Investigation of Land Use Types on Physical and Chemical Properties of Soil in a Basement Terrain

Raziskava vpliva uporabe zemljišča na fizikalne in kemijske lastnosti tal

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Abstract

We assessed the effect of different land use types on the physical and chemical properties of soil. We analysed three cases. Nine soil samples were taken at different depths (0–10, 10–20 and 20–30 cm) from three locations, namely, sawmill, dumpsite and market. Analyses were carried out to determine the influences on the physical and chemical properties of the soil. All the land types had considerably high sand contents, with minor silt and clay. Available phosphorus and the exchangeable bases were significantly ($p \leq 0.05$) affected by land use and soil depth. Moisture content ($p \leq 0.05$) was significantly affected by land use, while bulk density ($p \leq 0.01$) was significantly affected by soil depth. Soil organic matter and carbon were also generally low in all three locations. Consequently, ameliorative land management practices have to be adopted to prevent nutrient loss and land degradation.

Key words: land use, chemical properties, land degradation, bulk density, soil nutrient depletion.

Povzetek

Raziskali smo vpliv raznih tipov uporabe zemljišča na fizikalne in kemijske lastnosti tal. Analizirali smo tri primere. Devet vzorcev tal smo vzorčili v različnih globinah, 0–10, 10–20 in 20–30 cm na treh lokacijah, z območja žage, odlagališča odpadkov in tržnice. Namen analize je bil opredeliti vplive na fizikalne in kemijske lastnosti tal. Vsi trije tipi vsebujejo znatno količino peska in malo meljevca in gline. Uporaba zemljišča in globina statistično značilno ($p \leq 0.05$) vplivata na dostopni fosfor in izmenjevalne baze. Na vlago statistično značilno ($p \leq 0.05$) vpliva tip uporabe zemljišča, medtem ko ima statistično značilen ($p \leq 0.01$) vpliv na celotno gostoto tal globina vzorca. Organska snov in ogljik sta v vseh lokacijah splošno nizka. Sledi, da je potrebno s postopki melioracije omejiti izgubo hranil in degradacijo tal.

Ključne besede: uporaba zemljišča, kemijske lastnosti, degradacija zemljišča, celotna gostota, osiromašenje s hranili

Introduction

Nigeria, the most populous country in Africa, is faced with the evident problem of land degradation and soil infertility. Over the years, increase in population is leading to a noticeable modification in land use patterns. Enhanced land degradation processes have been attributed not only to rapid human population growth but also to associated escalation of land use [1]. Population increase poses different number of threats, including adequate food production, management of soil resources, meeting the challenges of intensive agriculture and adoption of appropriate technologies for sustainable agriculture production [2]. For successful soil management, it is imperative to understand the two determinant mechanisms, namely, the chemical properties (soil fertility) and physical properties of the soil. These properties are particularly important for both crop growth and soil quality maintenance [3]. Soil fertility is influenced by both land use and soil management practices, and it varies spatially from the field to larger scale of regions. High-quality soils not only produce better food and fibre but also help to maintain natural ecosystems, air quality and water quality [4].

A major indicator of the physical quality in agricultural soils is the soil water retention capacity; this includes soil parameters such as organic carbon content, dry bulk density, soil macroporosity, soil matrix porosity, air capacity, plant available water capacity and saturated hydraulic conductivity (K_{sat}) [5].

Various studies have been conducted to assess the effect of land use changes on physical and chemical properties of soil in Nigeria [1, 6, 7]. The research is directed towards providing adequate information on the effect of different land use patterns on the physical and chemical properties of soil in the study area.

Materials and methods

Description of the study area

The study was conducted in some selected parts of Abeokuta; the capital of Ogun State. Abeokuta lies between latitudes 7°00' N to 7°30' N and longitudes 3°00' E to 3°30' E [8]. The climatic

condition of Abeokuta consists of high annual temperature, lack of cold season, high precipitation and low pressures.

Site selection, soil sampling and preparation

Planning, surveying and appropriate sampling must be considered when measuring changes in soil's chemical and physical spatial variation [4]. Soil samples were collected at different soil depths (0–10, 10–20 and 20–30 cm) from three different land areas (sawmill, market and dumpsite) located at Lafenwa, Osiele and Saje areas of Abeokuta (Figure 1). The samples were placed in black, leak-proof sealed columns to prevent evaporation and labelled accordingly. After 72 hours of air-drying, the dried samples were crushed and sieved using a 2 mm sieve.

Laboratory analysis

Laboratory analyses were carried out to determine the physical and chemical properties of the soil. These properties include soil pH, soil texture, bulk density, moisture content, hydraulic conductivity, total nitrogen, organic carbon and matter, available phosphorus (AvP), exchangeable bases (Ca, Mg, Na and K), exchangeable acidity and cation exchange capacity.

The soil pH was measured in 1:1 soil–water suspension using glass electrode pH meter. Soil texture was determined by the hydrometer method [9] after destroying organic matter and dispersing the soil using sodium hexametaphosphate, as described earlier [10]. The core method was used in determining the bulk density of the undisturbed soil sample after drying a defined volume of soil in an oven at 105°C to a constant weight. The bulk density was calculated as the ratio of the weight of oven-dried soil to the volume of the sampling core. The moisture content was calculated as the ratio of the weight of wet soil to that of oven-dried soil multiplied by the bulk density. Soil organic carbon was estimated using the wet oxidation method [11] and converted to organic matter by multiplying the percentage of organic carbon content by a factor of 1.724, assuming that organic matter is composed of 58% carbon [11].

The exchangeable basic cations (K^+ , Ca^{2+} , Mg^{2+} and Na^+) were extracted with 1 M ammonium acetate at pH equal to 7.0. The cation exchange capacity (CEC) was calculated from the sum of

Figure 1: Map of the study area showing sample locations.

all exchangeable cations, which was expressed in centimoles (cmol) of charge per kilogram of air-dried soil. The Bray method [12] was used to determine the AvP. The soil samples were digested in a Kjeldahl apparatus, and the amount of ammonia trapped was determined to calculate the total nitrogen in the soils [13].

Data analysis

The univariate analysis of variance (ANOVA) procedure of IBM SPSS Statistics 20.0 software was used for assessing the significance of differences in the soil parameters. Separation of mean was done by the Tukey test after the main effects were found to be significant at $p \leq 0.05$. The analysis was done for each of the land use types in nine combined treatments. Pearson's

correlation analysis was also computed to determine the relationships between the various physical and chemical parameters of the soil.

Results and discussion

Physical properties of soil

The results of the analysis of the physical properties of soil across the three land use types located within the considered geological settings (Figure 2) at different depths are shown in Table 1. The particle size distribution data showed very high sand contents. Sand, clay and silt values were the same at all depths in the sawmill. The percentages of clay content had no definite sequence and did not follow a definite

pattern down the profiles in the dumpsite and market place, while the silt content decreased with depth in the dumpsite but was distributed in irregular patterns in the market. The values for bulk density increased with depth across the three land use types. The values for saturated hydraulic conductivity (K_{sat}) were generally low across the three land use types but with no definite pattern down the soil profiles. The moisture content increased with depth in the market place, while it had no definite sequence in the distribution down the profile at the sawmill and dumpsite.

The results of two-way ANOVA and the mean values for the physical properties of soil across the three land use types are shown in Tables 2 and 3, respectively.

Table 1: Physical properties of soil in the different land use types

Land use	Depth (cm)	Sand (%)	Clay (%)	Silt (%)	TC	K_{sat} (cm/h)	BD)	MC (%)
Sawmill	0–10	79.2	17.4	3.4	SL	0.901	0.69	6.20
	10–20	79.2	17.4	3.4	SL	1.102	0.71	8.16
	20–30	79.2	17.4	3.4	SL	0.987	0.76	4.96
Dumpsite	0–10	77.2	17.4	5.4	SL	1.104	0.69	3.92
	10–20	79.2	16.4	4.4	SL	0.796	0.74	3.97
	20–30	79.2	17.4	3.4	SL	0.876	0.77	3.47
Market	0–10	81.2	17.4	1.4	SL	1.750	0.74	7.26
	10–20	79.2	15.4	5.4	SL	0.570	0.75	8.40
	20–30	73.2	24.4	2.4	SCL	0.859	0.75	9.26

Notes: K_{sat} = saturated hydraulic conductivity; TC = textural class; BD = bulk density; MC = moisture content; SL = sandy loam; SCL = sandy clay loam.

Table 2: Two-way ANOVA result for the physical properties of soil in the selected land use types

		MS	F	p-value	Sig
Sand	Depth	1.333	0.182	0.840	No
	Land use	4.00	0.545	0.617	No
Clay	Depth	3.444	0.496	0.642	No
	Land use	8.778	1.264	0.375	No
Silt	Land use	1.444	0.743	0.532	No
	Depth	1.444	0.743	0.532	No
Bulk density	Depth	0.0005	1.280	0.372	No
	Land use	0.002	5.120	0.079	No
Moisture content	Depth	15.478	11.547	0.022	Yes
	Land use	1.005	0.750	0.529	No
Hydraulic conductivity	Depth	0.014	0.105	0.903	No
	Land use	0.155	1.195	0.392	No

Notes: MS = mean square; F = calculated value; p = probability; sig = significance.

Figure 2: Geological map showing the rock type that underlies the sampling point.

Table 3: Mean values of the physical properties of soils in the selected land use types

Land use	Sand (%)	Silt (%)	Clay (%)	K_{sat} (cm/h)	BD (g/cm ³)	MC (%)
Sawmill	79.200	3.400	17.400	0.997	0.720	6.440
Dumpsite	78.533	4.400	17.067	0.925	0.733	3.787
Market	77.867	3.067	19.067	1.060	0.747	8.307
SEM ($\pm$)	1.563	1.521	0.805	0.208	0.012	0.863

Notes: K_{sat} = saturated hydraulic conductivity; BD = bulk density; MC = moisture content; SEM = standard error of the mean.

The contents of sand, clay and silt were not significantly ($p > 0.05$) affected by land use and soil depths (Table 2). Considering the three land use types, the highest mean value of sand (79.20%) was recorded at the sawmill, while the lowest mean value of sand (77.87%) was observed at the market. This result is in agreement with previous findings [14] that soil with sand content $>70\%$ is highly permeable and allows large quantities of leachates to pass through. Silt fractions were the highest (4.40%) at the dumpsite, which may be due to the influence of organic waste, as stated by Elias and Gbadegesin [15], while its fractions were the lowest (3.07%) at

the market. In contrast, the highest clay content (19.07%) was observed at the market place, whereas its lowest content (17.067%) was observed at the dumpsite (Table 3). Bulk density was not significantly ($p > 0.05$) affected by land use and soil depth (Table 2). This may be due to differences in the organic matter content of the sites, as recorded by Olsen et al. [16]. Considering the mean values of the land uses, the highest bulk density (0.75 g/cm³) was observed at the market. This may be because of the frequent movement of people during the market and normal days, which invariably lead to an increase in soil compaction; the low-

est value (0.72) was observed at the sawmill (Table 3).

Moisture content was significantly ($p \leq 0.05$) affected by land use but not by soil depth (Table 2), while K_{sat} was not significantly ($p > 0.05$) affected by land use and soil depth (Table 2). Considering the mean values of land use on hydraulic conductivity, the highest (1.06 cm/h) was recorded at the market place and the lowest (0.93 cm/h) was observed at the dumpsite (Table 3). This result is in agreement with the findings of Senjobi and Ogunkunle [1], who reported low and no definite sequence distribution within the profile in the investigated land use type.

Chemical properties of soil

The results from analysis of chemical properties of soils across the three land use types at different depths are shown in Tables 4 and 5.

The contents of organic carbon and organic matter followed no definite sequence down the profile across the three land use types. The AvP level decreased with depth across the three land use types. The pH of sawmill and market followed irregular patterns, while the pH for the dumpsite increased down the profile. This is in line with the study carried out by Mengistu et al. [4], who reported that the pH of soils in Warandhab area, Oromiya, Ethiopia, is affected by land use system and that it also increases with depth. Exchangeable acidity increased with depth in the market and dumpsite areas, while it decreased with depth in the sawmill. Total nitrogen decreased with depth in the sawmill, while it fluctuated irregularly with depth in the dumpsite and market place (Table 4). The effective CEC and exchangeable bases (Ca, Mg, Na and K) decreased with depth in all three land use types and were generally low in all land use types. Calcium and magnesium dominated the exchangeable complex in the three land use types (Table 5).

Soil pH was significantly ($p \leq 0.05$) affected by land use and not significantly ($p > 0.05$) affected by depth (Table 6). The soil pH was significantly higher (alkaline) in the dumpsite compared to that at other locations, which might be due to the presence of high inherent phosphorus contents of the parent material (the older granite). Considering the mean values of land use, the

soil pH was observed to be the highest (9.23) at the dumpsite and lowest (7.37) at the sawmill (Table 7).

Exchangeable acidity was not significantly ($p > 0.05$) affected by land use and soil depth (Table 6). Considering the mean values of land use, the highest value (0.27 cmol/kg) for exchangeable acidity was recorded at the dumpsite, while its lowest value (0.13 cmol/kg) was recorded at the sawmill (Table 7).

Organic carbon was not significantly ($p > 0.05$) affected by either land or depth (Table 6). The mean values of land use on the variability of organic carbon were significantly higher (1.84%) in the market place and lower (1.42%) at the sawmill (Table 7). Organic carbon was generally low in all the three land use types, which may partly be due to the high temperature and high relative humidity, which favours rapid mineralisation.

Organic matter had values that ranged from 1.42% to 1.84%, considering the mean values of land use. Similar to organic carbon, organic matter was the highest in the market and lowest at the sawmill (Table 7). It was not significantly affected by land use and soil depth (Table 6).

AvP was significantly ($p \leq 0.05$) affected by land use and soil depth (Table 6). The mean values of land use on AvP were significantly higher (44.37 mg/kg) for the dumpsite than for other land use types. The lowest value (40.38 mg/kg) for AvP was recorded at the market place (Table 7). The content of phosphorus in all land use types was high when compared with the ratings for AvP [16]. The high phosphorus content in the three land use types might be due to the high phosphorus content of the parent material (the older granites).

Total nitrogen was significantly affected by land use ($p \leq 0.05$) but was not significantly ($p > 0.05$) affected by soil depth (Table 6). Nitrogen contents were medium at the sawmill and the market, but low in the dumpsite, when compared with the ratings for total nitrogen [17]. Intense mineralisation negatively affects the total nitrogen content in soils [18, 19], which may be the reason for the depletion of nitrogen content in the dumpsite.

Calcium was significantly ($p \leq 0.05$) affected by land use and soil depth (Table 8). Considering the mean values of land use, the calcium con-

Table 4: Chemical properties of soils across the three land use types and depths

Land use	Depth (cm)	OC (%)	OM (%)	AvP (mg/kg)	pH (H ₂ O)	EA (cmol/kg)	TN (%)
Sawmill	0–10	1.756	3.027	45.21	7.2	0.2	0.199
	10–20	1.197	2.084	42.36	7.6	0.1	0.188
	20–30	1.317	2.269	38.45	7.3	0.1	0.170
Dumpsite	0–10	0.519	0.894	47.21	8.9	0.2	0.119
	10–20	3.471	5.985	45.67	9.3	0.3	0.109
	20–30	0.758	1.307	40.22	9.5	0.3	0.115
Market	0–10	1.317	2.269	44.58	8	0.1	0.123
	10–20	3.192	5.503	40.36	7.9	0.2	0.151
	20–30	0.998	1.719	36.21	7.7	0.3	0.144

Notes: OC = organic carbon; OM = organic matter; AvP = available phosphorus; EA = exchangeable acidity; TN = total nitrogen.

Table 5: Chemical properties of soil across three land use types and depth

Land use	Depth (cm)	Ca (cmol/kg)	Mg (cmol/kg)	Na (cmol/kg)	K (cmol/kg)	CEC (cmol/kg)
Sawmill	0–10	0.538	0.481	0.348	0.372	1.551
	10–20	0.518	0.446	0.283	0.321	1.939
	20–30	0.502	0.421	0.239	0.289	1.568
Dumpsite	0–10	0.524	0.469	0.370	0.449	1.551
	10–20	0.511	0.440	0.304	0.385	2.102
	20–30	0.489	0.412	0.261	0.295	1.940
Market	0–10	0.521	0.457	0.326	0.346	1.757
	10–20	0.503	0.423	0.283	0.308	1.750
	20–30	0.467	0.403	0.239	0.269	1.717

Note: CEC = cation exchange capacity.

Table 6: Two-way ANOVA results of some chemical properties of soils in the selected land use types

		MS	F	p-value	Sig
Soil pH	Depth	2.801111	47.12150	0.001658	Yes
	Land use	0.041111	0.691589	0.552132	No
Exchangeable acidity	Depth	0.013333	2.00000	0.250000	No
	Land use	0.003333	0.50000	0.640000	No
Organic carbon	Depth	0.129707	0.137959	0.875107	No
	Land use	2.300031	2.446357	0.202326	No
Organic matter	Depth	0.378277	0.136387	0.876395	No
	Land use	6.877982	2.479849	0.199312	No
Available phosphorus	Depth	12.03588	22.28408	0.006783	Yes
	Land use	41.44148	76.72769	0.000645	Yes
Total nitrogen	Depth	0.00393	18.66051	0.009371	Yes
	Land use	3.08e ⁻⁰⁵	0.146136	0.868452	No

Notes: ANOVA = analysis of variance; MS = mean square; F = calculated value; p = probability; Sig = significance.

tents were the highest (0.52 cmol/kg) in the sawmill and the lowest (0.50 cmol/kg) at the market (Table 9). Magnesium was significantly ($p \leq 0.05$) affected by land use and soil depth (Table 8). The contents of magnesium in all the three land use types were significantly different

from each other, which implies that the activities of the three land use types had significant effects on magnesium. This result is in line with a previous study [20], which stated that increase in calcium and magnesium contents in a sawmill is due to ashing from sawdust.

Table 7: Mean values of some chemical properties of soils in the selected land use types

Treatments	OC (%)	OM (%)	AvP (mg/kg)	pH (H ₂ O)	EA (cmol/kg)	TN (%)
Sawmill	1.423	2.460	42.001	7.367	0.133	0.186
Dumpsite	1.583	2.729	44.367	9.233	0.267	0.114
Market	1.836	3.164	40.383	7.867	0.200	0.139
SEM (±)	0.560	0.962	0.424	0.141	0.047	0.008

Notes: OC = organic carbon; OM = organic matter; AvP = available phosphorus; EA = exchangeable acidity; TN = total nitrogen; SEM = standard error of the mean.

Table 8: Two-way ANOVA result for the exchangeable bases (Ca, Mg, Na and K) and CEC

		MS	F	p-value	Sig
Calcium	Depth	0.001317	33.95702	0.003094	Yes
	Land use	0.000374	9.647564	0.029484	Yes
Magnesium	Depth	0.002454	412.8411	2.32E-05	Yes
	Land use	0.000355	59.79439	0.001048	Yes
Sodium	Depth	0.007803	141.5948	0.000194	Yes
	Land use	0.000682	12.37702	0.019352	Yes
Potassium	Depth	0.008218	16.40523	0.011808	Yes
	Land use	0.003751	7.488743	0.044427	Yes
CEC	Depth	0.056972	5.132951	0.078618	No
	Land use	0.054687	4.927053	0.083361	No

Note: MS = mean square; F = calculated value; p = probability; Sig = significance; CEC = cation exchange capacity.

Table 9: Mean values of the exchangeable bases and the CEC of soils in the selected land use type

Treatments	Ca	Mg	Na	K	CEC
Sawmill	0.519	0.449	0.290	0.327	1.686
Dumpsite	0.508	0.440	0.312	0.376	1.933
Market	0.497	0.428	0.283	0.308	1.715
SEM (±)	0.004	0.001	0.004	0.013	0.061

Notes: CEC = cation exchange capacity; SEM = standard error of the mean.

Sodium was significantly ($p \leq 0.05$) affected by land use and soil depth (Table 8). The sodium content in the dumpsite was significantly different from that in other land use types, which implies that the activities at the dumpsite had a more significant effect on the sodium content than the activities in other land use types. Potassium was significantly ($p \leq 0.05$) affected by land use and soil depth (Table 8). The exchangeable bases were generally low in the three land use types when compared with the ratings for exchangeable bases [21, 22]. The depletion in exchangeable bases may be attributed to leaching of nutrients and weathering, which consequently leads to inherent low fertility status.

The effective CEC was not significantly ($p > 0.05$) affected by either land use or soil depth (Table 8). The result of this study is in line with the result of a previous study [23], which showed that the CEC was the highest in the dumpsites relative to the soils of fallow and cropped lands.

Pearson's correlation matrix for the various physical and chemical properties of soil

Table 10 shows that sand was significantly ($p \leq 0.01$) and negatively correlated with clay, with correlation coefficient $r = -0.861$, and significantly ($p \leq 0.01$) negatively correlated with clay, with correlation coefficient $r = -0.86$. Soil

Table 10: Pearson's correlation and *p*-value matrix for the various physical and chemical properties of soil

	P	Na	K	Ca	Mg	TN	PH	OC	OM	Sand	Clay	Silt	EA	K _{sat}	BD	MC	CEC
P																	
Pearson correlation	1	0.930**	0.937**	0.850**	0.880**	-0.182	0.319	0.137	0.137	0.469	-0.555	0.284	0.119	0.336	-0.704*	-0.443	0.253
<i>p</i> -value		0.000	0.000	0.004	0.002	0.639	0.403	0.725	0.724	0.203	0.121	0.458	0.760	0.376	0.034	0.233	0.512
Pearson correlation	0.930**	1	0.920**	0.826**	0.923**	-0.082	0.151	-0.002	-0.002	0.297	-0.397	0.268	0.041	0.336	-0.809**	-0.268	0.051
<i>p</i> -value		0.000	0.000	0.006	0.000	0.834	0.699	0.996	0.995	0.437	0.290	0.485	0.917	0.377	0.008	0.486	0.897
K																	
Pearson correlation	0.937**	0.920**	1	0.727*	0.813**	-0.244	0.345	0.046	0.046	0.199	-0.401	0.445	0.172	0.211	-0.746*	-0.483	0.027
<i>p</i> -value		0.000	0.000	0.027	0.008	0.526	0.363	0.906	0.907	0.608	0.285	0.230	0.659	0.586	0.021	0.188	0.946
Ca																	
Pearson correlation	0.850**	0.826**	0.727*	1	0.945**	0.300	-0.148	0.113	0.114	0.640	-0.653	0.182	-0.250	0.350	-0.752*	-0.236	0.165
<i>p</i> -value		0.004	0.006	0.027	0.000	0.433	0.705	0.773	0.771	0.063	0.057	0.640	0.516	0.356	0.019	0.541	0.672
Mg																	
Pearson correlation	0.880**	0.923**	0.813**	0.945**	1	0.235	-0.130	-0.036	-0.035	0.406	-0.408	0.104	-0.198	0.411	-0.874**	-0.187	0.108
<i>p</i> -value		0.002	0.000	0.008	0.000	0.235	0.542	0.927	0.928	0.279	0.276	0.790	0.610	0.272	0.002	0.629	0.781
TN																	
Pearson correlation	-0.182	-0.082	-0.244	0.300	0.235	1	-0.858**	-0.050	-0.048	0.038	0.017	-0.098	-0.534	-0.136	-0.377	0.452	0.027
<i>p</i> -value		0.639	0.834	0.526	0.433	0.542	0.003	0.898	0.902	0.922	0.966	0.801	0.139	0.727	0.317	0.222	0.945
PH																	
Pearson correlation	0.319	0.151	0.345	-0.148	-0.130	-0.858**	1	0.061	0.060	0.061	-0.217	0.322	0.754*	-0.096	0.213	-0.668*	0.281
<i>p</i> -value		0.403	0.699	0.363	0.705	0.739	0.003	0.877	0.878	0.877	0.574	0.397	0.019	0.806	0.582	0.049	0.465
OC																	
Pearson correlation	0.137	-0.002	0.046	0.113	-0.036	-0.050	0.061	1	10.000**	0.285	-0.439	0.373	0.310	-0.462	0.155	0.083	0.468
<i>p</i> -value		0.725	0.996	0.906	0.773	0.927	0.898	0.877	0.000	0.457	0.237	0.323	0.417	0.211	0.690	0.831	0.204
OM																	
Pearson correlation	0.137	-0.002	0.046	0.114	-0.035	-0.048	0.060	10.000**	1	0.286	-0.440	0.373	0.309	-0.462	0.154	0.084	0.470
<i>p</i> -value		0.724	0.995	0.907	0.771	0.928	0.902	0.878	0.000	0.456	0.236	0.322	0.419	0.211	0.692	0.829	0.202
Sand																	
Pearson correlation	0.469	0.297	0.199	0.640	0.406	0.038	0.061	0.285	0.286	1	-0.861**	-0.029	-0.191	0.359	0.000	-0.302	0.288
<i>p</i> -value		0.203	0.437	0.608	0.063	0.279	0.922	0.877	0.456	0.003	0.003	0.942	0.623	0.342	10.000	0.430	0.452
Clay																	
Pearson correlation	-0.555	-0.397	-0.401	-0.653	-0.408	0.017	-0.217	-0.439	-0.440	-0.861**	1	-0.484	-0.035	0.015	0.127	0.432	-0.214
<i>p</i> -value		0.121	0.290	0.285	0.057	0.276	0.966	0.574	0.237	0.003	0.186	0.929	0.969	0.745	0.245	0.581	0.581
Silt																	
Pearson correlation	0.284	0.268	0.445	0.182	0.104	-0.098	0.322	0.373	0.373	-0.029	-0.484	1	0.396	-0.647	-0.249	-0.330	-0.075
<i>p</i> -value		0.458	0.485	0.230	0.640	0.790	0.801	0.397	0.323	0.942	0.186		0.292	0.060	0.518	0.386	0.847
EA																	
Pearson correlation	0.119	0.041	0.172	-0.250	-0.198	-0.534	0.754*	0.310	0.309	-0.191	-0.035	0.396	1	-0.574	0.180	-0.494	0.498
<i>p</i> -value		0.760	0.917	0.659	0.516	0.610	0.139	0.417	0.419	0.623	0.929	0.292		0.106	0.643	0.176	0.172
K _{sat}																	
Pearson correlation	0.336	0.336	0.211	0.350	0.411	-0.136	-0.096	-0.462	-0.462	0.359	0.015	-0.647	-0.574	1	-0.173	0.033	-0.209
<i>p</i> -value		0.376	0.377	0.586	0.356	0.272	0.727	0.806	0.211	0.342	0.969	0.060	0.106		0.657	0.933	0.590
BD																	
Pearson correlation	-0.704*	-0.809**	-0.746*	-0.752*	-0.874**	-0.377	0.213	0.155	0.154	0.000	0.127	-0.249	0.180	-0.173	1	0.000	-0.031
<i>p</i> -value		0.034	0.008	0.021	0.019	0.002	0.317	0.582	0.690	10.000	0.745	0.518	0.643	0.657		0.999	0.938
MC																	
Pearson correlation	-0.443	-0.268	-0.483	-0.236	-0.187	0.452	-0.668*	0.083	0.084	-0.302	0.432	-0.330	-0.494	0.033	0.000	1	-0.101
<i>p</i> -value		0.233	0.486	0.188	0.541	0.629	0.222	0.049	0.831	0.430	0.245	0.386	0.176	0.933	0.999		0.795
CEC																	
Pearson correlation	0.253	0.051	0.027	0.165	0.108	0.027	0.281	0.468	0.470	0.288	-0.214	-0.075	0.498	-0.209	-0.031	-0.101	1
<i>p</i> -value		0.512	0.897	0.946	0.672	0.781	0.945	0.204	0.202	0.452	0.581	0.847	0.172	0.590	0.938		0.795

Notes: K_{sat} = saturated hydraulic conductivity; BD = bulk density; MC = moisture content; CEC = cation exchange capacity; OC = organic carbon; OM = organic matter; AvP = available phosphorus; EA = exchangeable acidity; TN = total nitrogen. **Correlation is significant at the 0.01 level (two tailed), *correlation is significant at the 0.05 level (two tailed). Others are not significant at the 0.01 and 0.05 levels (two tailed).

bulk density was significantly ($p \leq 0.05$) negatively correlated with AvP. Moisture content was moderately ($p \leq 0.05$) negatively correlated with soil pH, with $r = -0.67$. Soil pH was significantly ($p \leq 0.01$) negatively correlated with total nitrogen, with $r = -0.86$. AvP was significantly ($p \leq 0.01$) and strongly positively correlated with potassium, calcium, magnesium and sodium, with $r = 0.94, 0.85, 0.88$ and 0.93 , respectively. AvP was also significantly ($p \leq 0.05$) positively correlated with the CEC, with $r = 0.77$, which implies that as the AvP increases, the contents of sodium, potassium, calcium and magnesium in the soil increase, as does the effective CEC.

Conclusion

It was observed that soil nutrients vary from one land use type to another. The results of this study suggest that the three land use types have high sand contents. Findings from the study revealed that soil properties, such as pH, AvP, Ca, Na, K and TN, are influenced by land use at the different depths considered. Soil nutrient depletion was also observed to be very prominent across all the three land use types. AvP and exchangeable bases (such as Ca, Mg, Na and K) were observed to be significantly affected by land use with respect to soil depth. It was observed that the pH of the dumpsite was very high/strongly alkaline compared to that at the other land use types; this may be attributed to the high content of AvP in the dumpsite. Nitrogen contents were generally low in the dumpsite and the market place but were found in medium quantities at the sawmill. Soil nutrient depletion was observed to be predominant in all the three land use types. Therefore, ameliorative land management practices must be put in place to help prevent nutrient loss and land degradation.

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