8.43	0.22	0.43	7.50	-	-	0.27	0.18	57.12	0.75	100	0.31
Mean		4.20	22.45	72.51	8.6	0.24	0.46	8.70			0.28	0.23	39.36	0.80	100	0.58
Soils of Laterite landscape																
Kinhi (KNH) series																
Ap	0-18	44.63	18.45	36.92	6.35	0.07	0.73	1.26	-	-	0.32	0.02	15.26	0.41	100	0.16

Classification of Soils

The 10-soil series under study are classified based on morphological, physical and chemical properties according to Soil Taxonomy (Soil Survey Staff, 2014) [9]. At higher categories (Order) the presence or absence of diagnostic horizons which are indications of pedogenic process were considered. At Sub-order level, the moisture and temperature regimes were used. At lower categories (Great group, Sub-group and Family), diagnostic subsurface horizons, soil depth, mineralogy, texture, soil chemical properties and drainage are considered. The classification of the soil series under study is given in Table 4.

In this study, three soil orders were identified namely, Entisols, Inceptisols and Vertisols. Among the ten-soil series Margutti (MGT) and Kinhi (KNH) classified as "Entisols'' because there was no evidence of development of pedogenic horizons. So it was classified as Orthents at great group level and as Ustorthents due to the prevailing soil moisture regime as "Ustic".

Novinihala (NHA), Bhimanahalli (BHI), Kalamundargi (KGI) and Gutti (GTT) series were classified as ''Inceptisols'' owing to the presence of cambic horizon and as the moisture regime is Ustic classified as Ustepts at suborder level.

Dinsi (DSI), Kamalapur (KMP), Rajanala (RNL) and Mahagaon (MAN) soil series were classified as ''Vertisols'' at order level as these pedons did not have lithic or paralithic contact within 50 cm of soil surface and had a weighted average of more than 30 per cent clay in all the horizons down to a depth of 1 m and had cracks that open and close periodically. These series have a layer of more than 25 cm thick, with an upper boundary within 100 cm of mineral soil surface that had intersecting slickensides. These series key out as Vertisols and Usterts at suborder level as they have cracks in normal year that are 5 mm or more through a thickness of 25 cm or more within 50 cm of mineral soil surface for 90 or more cumulative days per year. They further key out as Haplusterts at great group level as they do not have salic, gypsic or calcic horizons and at subgroup level classified as Typic Haplusterts as it did not qualify for any other subgroup under Haplusterts.

Table 4: Classification of soils of Parts of Alur, Khairat, Matki and Padasavli Subwatersheds

Sl. No	Order	Suborder	Great group	Sub group	Family	Soil series
1	Entisols	Orthents	Ustorthents	(Paralithic) Ustorthents	Clayey, mixed, isohyperthemic, (Paralithic) Ustorthents	Margutti (MGT)
2	Inceptisols	Ustepts	Haplustepts	Paralithic) Haplustepts	Clayey, mixed, isohyperthemic, (Paralithic) Haplustepts	Novinihala (NHA) Bhimanahalli (BHI)
3	Inceptisols	Ustepts	Haplustepts	Lithic Haplustepts	Loamy- skeletal, mixed isohyperthermic, Lithic Haplustepts	Kalamundargi (KGI)
4	Inceptisols	Ustepts	Haplustepts	Typic Haplustepts	Fine, montmorillonite, isohyperthermic, Typic Haplustepts	Gutti (GTT)
5	Entisols	Orthents	Ustorthents	(Paralithic) Ustorthents	Clayey-skeletal, mixed, isohyperthemic, (Paralithic) Ustorthents	Kinhi (KNH)
6	Vertisols	Usterts	Haplusterts	Typic Haplusterts	Very fine, smectitic, isohyperthermic (calcareous), Typic Haplusterts	Rajanala (RNL) Mahagaon (MAN)
7	Vertisols	Usterts	Haplusterts	Typic Haplusterts	Very fine, smectitic, isohyperthermic, Typic Haplusterts	Dinsi (DSI) Kamalapur (KMP)

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