Assessment of Soils along the Toposequence of Tsokundi River in Wukari LGA, Taraba State, Northeastern Nigeria

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Abstract

Soils along the Toposequence of Tsokundi River in Wukari LGA of Taraba State, Nigeria were studied with the aim of characterizing them for sustainable crop production. Three soil units (Upper, Middle and Lower slopes) were identified in the area. The soils were generally deep (100 to 122 cm). The studied soils from upper and lower slope were well drained whereas, that of the middle slope was poorly drained. Soil texture was assessed as sandy loam, sandy clay loam and silt clay loam. Soil reaction varied between extremely acidic to slightly acidic with pH values ranging from 3.71 up to 6.86. Based on the physical and chemical properties of the soils, they were classified as: *Typic Hapludalf/Eutric Haplic Luvisols*, *Typic Endoaqualfs/Eutric Luvisols, Arenic Kandiustalfs/ Haplic Lixisols*. Although these soils exhibit high base saturation, they are characterized by low nutrient status, particularly in terms of organic carbon and total nitrogen. However, given their classification as *Typic Hapludalfs* under USDA Soil Taxonomy and *Haplic Luvisols* under the WRB system, they possess favorable physical properties and potential for agricultural use. With adequate management practices—such as the application of both organic and inorganic fertilizers and the implementation of effective soil erosion control measures—these soils can be significantly improved and rendered highly productive for sustainable agricultural purposes.

Keywords: soil assessment, toposequence, soil properties, Tsokundi River, Wukari LGA, Taraba State, Northeastern Nigeria, soil classification, soil fertility, soil management, USDA Soil Taxonomy and WRB classification

Introduction

Soil is a dynamic natural resource that plays a vital role in agricultural productivity, environmental quality, and land-use planning. Its characteristics vary across landscapes due to differences in parent material, climate, biological activity, time, and particularly topography — a factor that significantly influences soil formation, distribution, and fertility status (Brady & Weil, 2017; Jenny, 1941). One widely used approach to studying this variability is the toposequence concept, which involves evaluating soils along a slope gradient to understand pedogenic processes, nutrient distribution, and land-use suitability

(Buol et al., 2011).In tropical regions such as Nigeria, toposequences are particularly important due to intense weathering, seasonal rainfall patterns, and variations in land cover. Studies along toposequences provide insight into how erosion, deposition, drainage, and organic matter accumulation influence soil development and fertility (Esu, 2005). These studies are essential for guiding sustainable land management practices, especially in agriculturally active areas.

The Wukari Local Government Area of Taraba State, located in northeastern Nigeria, is one such area where soil resource evaluation is necessary. The area lies within the southern Guinea savanna zone and is characterized by undulating terrain with rivers like Tsokundi playing significant roles in landscape modification and soil redistribution. Despite the region's agricultural potential, detailed scientific data on its soils — particularly along its toposequences — remains limited. Yet, such information is crucial for soil classification, land evaluation, and precision agriculture (FAO, 2006; Ojanuga, 2006).

Moreover, evaluation of soil physical and chemical properties along a toposequence helps identify fertility constraints and their relation to slope position, as topography influences moisture retention, organic matter distribution, and cation exchange processes (Akamigbo, 1999; Nwaka et al., 2018). Understanding these spatial variations aids in identifying areas at risk of erosion, nutrient depletion, or waterlogging, and in recommending appropriate soil conservation strategies.

Therefore, this study aims to evaluate selected soils along the toposequence of Tsokundi River in Wukari LGA to determine their morphological, physical, and chemical properties, assess their agricultural potential, and provide baseline data for land-use planning and sustainable management in the region.

Materials and Methods

Study Area

The study area is located at Tsokundi in Wukari Local Government area, Taraba state. It lies between latitude 7° 51' N to7^{o} 85' N and longitude 9^{o} 46' E to 9° 78' E of the Greenwich Meridian. The entire area is a gently undulating plain, with a mean altitude of 200 m above sea level. The mean annual rainfall value ranges from 1000-1500 mm. The unset of raining season is usually around April while the offset period is October. The mean maximum temperature is being experienced around April at about 40^{o}C while the mean minimum temperature occurs between the period of December and February at about 20^{o}C (Andrew *et al*., 2017). The geology of the area is cretaceous sediment over undifferentiated basement complex rock resulting in sandstone as the chief parent material (Andrew *et al*.,2017).

The vegetation is predominantly tree savannah with seasonal patterns, featuring dominant species like *Hymenocardia*, various grasses and shrubs such as Guinea grass and spear grass, alongside patches of hardwood savannah woodland and scattered forest reserve species including *Isoberlina*, *Eucalyptus*, *Neem*, and fruit trees like guava, mango, and cashew.

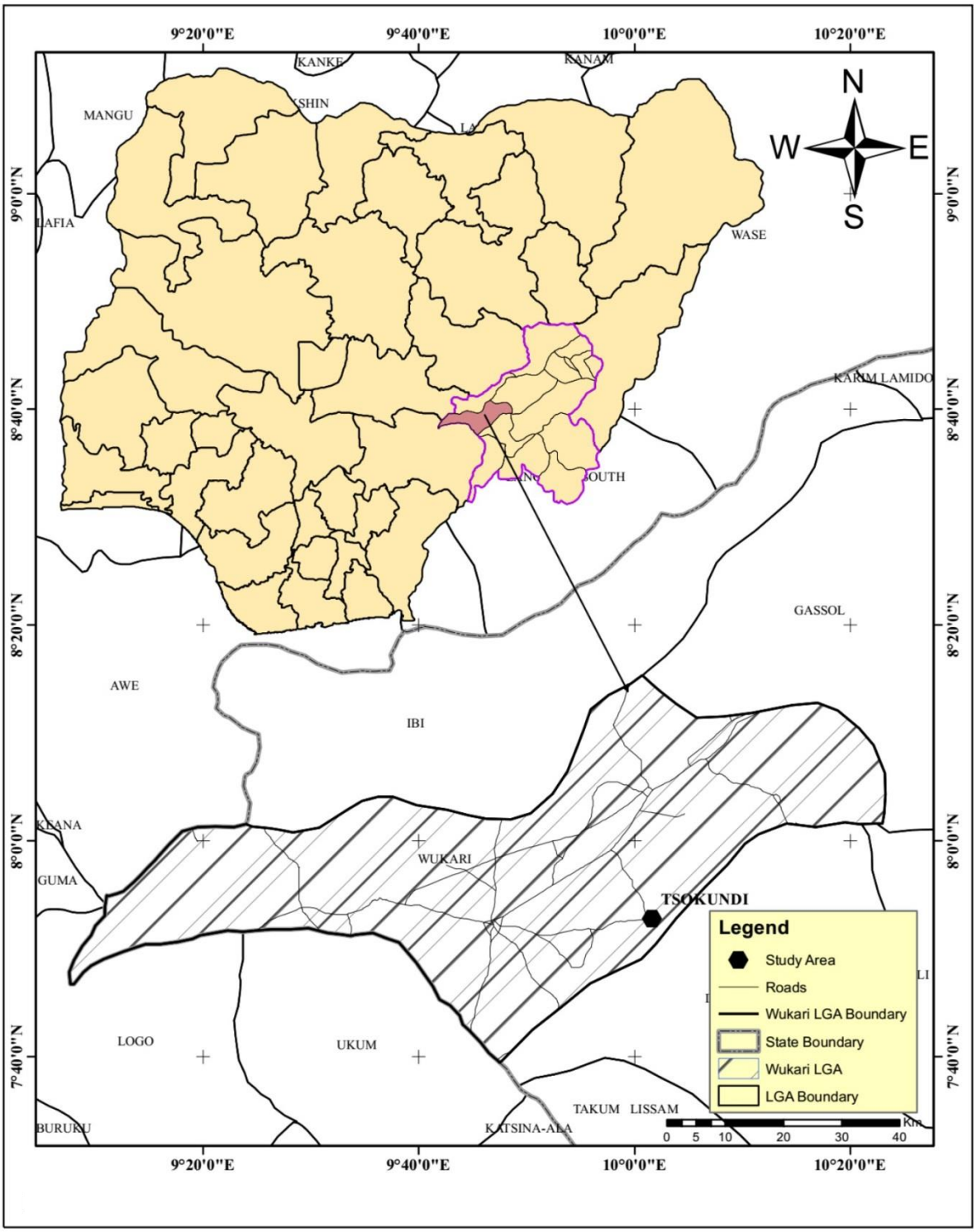


Figure 1. *Map of Wukari LGA showing Location of study area. Source: GIScore,*

Field and Laboratory Studies

Soil survey was carried out to identify the soil units of the experimental site. Profile pits were dug on each of the identified units. Morphological properties of the various horizons were determined in the field and samples were collected based on horizon differentiation from the soil profile pits according to Soil Survey Staff (2016) guidelines. Soil color was determined with Munsell soil color chart (Munsell, 2009). The soil samples collected from each horizon were air dried, grinded using mortar and pestle, and sieved. The samples were analyzed for texture, pH, organic carbon, total nitrogen, available phosphorus,

exchangeable bases (Ca, Mg, K and Na), cation exchange capacity (CEC) and base saturation (BS).

Soil texture was determined by Bouyoucos hydrometer method (Day, 1965). Soil pH was determined by electrometric methods as described by IITA (2015). Walkley and Black method as described by Nelson and Sommers (1982) was employed for organic matter content determination. Total N was determined using the modified macro-Kjeldahl method as described by IITA (2015). Bray No.1 method was used for extractable P. For exchangeable bases, Ca and Mg were determined by AAS while K and Na were done by flame photometer. CEC was determined by IITA (2015) procedures while base saturation was calculated by dividing TEB by ECEC and multiplying by 100%.

Results and Discussion

Morphological properties of the soils

The soil morphological characteristics of the study area were; soil colour, texture, structure, depth, consistence etc. The obtained results are presented in Table 1. The soils at the upper slope were well drained with gentle slopes gradients of about 0-2%. They were predominantly light reddish brown (5YR6/4) to yellowish red (5YR5/6) coloured (moist) at the surface while those of the subsurface varied from Light Reddish Brown (2.5YR6/4) to strong brown (7.5YR 5/8) (moist). The soil textures were generally loam, Sandy Loam and clay loam at surface while that of subsurface was sandy loam and clay loam.

The presence of light reddish brown (5YR6/4 moist) and yellowish red (5YR5/6) color is an indication of complete organic matter decomposition (i.e. oxygen rich soil). However, the soil at the middle slope position were poorly drained as indicated by the presence of few fine faint mottles at the Bt_2 horizon. They varied from light reddish brown (5YR6/4) to yellowish red (5YR5/6) in colored (moist) at the surface. As for the subsurface, the colors were pale red (10YR6/4) and strong brown (7.5YR5/8) moist. In the subsurface horizons of the profiles, the presence of light reddish brown (5YR6/4 moist) and yellowish red (5YR5/6) color is an indication of complete organic matter decomposition (oxygen rich soil) and seasonal fluctuation of ground water table resulting in the few fine faint mottles observed at the Bt_2 horizon.

Such mottles were mainly confined to root channels because of the oxidizing effect of oxygen, which enters the channels as soon as the water table receded. The soil was deep ranging from 80 to 110 cm. The soil texture at the surface was sandy loam and silty while those of the subsurface horizons were predominantly sandy loam texture. The soils of the lower slope were pale red (10YR6/3) and light reddish brown (5YR6/4) color moist with sandy loam texture while surface color of the soils was Strong Brown (7.5YR4/6) and light reddish brown (5YR6/4) with silty clay loam and sandy loam textured.

Table 1. *Morphological properties of the studied Area*

Horizon	Depth (cm)	Color (moist)	Mottle	Texture	Structure	Consistency	Inclusion	Root	Drainage	Boundary
Pedon 1: Upper slope (Coordinate = N07^{0}52'51.4', E10^{0}01'37.6 elevation =104m)										
Ap	0-14	5YR6/4 (light reddish brown)	Nil	SL	2MCR	Friable	Very few	Mv1rts	Well Drained	Diffused smooth
Bt_1	14-42	5YR5/6 (Yellowish red)	Nil	CL	2MSBK	Firm	Few	C12rts	Well Drained	Clear wavy
Bt_2	42-70	2.5YR6/4 (light reddish brown)	Nil	SL	2MSBK	Friable	Very few	Mv1rts	Well Drained	Clear smooth
Bt_3	70-100	7.5YR5/8 (Strong Brown)	Nil	CL	2MSBK	Friable	Very few	Mv1rts	Well Drained	
Pedon 2: Middle slope (Coordinate = N07^{0}52'55.7', E10^{0}01'36.7 elevation =106m)										
Ap	0-15	10R6/4 (pale red)	Nil	L	2MCR	Very friable	Few	FV1rts	Well Drained	Clear smooth
Bt_1	13-57	7.5YR5/8 (strong Brown)	Nil	L	2MSBK	Firm and Hard	Very Few	FV1rts	Well Drained	Clear smooth
Bt_2	57-76	2.5YR6/4 (light reddish Brown)	Nil	SL	2MCR	Firm and hard	Very Few	FV1rts	Poorly Drained	Clear wavy
Bt_3	76-122	7.5YR5/8 (strong Brown)	Few fine faint	SL	2MCR	Friable	Few	FV1rts	Well Drained	
Pedon 3: Lower slope (Coordinate = N07^{0}52'51.4', E10^{0}01'37.6 elevation =104m)										
Ap	0-20	10R6/3 (pale red)	Nil	L	2MCR	Friable	Few	VFrts	Well Drained	Clear smooth
Bt_1	20-56	5YR6/4 (light reddish brown)	Nil	SL	2MSBK	Firm and Hard	Few	VFrts	Well Drained	Clear wavy
Bt_2	56-80	7.5YR4/6 (strong Brown	Nil	SL	2MCR	Friable	Very few	VFrts	Well Drained	Clear smooth
Bt_3	80-120	5YR6/4 (light reddish brown)	Nil	SL	2MSBK	Very friable	Very few	VF1rts	Well Drained	

Ls=Loamy Sand, SL = Sandy Loam, SBK = Sub Angular Blocky, LC = Loamy Clay, S = Sand, C = Common M = Many, F = Few, VF = Very Few, 1 = Fine, 2 = Medium, 3 = Coarse, rts = Roots, CS = Clear and smooth, St = Structure, SCL Sandy Clay Loam.

Table 2. *Physical properties of the soils of Tsukundi*

Horizon	Depth (cm)	Sand %	Silt %	Clay %	SCR	TC	BD (gcm-3)	PO%	Moisture Contents %
Pedon 1 Profile 1: Upper slope (Coordinate = N07^{0}52'51.4', E10^{0}01'37.6 elevation =104m)									
Ap	0-14	61.20	22.80	16.00	1.43	SL	0.45	83.00	27.28
Bt_1	14-42	41.20	26.80	32.00	0.84	CL	0.46	82.60	34.40
Bt_2	42-70	59.20	32.80	8.00	4.10	SL	0.45	83.00	36.20
Bt_3	70-100	43.20	28.80	28.00	1.03	CL	0.65	75.50	19.97
Total		204.80	111.20	84.00	7.39		2.01	324.10	117.85
Mean		51.20	27.80	21.00	1.85		0.50	81.03	29.46
SD		10.46	4.16	11.02	1.52		0.10	3.69	7.41
CV		20.42	14.398	52.45	82.33		19.59	4.55	25.14
Pedon 1 Profile 2: Middle slope (Coordinate = N07^{0}52'55.7', E10^{0}01'36.7 elevation =106m)									
Ap	0-15	45.20	34.80	20.00	1.74	L	0.30	88.7	55.3
Bt_1	13-57	49.20	24.80	26.00	0.95	L	0.41	84.5	39.17
Bt_2	57-76	63.20	32.80	4.00	8.20	SL	0.27	90.9	58.28
Bt_3	76-122	59.20	30.80	10.00	3.08	SL	0.35	86.8	43.73
Total		216.80	123.20	60.00	13.97		0.06	2.73	9.13
Mean		54.20	30.80	15.00	3.49		0.33	87.73	49.12
SD		8.41	4.32	9.87	3.26		0.06	2.73	9.13
CV		15.51	14.03	65.77	93.26		18.44	3.11	18.59
Pedon 1 Profile 3: Lower slope (Coordinate = N07^{0}52'51.4', E10^{0}01'37.6 elevation =104m)									
Ap	0-20	51.2	32.8	16	2.05	L	0.21	92.1	70.41
Bt_1	20-56	59.2	36.8	4	9.20	SL	0.44	83.4	36.16
Bt_2	56-80	59.2	32.8	8	4.10	SL	0.43	83.8	30.04
Bt_3	80-120	60	30	10	3.00	SL	0.51	80.7	34.24
Total		229.60	132.40	38.00	18.35		1.59	340.00	170.85
Mean		57.40	33.10	9.50	4.59		0.40	85.00	42.71
SD		4.15	2.80	5.00	3.19		0.13	4.93	18.64
CV		7.23	8.45	52.63	69.47		32.70	5.80	43.64

SCR = Silt clay ratio, TC = Textural Class, BD = Bulk density, PO = Porosity, SCL = Sandy clay Loam, SL = Sandy Loam

Table 3. *Chemical properties of the studied soils*

Horizon	Depth (cm)	pH (H_2O)	OC	TN	C/N	AVP	Ca	Mg	K	Na	TEB	CEC	BS
			→	(%)	←	(mg/kg)	→		(Cmol/kg)		←		(%)
Pedon 1 Profile 1: Upper slope (Coordinate = N07^{0}52'51.4', E10^{0}01'37.6 elevation =104m)													
Ap	0-14	4.66	0.70	0.05	1.40	2.86	5.28	0.0001	0.12	0.8	0.31	6.51	98.04
Bt_1	14-42	3.71	0.28	0.06	4.70	4.70	4.24	0.0001	0.10	0.81	0.34	5.49	96.20
Bt_2	42-70	4.31	0.49	0.04	12.25	5.66	5.29	0.0001	0.12	0.80	0.35	6.56	94.30
Bt_3	70-100	3.92	0.68	0.08	7.90	5.38	5.30	0.0001	0.11	0.80	0.28	6.49	90.02
Total		16.60	2.15	0.23	26.25	18.60	20.11	0.0004	0.45	3.21	1.28	25.05	378.56
Mean		4.15	0.54	0.06	6.56	4.65	5.03	0.0001	0.11	0.80	0.32	6.26	94.64
SD		0.42	0.20	0.02	4.63	1.26	0.53	0.0000	0.01	0.01	0.03	0.52	
CV		10.15	36.47	29.70	70.50	27.09	10.44	0.0000	8.51	0.62	9.88	8.24	3.63
Pedon 1 Profile 1: Upper slope (Coordinate = N07^{0}52'51.4', E10^{0}01'37.6 elevation =104m)													
Ap	0-15	5.28	0.47	0.21	0.45	8.29	4.26	0.0001	0.12	0.75	0.39	5.52	86.65
Bt_1	13-57	4.42	0.14	0.31	0.42	3.58	5.27	0.0001	0.09	0.81	0.32	6.49	88.20
Bt_2	57-76	6.86	0.18	0.28	0.64	4.48	4.25	0.0001	0.10	0.81	0.40	6.50	60.60
Bt_3	76-122	4.89	0.18	0.07	0.57	6.94	4.26	0.0001	0.08	0.83	0.37	5.54	71.10
Total		21.45	0.97	0.87	2.08	23.29	18.04	0.0004	0.39	3.20	1.48	24.05	306.55
Mean		5.36	0.24	0.22	0.52	5.82	4.51	0.0001	0.10	0.80	0.37	6.01	76.64
SD		1.06	0.15	0.11	0.10	2.17	0.51	0.0000	0.02	0.03	0.04	0.56	
CV		19.74	63.02	49.14	19.80	37.32	11.23	0.0000	17.52	4.33	9.62	9.27	17.21
Pedon 1 Profile 1: Upper slope (Coordinate = N07^{0}52'51.4', E10^{0}01'37.6 elevation =104m)													
Ap	0-20	3.78	0.12	0.02	6.00	6.44	5.23	0.0001	0.10	0.72	0.29	6.34	70.50
Bt_1	20-56	6.78	1.89	0.1	18.90	6.33	5.24	0.0001	0.11	0.71	0.38	6.44	69.30
Bt_2	56-80	4.46	0.46	0.15	3.10	8.68	5.23	0.0001	0.11	0.81	0.41	6.56	55.50
Bt_3	80-120	3.75	0.78	0.14	5.60	4.54	5.23	0.0001	0.07	0.82	0.36	6.48	60.90
Total		18.77	3.25	0.41	33.60	25.99	20.93	0.0004	0.39	3.06	1.44	25.82	256.20
Mean		4.69	0.81	0.10	8.40	6.50	5.23	0.0001	0.10	0.77	0.36	6.46	64.05
SD		1.43	0.77	0.06	7.12	1.70	0.00	0.0000	0.02	0.06	0.05	0.09	
CV		30.47	94.43	57.65	84.72	26.10	0.10	0.0000	19.42	7.58	14.16	1.42	11.12

OC = Organic Carbon, OM = organic Matter, TN = Total Nitrogen, CEC= Cation Exchange Capacity, AVP = Available Phosphorus, K = Potassium, Na = Sodium, TEA = Total Exchangeable Acidity, Ca = Calcium, Mg = Magnesium.

Physical properties of the studied soils

Soil physical properties are those responsible for the transport of air, heat, water and solutes through the soil and they are shown in Table 2. The percentage sand fractions of the study area had no definite pattern of distribution with depth in profiles 1 and 2 but increased with depth in profile 3. The sand content ranged between 41.20 and 63.20%. The silt content of the surface horizons was lowest (22.80%) in Ap horizon of profile 1 and highest (36.8%) in profile 3 Bt_1 horizon. The percentage clay content of the study area ranged between 4.00 and 32.00%. The percentage sand fraction was the most dominant particle size fraction in both surface and subsurface horizons in all the mapping units. Most savannah soils have a high sand fraction, which is mostly caused by the parent materials' composition, the rocks' ongoing weathering, and the clay's downward movement through the soil mass (Ogbu, 2011). The Aeolian source is thought to be the parent material of the top horizons, as shown by the high sand content at the surface Ap horizons. Due to the high percentage of sand, the soil is highly susceptible to erosion since the sand can readily separate when raindrops or flowing water strike it. The colluvial or saprolitic origin of the lower subsurface soils may also be the cause of the high concentration of sand in some subsurface strata (Yau et al., 2015). Yakubu (2006) observed comparable findings in the Sokoto State soils.

For agricultural productivity and soil genesis, the natural aggregation formation of soil particles is crucial. The rate at which water and nutrients move from the surface soil to the roots at the subsurface soil, as well as other processes like infiltration, percolation, excess water drainage, aeration, and water holding capacity, are all significantly impacted by the structure of a soil. The common soil structures identified in the study area were as follows; moderate medium crumb, characterizing the Ap horizons of profiles 1, 2 and 3 respectively and moderate medium subangular blocky, found in AB and Bt horizons of all the soil profiles studied. This could be attributed to the relatively high clay content coupled with the moderate amount of organic matter which aids the aggregation of soil particles in the A horizon. A well aggregated soil is described as having good crumb structure (Idoga, 1985; Ufot, 2012).

Chemical properties of the studied soils

The soil chemical properties are presented in table 3. Given its function in nitrogen fixation, the metabolism of urea (a nitrogen-containing molecule), and seed germination, soil pH has a significant impact on the availability of Ni in the soil (Brown et al., 2006). The soil pH had mean value of 4.15 in upper slope and 5.36 in middle slope while that of lower slope was 4.69%. The soils were slightly to moderately acidic when compared with range of 5.5 to 7.5 where plants may access most of their critical nutrients (Halving et al., 1999). Osujuike (2016) have pointed out that these responses could be related to the parent material's nature as well as the study area's climate. The organic carbon was given a low rating and had means of 0.54%, 0.24%, and 0.81% on the upper, middle, and lower slopes, respectively. The ongoing cultivation and bush burning, which promote the breakdown of organic matter, may be the cause of the low percentage of organic carbon in the soils (Kang, 1993). Total nitrogen (TN) content has a range of 0.05 to 0.81% and was rated low. The quantity of organic matter in the soil is reflected in the low TN content. The low TN content could be the result of a lessivage pedogenic process (a type of leaching from suspended clay particles). It is evident that the low amount of N in the area may be caused by the local

climate, vegetation, and human activity. Due to the low amount of nitrogen in these soils, sorghum requires the use of either organic or inorganic fertilizer to provide the essential nutrients (Usman et al., 2018). Available phosphorus ranged between 2.86 and 8.68 mg/kg and were rated low. The low numbers do, however, support the findings of Brady and Ray (2014), who found that most native soil has a low overall P content and that most of it is present in a form that is not very useful to plants. The low pH level, which fixed the P and rendered it inaccessible, may be the cause of the poor P availability in the soils along the Tsokundi River's toposequence (Usman et al., 2020).

The exchangeable bases as indicated in table 3 showed that calcium and sodium are the dominating elements in the exchangeable site in all the profile pits with values ranging from 4.24 to 5.30 and 0.71 to 0.82 $cmolkg^{-1}$ followed by potassium which has values ranging from 0.10 to 0.12 $cmolkg^{-1}$. The cation exchange capacity was assessed as low. The underlying minerals, degree of weathering, leaching, low organic matter content, and lateral translocation of bases could all contribute to these soils' low exchangeable bases (Krasslinikoff et al., 2002; Kang 1993). Ahn (1970); Ogunkunle (1989); Idoga (1985) found similar findings. Fagbami and Akamigbo (1986) also reported similar findings. Idoga 2005. The fact that calcium is the least easily leached from the exchangeable site among all the exchangeable cations could account for its predominance over other cations (Brady 1990). Cation exchange capacity (CEC) varied from 6.01 to 6.46 cmol/kg and was assessed as low. High acidity and low chemical weathering activity of the soil are the causes of the low CEC level (Okunsanmi and Oyediran 1987). According to Usman et al. (2018), it might also be caused by the impact of soil organic matter and the contribution of clay content of the soils at the lower horizons (FAO-UNESCO, 2001; Idoga and Azagaku, 2005).

A soil's percentage base saturation is closely correlated with its total enzymatic balance (TEB). High TEB values are accompanied by high B.S. values, and vice versa. There is a strong correlation between a soil's pH and B.S. (Usman et al., 2018). The BS values of the soil (60.60 to 98.04%) were rated moderately high to very high when compared to the ratings of FMANR (1990) as; <20% - very low, 20-40% - low, 40-60% - medium, 60- 80% - high and > 80% - very high. The distributions of base saturation (BS) decreased with depth in pedon 1 while pedons 2 and 3 were irregular distributed with depth. Nutrient biocycling may be the cause of this BS declining trend in depth (Idoga and Azagaku, 2005). The pH decreases in a more or less defined proportion along with the B.S. due to the loss of calcium and other metallic elements in the drainage process.

Soil Classification

Soil classification based on USDA soil taxonomy

Using the USDA Soil Taxonomy (Soil Survey 2014), the soils in the research locations were categorized according to their morphological, physical, and chemical characteristics as well as the local climate. Alfisol is compatible with the clay distribution pattern and the high base status (<50%) of the soils. The soils had a regime of isohyperthermic soil temperature (>22°c), good drainage, and a ustic moisture regime—limited soil moisture content but sufficient for plant growth during the rainy season. These characteristics belong to the Ustalfs suborder. The pedon 1 (upper slope) soils exhibited a coarse redox concentration, a value of 4 or more, a chroma of 4 or more, and a soil color hue of 7.5YR in subsurface horizons. Due to these characteristics, the soils were categorized as Arenic Paleustalfs and placed under the great group of Paleustalfs. This is because the

soil has a high percentage of sand (41.20 to 61.20%) throughout all horizons, which extend from the mineral soil surface to the top of an argillic horizon at a depth of 50 cm or more. The soils in Pedon 2 (Middle Slope) were further classified as Aqualfs due to the presence of mottles. The mottles' right subsurface location designated them as endoaqualfs, which were then further categorized as Typic Endoaqualfs. The Ustic moisture regime with Kandic horizon, increased subsurface clay content, and irregular decrease of organic carbon with depth in the soils of Podon 3 (Lower Slope) classified the soil in the great group Kandiustalfs and the Arenic Kandiustalfs at the subgroup level.

Classification according to World Reference Base

The research area's soils were associated with luvisols due to the existence of argic horizons. They were further connected as Eutric Luvisols by the high base status. The top slope was designated as Haplic Luvisolas because it exhibited specific traits in a typical expression (typical in the sense that there is no further or meaningful categorization because there isn't any significant clay in the horizon). The upper slope's simple horizon identification and strong base saturation roughly corresponded to Eutric Haplic Luvisols. The middle slope's soils were categorized as luvisols due to their base saturation levels exceeding fifty percent and argic horizons. As a result, they are categorized as Eutric Luvisols. The subsurface clay concentration of lower slope soils was higher than that of the surface soil. This suggests that they possessed argic B horizon evidence. In all of the B horizons, their CEC was less than 24 cmol/kg clay, and their base saturation was more than 50%. Because of their coarse surface structure and sandy clay loam texture, they were categorized as Aeric Lixisols.

Conclusion

Soils along the toposequence of Tsokundi river were studied with the aim of characterizing them for sustainable production. Three soil units were identified in the area. They vary considerably on their toposequence and influence their agricultural potentials. Soils at the upper and lower slope were deep and well drained whereas, that of the middle slope was deep but poorly drained as indicated by the presence of mottles at the subsurface. They had sandy loam to sandy clay loam to silt clay loam texture. They were extremely acidic to slightly acid with pH values ranging from 3.71 to 6.86. Based on the physical and chemical properties of the soils, they were classified as: *Arenic Paleustalfs/Eutric Haplic Luvisols*, *Typic Endoaqualfs/Eutric Luvisols, Arenic Kandiustalfs/Haplic Lixisols*. They also have high base saturation, low nutrient status which makes the application of organic or inorganic fertilizer necessary to supply the basic nutrient elements to the soils alongside strict measures to prevent soil erosion may also help the soil regain back their productive capacity.

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