__Original Research Article__

Plant Available Nutrients in degradation vulnerable soils of central dry zone in Tumkur district, Karnataka

Abstract

Land degradation resulting from various natural and anthropogenic activities including the loss of organic matter, decline in soil fertility, erosion, acidity, alkalinity and the effect of toxic chemical is a serious global environmental problem, which may be triggered by climatic factors and their aberrations. The detailed reconnaissance soil survey was carried out in Tumkur district of Karnataka to study plant available nutrients in degradation vulnerable soils of central dry zone in Tumkur district, Karnataka during 2021-2022 using remote sensing, GIS and field studies. Satellite imageries (Sentinal -2) of three seasons were used along with soil map to delineate the degradation soils through visual interpretation. Using this map resource characterization was carried out. Out of thirteen soil pedons studied from Tumkur district, nine pedons were studied from central dry zone of Tumkur covering six taluks. These pedons belongs to Alfisols, Inceptisols and Entisols soil order. Soils were very strongly acidic (4.54) to very strongly alkaline (9.33) with non- saline nature in all pedons. The organic carbon content was low high, with higher content in Hosahalli of Madhugiri and decreased with increased depth in pedons. Available nitrogen was low to high and available phosphorus and potassium were low to medium in range. Secondary and micronutrients is soil was low to high, except zinc and boron, showing deficiency in most of the pedon. This fertility status assessment of different major soils of central dry zone of Tumkur help in developing sustainable management plan for improving the productivity and also growing the suitable crop, by preventing the degradation.

Keywords: degradation, Tumkur, plant available nutrients, central dry zone

Introduction

The land resources of the country are their most precious and sacred endowment. It is the most valuable resource for the production of food, fibre, fuel and many other vital goods required to meet human and animal needs. However, it is facing serious threats of deterioration due to inexorable human pressure and utilization incompatible with its capacity. Land degradation is considered as one of the most severe global problems worldwide. The dynamic and complex combination of geology, topography, hydrology, soil, flora and fauna influences every sphere of human activity. Different sectors, including agriculture, industries, infrastructure and power projects put forth competing demands for land. Subsistence farming practices, accelerated soil and water erosion, erratic rainfall, increasing population and high density of livestock population have also contributed to unsustainable land use, leading to the degradation of valuable resources. Despite the known degradation of resources, we continue squandering and abusing such precious resources for greed to combat the pressure of increasing population.

Soil is a complex system that can be defined as a mixture of minerals and organic materials that are capable of supporting plant life (Ayoub *et al*., 2007). At present, explosive agriculture with sustained efforts to increase crop yield has not only depleted our soils of their nutrient serve but also resulted in the emergence of a number of new nutrient deficiencies due to salinization, hill topography, *etc*. According to Cope and Evans (1985), the term, "available" is defined as the amount of a nutrient that is directly proportional to the quantity taken up by growing plants in a growing crop season. Through the weathering of minerals and the breakdown of organic matter into inorganic minerals, nutrients become accessible and are then taken up by plants as ions. Macronutrients, such as N, P, K, Ca, Mg, and Na, are necessary plant nutrients. Micronutrients, on the other hand, include Fe, Zn, Cu, and Mn required for plant growth and development.To provide the remaining amounts of required plant nutrients, it is vital to evaluate a soil's ability to provide nutrients.Agriculture potentials are threatened by soil nutrients since their availability is influenced by factors including SOM content, soil pH, adsorptive surface, soil texture, and nutrient interactions in the soil.In Tumkur district of Karnataka, soil erosion is the major problem, which effect the nutrient availability. Hence it is very important to study the available nutrient-supplying capacity of soil in degradation vulnerable soils to develop sustainable management plan to increase productivity.Therefore, attempt was made to study available nutrient status in central dry zone of Tumkur district, Karnataka.

Materials and Method

Tumkur district constituting the study area is situated in south-eastern part of Karnataka state and lies between 12° 45" and 14° 30" North latitudes and 76° 15" and 77° 45" East longitudes. The district, administratively divided into ten taluks, has a total area of 10,64,755 ha. It is bound by the Anantapur district of Andhra Pradesh on the North-East, Kolar and Bangalore districts on the East, Mandya district on the South, Chitradurga district on the North and Chickmagalur and Hassan districts on west (Fig. 1).The district is divided into ten taluksand among ten taluks Pavagada, Sira, Madhugiri, Chikkanayakanahalli, Koratagere and Tiptur fall under central dry zone, Gubbi and Tumkur fall under eastern dry zone and Turuvekere and Kunigal fall under southern dry zone. The granite, gneissic and schistose landform, with dykes and laterized parent materialgive rise to well, somewhat excessiveor moderately well drained soils.

Image Interpretation and ground truth studies

For delineation and mapping of land degradation classes, satellite imageries (Sentinal -2) of three seasons *i.e.*, summer, winter and rainy season of 2021 were extracted from Google Earth pro.These imageries were used to identify and delineate the degraded soils *i.e.*, water erosion (slight, moderate and severe), salt affected (slight, moderate and severe), mining, forest, river, water bodies and habitation using image interpretation keys such as variations in texture, colour, tone *etc*.,with the help of Bhuvan and Google Earth images for identification. The land degradation map was finalized based on the ground truth observations, visual interpretations and available ancillary data.

Soil survey and taxonomic classification

Detailed reconnaissance soil survey was carried out. The district is covered by survey of India toposheet (1:50000) of 57C/ 6 to 16, 57D/ 13, 57F/ 3, 7, 8, 11 and 12, 57G/1 to 7, 57H/1 and 2 respectively. Field traversing was done for ground truth and to identify the location for profile study.Site was selected based on type, extent and severity of degradation. The sampling sites which are representative of the area were chosen on the basis major soil type. A profile was dug on the dimension of 1.5 x 1.5 x 1.5 m, and the orientation of the profile should be in such a manner that a face got well-lit and easy for demarcation of the horizons. Thirteen pedons were studied from Tumkur district, out of that nine pedons are collected from central dry zone (Table 1). These pedons are belonging to Alfisols, Inceptisols and Entisols soil order. The taxonomy of these nine pedons*viz*., Rajavanthi of Pavagada (Clayey-skeletal, mixed, semi-active, Ustic Haplargids), Kanavenahalli of Pavagada (Loamy- skeletal, mixed, semi-active,Ustic Paleargids), Chinnenahalli of Sira (Clayey- skeletal, mixed, sub-active, Rhodic Kanhaplustalfs), Hosahalli of Madhugiri (Clayey- skeletal, mixed, semi-active, KanhaplicRhodustalfs), D. Nagenahalli of Koratagere (Fine, mixed, semi-active, Kandic Paleustalfs), Kurubarahalli of Koratagere-1 (Mixed, semi-active,Lithic Ustipsamment), Kurubarahalli of Koratagere- 2 (Fine, mixed, semi-active, Typic Rhodustalfs), Dobbeghatta of Chikkanayakanahalli (Loamy- skeletal, kaolitic, sub-active, Rhodic Kanhaplustalfs) and Hanapanahalli of Tiptur (Fine, mixed, super-active,VerticHaplustepts).

Climatic condition of central dry zone

Climate of the Tumkur is hot moist semi-arid tropical, with mean average annual rainfall of 687.9 mm in 45 days. The rainfall was observed from 13th week to 49th week with peak precipitation in September month. But during end of June and beginning of July dry spell is observed for two to three weeks. Hence there is a need of water conservation and life-saving irrigation for protected cultivation. The highest annual mean rainfall in central dry zone of Tumkur was observed in Koratagere(763.31 mm) and lowest was observed in Pavagada (603.95 mm). The mean annual temperature was recorded high during April and May with temperature more than 27 ^{o}c in central dry zone. The mean summer soil temperature and mean winter soil temperature are less than 6 ^{o}c, thus qualifying the soil temperature regime as iso-hyperthermic.

Soil sample analysis

Horizon differentiation was done based on morphological characters and samples were collected for analyzing different chemical properties (Soil survey staff, 2022). samples were analyzed for pH, EC, OC, available N, P, K, exchangeable Ca, Mg, available sulphur, DTPA extractable Fe, Mn, Zn and Cu. Soil pH and electrical conductivity was determined in 1: 2.5 soil: water suspension (Jackson, 1973). The soil organic carbon was estimated by following Walkley and Black’s method (Jackson, 1973). Available N was estimated by alkaline permanganate method (Subbiah and Asija, 1956). Available P was extracted using Bray’s reagent and estimated through spectrophotometer after developing blue colour by ascorbic method (Black, 1965). Available Kwas extracted with neutral 1N ammonium acetate and estimated by flame photometer (Jackson, 1973). The available Ca and Mg were estimated with neutral 1N ammonium acetate by atomic absorption spectrometer (Page *et al*., 1982). The available surface was estimated with using 0.15 per cent $CaCl_2$ solution (Black, 1965). The DTPA extractable Fe, Mn, Zn and Cu were estimated by using atomic absorption spectrophotometer (Lindsay and Norvell, 1978).

Table 1: Location of soil pedons collected from central dry zone of Tumkur district

Pedon No.	Location	Taluk	Land use/ land coverage
1	14° 02′ 58.6" N latitude, 77° 16′ 51.5" E longitude	Rajavanthi, Pavagada	Scrub Forest: Calotropis, Agave, Neem, Pongamia
2	14° 03′ 49.3" N latitude, 77° 17′ 19.27" E longitude	Kanavenahalli, Pavagada	Fallow Land: Acacia, Pongamia, Agave, Imopoea
3	13° 35′ 23.3" N latitude, 77° 00′ 28.8" E longitude	Chinnenahalli, Sira	Plantation Crops: Coconut, Tamarind, Arecanut, Lantana
4	13° 43′ 52.5" N latitude, 77° 03′ 33.5" E longitude	Hosahalli, Madhugiri	Cultivated: Coconut, Tamarind, Pongamia, Calotropis, Sesbania, Prosopis
5	13° 23′ 15.6" N latitude, 77° 13′ 55.6" E longitude	D. Nagenahalli, Koratagere	Cultivated: Tamarind, Cashew, Ragi, Neem, Mango
6	13° 30′ 54.2" N latitude, 77° 08′ 01.1" E longitude	Kurubarahalli, Koratagere- 1	Cultivated: Mango, Ragi, Goose Berry
7	13° 30′ 53.4" N latitude, 77° 05′ 04.5" E longitude	Kurubarahalli, Koratagere- 2	Horticulture: Mango
8	13° 23′ 07.6" N latitude, 76° 36′ 52.2" E longitude	Dobbeghatta, Chikkanayakanahalli	Plantation Crops: Coconut, Arecanut, Cashew, Cassia
9	13°10′ 09.6" N latitude, 76° 34′ 38.4" E longitude	Hanappanahalli, Tiptur	Plantation Crops: Coconut, Arecanut

Results and Discussion

Site characteristics of selected pedons

The elevation was ranging from 642 to 864 m above mean sea level with Kurubarhalli of Koratagere- 1 pedon studied from 864 m above mean sea level. These are studied from undulating plateau to rolling hills side slopes of Bangalore plateau with slopes ranging from 1 to 3 per cent to 10 to 15 per cent and slight to severe erosion was observed.

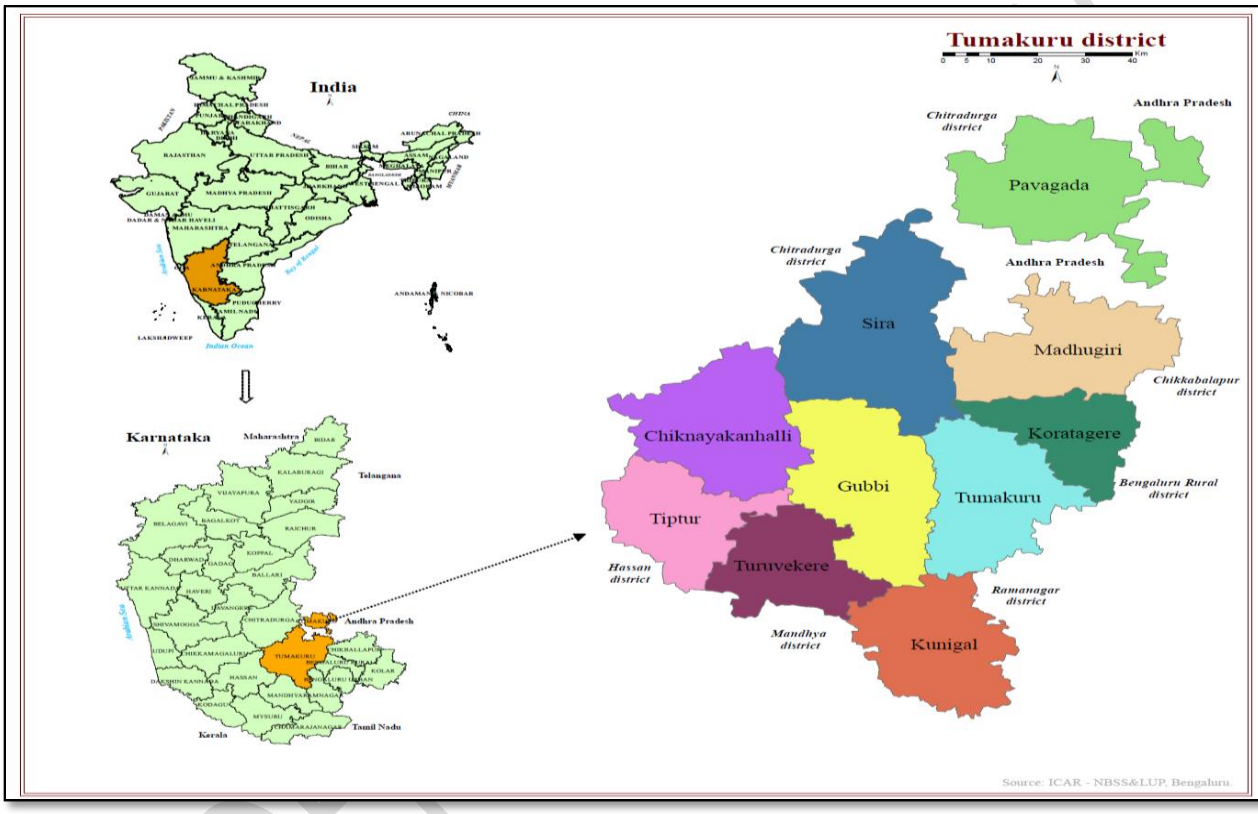

Fig. 1: Map of study area

Poorly drained inHanapanahalli of Tiptur to somewhat excessively drained condition was observed in Rajavanthi of Pavagada, Kanavenahllli of Pavagada and Kurubarahalli of Koratagere-1. The granite and granitic gneiss with alluvium/ colluvium are the major parent material (Table 2).

Table 2: Site characteristics of selected pedons of Tumkur district, Karnataka

Pedon No./Name	Elevation (m)	Rainfall (mm)	Physiography	Slope (%)	Drainage	Erosion	Parent Material
P1. Rajavanthi, Pavagada	670	603.95	Undulating highlands of Bangalore plateau	1-3	Somewhat excessive	Moderate	Granite gneiss and pediment
P2. Kanavenahalli, Pavagada	642	603.95	Very gently sloping interfluves of Bangalore plateau	1-3	Somewhat excessive	Slight	Archaean granite gneiss complex and colluvium/ alluvium
P3. Chinnenahalli, Sira	740	625.45	Undulating plateau summit and Bangalore plateau	1-3	Well drained	Slight	Granite
P4. Hosahalli, Madhugiri	701	708.49	Undulating upland of Bangalore plateau	1-3	Well	Moderate	Granite and granite/ colluvium
P5. D. Nagenahalli, Koratagere	859	763.31	Undulating plateau of Bangalore plateau	1-3	Well	Moderate	Granite
P6. Kurubarahalli, Koratagere-1	864	763.31	Moderately sloping upland of Bangalore plateau	5-10	Somewhat excessive	Severe	Granite
P7. Kurubarahalli, Koratagere- 2	861	763.31	Moderately sloping hills and Bangalore plateau	5-10	Well drained	Severe	Granite and granitic colluvium
P8. Dobbeghatta, Chikkanayakanahalli	840	754.65	Rolling hills side slopes of Bangalore plateau	10-15	Well	v. severe	Metamorphic: colluvium of schist
P9. Hanapanahalli, Tiptur	801	712.88	Undulating interfluves of Bangalore plateau	1-3	Poorly drained	Slight	Granite gneiss of alluvium/ colluvium

Soil reaction

In the natural environment, soil reaction has an enormous influence on soil biochemical process (Table 3). The soil pH in central dry zone pedons of Tumkur district varied from very strongly acidic (4.54) to very strongly alkaline (9.33).The high pH in black soil pedons was due their calcarius nature and the accumulation of bases in the solum as they were poorly drained (Nagendra and Patil, 2015).The variation in soil reaction depends on chemical and mineralogical composition of parent material, topography, vegetation and its management and climatic condition *etc*.,. In pedon P1, P4, P5, P6, P7 and P8 acidic pH was recorded in surface horizon. The leaching of bases and releasing of organic acids during decomposition of organic matter and these acids might have brought down the pH in the surface soils (Reddy and Naidu, 2016).Slightly, moderately or strongly alkaline soil reaction in other areas was due to accumulation of basic salts from the weathered parent material. In most of the pedon, pH increased with depth due to leaching of bases along with percolating water (Vasundhara *etal*., 2022).The pH was high at surface and then showed decreasing trend with depths in some other pedons (Kanavenahalli, Pavagada). This may be attributed to high base status of these horizons resulting from the recycling of bases through the addition of crop residues.

Soilelectricalconductivity

Electrical conductivity was more in black soil pedons, which indicate that black soil pedons were less leached (Table 3). In soils EC ranged from 0.043 to 0.194 dS m^{-1} and 0.031 to 0.482dS m^{-1} in subsurface and surface horizon, respectively, indicate non-saline nature of soils. A most of the soil are formed from granite and granite gneiss having low soluble salts might have led to non- saline nature of soil. These soils did not show any specific relationship of EC with depth. This may be due to free drainage conditions, which removes the bases by the percolating and drainage water. These results are in confirmation with the findings of Sumithra *et al*. (2013) in soils of Timanhal micro-watershed, Kushtagi taluk of Karnataka.

Soilorganiccarbon

The organic carbon content in the soils ranged from 0.07 per cent to 0.96 per cent. The organic carbon content ranged from low to high in horizons due to the rapid oxidation and decomposition of added organic matter (Kaushik Saha,2020). The lower organic carbon content was observed in Kurubarahalli, Koratagere-1 and higher content in Hoahalli of Madhugiri (Table 3). Due to the addition of plant residues and farmyard manure to surface layers, almost all of the pedons displayed a decreasing trend in OC with depth, which may be explained by the fact that surface horizons contained more organic matter than sub-surface horizons. The presence of tropical conditions, where organic matter degrades more quickly and with less vegetative cover, may be to blame for the low levels of organic carbon in the soils (Satish *etal*., 2018).

Availableprimarynutrients

The available nitrogen, phosphorous and potassium content in surface soil varied from 156.80 to 297.90, 11.74 to 33.17 and 50.32 to 170.24 kg ha^{-1}, respectively (Table 3). The lower level of nitrogen, phosphorous and potassium in cultivated fields implies that fertilizer additions have not replaced the total N lost due to harvest removal, leaching and humus losses associated with cultivation (Malo *etal*., 2005). In sub-surface available nitrogen, phosphorous and potassium varied from 31.40 to 339.04, 5.18 to 32.55 and 33.60 to 170.24 kg ha^{-1}, respectively. The possible reason for low nitrogen could be due to low organic matter content in these soils. Low rainfall and low vegetation were reported to cause faster degradation and removal of organic matter leading to nitrogen deficiency (Ashok, 2001). Depth wise decrease of nitrogen might be due to the accumulation of plant residues, debris and rhizosphere activity in the upper solum (Srinivasan *etal*., 2013). The low phosphorus content might be due to the fixation of phosphorous by clay minerals and oxides of iron and aluminium (Sekhar *et al*., 2017). While, potassium content in most of pedon decreased with depth wise which could be attributed to more intense weathering, release of labile K from organic residue, along with capillary rise of ground water might have increased potassium in upper part of solum (Hirekurabar*etal*., 2000).

Available secondary nutrients

The available calcium, magnesium and sulphur in surface varied from 162.50 to 1751.42, 13.30 to 350.84 and 9.98 to 37.43 mg kg^{-1}, respectively. In sub-surface available calcium, magnesium and sulphur varied from 212.30 to 1710.80, 30.67 to 687.80 and 7.49 to 42.42 mg kg^{-1}, respectively (Table 3). The application of organic matter act as good source of secondary nutrients in soil and can observed calcium and magnesium showed irregular trend with trend. While available sulphur decreased with increase in depth. This might be due leaching of organic matter along with these nutrients in percolating water.

Availablemicronutrients

The available micronutrients, *i.e.*, iron, manganese, copper, zinc and boron content in soil ranged from 2.90 to 16.74, 0.78 to 17.60, 0.06 to 0.76, 0.08 to 0.54 and 0.16 to 0.67 mg kg^{-1}, respectively (Table 3). Higher concentration of available iron and manganese were found in to the pedons as compare with zinc and copper. The micronutrient content of soils is influenced by several factors among which organic matter content, soil reaction and clay content are the major ones (Fisseha, 1992). The higher iron and manganese in surface horizon might be due to higher biological activity and higher organic carbon (Murthy *et al*., 1997). The higher level of manganese content in most of the red soil is due its granite gneiss parent material. Rajkumar *et* *al*. (1994)relatively lower available manganese content in black soils coupled with semi-arid conditions

Table 3: soil reaction, electrical conductivity, organic carbon and primary nutrient in soil of central dry zone of Tumkur district

Depth (cm)	Horizon	pH Water (1:2.5)	EC	OC	Available nutrients										
					N	P_2O_5	K_2O	Ca	Mg	S	Fe	Mn	Cu	Zn	B
			dS m^{-1}	%	kg ha^{-1}			mg kg^{-1}							
P1. Rajavanthi, Pavagada(Clay- skeletal, mixed, semi-active, Ustic Haplargids)															
0-16	**A**	6.40	0.082	0.51	244.96	15.96	170.24	426.33	51.48	27.43	9.74	6.32	0.34	0.34	0.41
16-44	**Bt1**	6.47	0.051	0.60	339.04	11.81	108.64	1334.83	358.41	27.45	9.00	4.28	0.36	0.38	0.54
44-65	**Bt2**	6.75	0.052	0.41	203.84	29.83	99.68	1474.58	359.68	34.93	9.10	6.82	0.56	0.24	0.34
65-103	**Bt3**	7.17	0.042	0.24	156.8	19.87	73.92	1609.49	434.25	22.46	8.04	3.90	0.38	0.20	0.57
103-134	**CB**	7.30	0.053	0.23	62.72	16.46	66.08	1710.80	426.35	19.96	7.84	1.96	0.20	0.24	0.53
134-173	**Cr**	7.46	0.051	0.19	47.04	9.29	35.28	982.77	265.29	19.96	7.84	2.08	0.12	0.16	0.46
P2. Kanavenahalli, Pavagada(Loamy- skeletal, mixed, semi-active, Ustic Paleargids)															
0-18	**Ap**	8.38	0.149	0.44	219.52	11.74	169.44	1751.42	350.84	22.46	8.10	1.18	0.28	0.46	0.32
18-33	**Bt1**	7.36	0.253	0.69	235.20	32.55	84.00	1689.91	322.71	34.87	8.32	3.34	0.30	0.32	0.58
33-58	**Bt2**	7.23	0.133	0.37	188.16	8.31	76.16	1174.20	281.58	32.36	8.08	1.76	0.20	0.34	0.32
58-77	**Bt3**	7.51	0.061	0.29	188.16	27.88	54.88	835.67	288.99	27.45	8.30	4.22	0.22	0.26	0.36
77-116	**Bt4/C**	7.23	0.060	0.23	125.44	5.87	46.80	1095.95	292.84	14.93	7.90	3.52	0.14	0.18	0.23
116-126	**Cr**														
P3. Chinnenahalli, Sira(Clayey skeletal, mixed, sub-active, Rhodic Kanhaplustalfs)															
0-22	**Ap**	8.30	0.091	0.66	156.80	18.31	152.64	613.53	34.96	27.35	8.26	1.72	0.42	0.52	0.47
22-36	**Bt1**	8.45	0.091	0.24	125.44	11.25	139.20	748.21	111.74	19.96	9.18	3.08	0.22	0.40	0.42
36-63	**Bt2**	8.66	0.076	0.42	172.48	21.78	170.24	644.30	173.47	39.84	8.68	2.30	0.24	0.54	0.67
63-105	**BC**	8.66	0.061	0.15	141.12	10.76	64.96	385.51	130.75	42.42	8.14	0.98	0.14	0.32	0.38
105-124	**CB**	8.93	0.058	0.12	109.76	15.87	52.64	587.80	91.77	32.44	8.06	1.48	0.18	0.28	0.32
124-154+	**Cr**	8.94	0.060	0.12	47.00	12.72	47.04	632.45	109.49	12.48	8.16	1.12	0.14	0.20	0.16
P4. Hosahalli, Madhugiri (Clayey- skeletal, mixed, semi- active, KanhaplicRhodustalfs)															
0-13	**Ap**	4.54	0.194	0.96	282.24	22.33	132.48	166.30	50.92	14.97	16.74	17.60	0.48	0.28	0.29
13-37	**Bt1**	6.02	0.057	0.63	266.56	12.72	116.8	965.30	132.65	29.94	11.04	8.20	0.68	0.22	0.37
37-61	**Bt2**	6.40	0.051	0.24	156.80	15.38	77.28	998.71	153.66	12.48	9.32	2.98	0.48	0.30	0.31
61-88	**Bt3**	6.83	0.036	0.15	109.76	5.18	55.84	722.50	135.15	9.98	8.52	3.24	0.40	0.18	0.23
88-120	**BC**	7.20	0.029	0.12	94.08	7.78	33.60	590.61	114.50	14.97	8.08	3.02	0.28	0.20	0.21
120-125	**Cr**														
P5. D. Nagenahalli, Koratagere(Fine, mixed, semi- active, Kandic Paleustalfs)															
0-24	Ap	5.32	0.062	0.72	235.20	33.17	123.92	162.50	16.05	9.98	11.78	5.24	0.12	0.12	0.43
24-49	Bt1	5.42	0.040	0.54	266.56	16.22	92.42	262.85	39.29	19.96	8.80	4.10	0.10	0.36	0.39

49-76	Bt2	5.88	0.041	0.48	188.16	24.41	62.72	387.65	77.06	24.95	8.14	2.06	0.08	0.28	0.43
76-102	Bt3	6.32	0.044	0.33	78.40	14.67	57.12	271.76	61.01	34.93	7.88	1.68	0.08	0.26	0.52
102-138	BC	6.82	0.034	0.12	109.76	9.29	58.24	212.30	48.46	24.89	7.66	0.78	0.06	0.12	0.22
138-155	Cr	6.75	0.035	0.09	47.00	10.76	46.00	361.59	41.92	9.98	7.80	1.62	0.06	0.16	0.17
P6. Kurubarahalli, Koratagere- 1(Mixed, semi- active, Lithic Ustipsamment)															
0-18	Ap	5.23	0.050	0.33	188.16	20.22	56.00	288.10	13.30	37.43	13.54	9.10	0.10	0.26	0.40
18-36	Cr	7.64	0.050	0.07	78.40	17.12	44.80	461.73	30.67	12.48	8.24	2.46	0.06	0.12	0.35
P7. Kurubarahalli, Koratagere-2(Fine, mixed, semi-active, Typic Rhodustalfs)															
0-9	Ap	5.71	0.043	0.42	172.48	17.12	50.32	327.87	31.78	29.94	10.98	9.66	0.18	0.28	0.43
9-28	Bt1	6.04	0.041	0.23	188.16	15.70	53.36	534.75	56.40	22.40	8.40	4.98	0.14	0.12	0.30
28-55	Bt2C	6.84	0.050	0.16	78.40	12.23	42.72	631.55	54.41	29.94	7.94	2.66	0.12	0.14	0.24
55-60+	Cr	6.54	0.040	0.09	31.40	5.96	36.00	503.19	30.76	14.44	7.36	3.14	0.06	0.08	0.16
P8. Dobbeghatta, Chikkanayakanahalli(Loamy skeletal, kaolitic, sub-active, Rhodic Kanhaplustalfs)															
0-13	A	6.45	0.057	0.63	219.52	27.00	141.44	456.99	159.56	22.46	12.58	11.50	0.38	0.26	0.42
13-29	Bt1	6.56	0.036	0.45	188.16	12.23	82.88	506.23	189.54	32.30	9.92	3.10	0.26	0.34	0.52
29-58	Bt2	7.01	0.034	0.21	156.80	19.29	104.80	572.69	218.20	14.97	9.10	1.22	0.20	0.26	0.49
58-82	Bt3C	6.94	0.033	0.18	94.10	19.29	45.92	510.62	171.72	34.93	8.84	1.12	0.16	0.16	0.56
82-133+	CB	7.10	0.031	0.09	62.70	10.27	41.44	340.88	104.58	27.45	2.90	1.16	0.10	0.10	0.48
P9. Hanapanahalli, Tiptur(Fine, mixed, super-active, VerticHaplustepts)															
0-15	**Ap**	8.99	0.183	0.82	297.90	18.31	134.72	902.42	345.28	9.98	9.92	1.58	0.68	0.36	0.51
15-29	**Bw1**	9.13	0.316	0.84	250.90	14.67	130.24	738.88	311.15	7.49	9.58	1.84	0.76	0.30	0.67
29-52	**Bw2**	9.33	0.409	0.63	266.56	19.78	104.96	836.81	418.73	27.39	9.38	1.98	0.68	0.40	0.52
52-73	**Bw3**	9.23	0.482	0.27	188.16	10.27	97.04	1056.53	687.55	31.86	8.34	1.32	0.54	0.28	0.23

resulting in conversions of Mn^{2+} to Mn^{3+} form. Available B was also found to be showing decreasing trend increasing soil depth which can be attributed to the decreasing trend of organic carbon with soil depth (Mishra*etal*., 2015). In most of the pedon lower availability might be due to precipitation as oxides or carbonates, reducing the availability (Pulakeshi*et al*., 2014).

Conclusions

Land degradation can be described as a reduction in the present and prospective land quality and production, due to natural anthropogenic intervention. Soil fertility is one of the important factor which is affected due to degradation, in turn reducing the soil productivity. The study of vertical distribution of available nutrient in soil help in sustainable management plan development for reducing degradation and increasing land under cultivation.

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