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CHARACTERIZATION AND CLASSIFICATION OF SOILS ALONG RIVER DONGA, DONGA, TARABA STATE, NIGERIA

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ABSTRACT

This study was carried out to ascertain the characterization and classification of soils along river Donga in Donga local government area of Taraba State. Three profile pits were dug on the flat terrain for the physio-chemical properties of the soils. The pits were described and samples were collected for routine laboratory analysis for the selected physio-chemicals properties. Data collected were analyzed statistically using analysis of variance (ANOVA)

The result of the laboratory analysis of the physical and chemical properties indicated that particle size distribution of sand particle dominated other fraction of fine earth materials. This can be attributed to the parent materials that gave rise to the soils.The pH (H2O) was slightly acidic in reaction in all the pedons studied (6.44, 5.82 and 5.67). The organic carbon content ranges from very low to low compared to the maximum level (5%) for tropical soils. Available phosphorus obtained exceeded the critical limits of 8.0 to >18mg/kg, which indicates that the available phosphorus were high. The exchangeable bases (Ca, Mg, K & Na) as indicated in the table 3 that Ca, Mg, K & Na were low in all the pedons studied. The results obtained from analyzed profile samples showed that percentage (%) base saturation values for all the pedons were high. The Correlation was done to determine non-significant and significant values among soil physio-chemical properties studied at 5% and 1% probability level.

In addition, after the profile description and examination of the soil properties of the study area, the soils were classified using USDA soil taxonomy (2014). Pedons 1 and 2 are classified into the order of Alfisols and sub-group of Typical Haplustalf while pedon 3 is also classified into Alfisols but sub-group of Arenickandiustals (Hypereuticlixisels).

Keywords: Characterization, Classification, Soils, Riverbank.

1. INTRODUCTION

Soil plays a vital role in sustaining life for most living organism on the habitat; nearly all of the food consumed by humans except from the marine environment comes from the soil, this has led to a tremendous increase in the production of agricultural product and also in the area of development. Providing a medium to attenuate pollutants and excess water, groundwater recharge, nutrient cycling and habitat for microorganisms and biota, serves the less obvious function of the soil. Soil also has many secondary uses such as ingredients in confectionaries, insecticides, inks, paints, makeup and medicines; uses clays for instance range from drilling mud's pottery and art work to providing glossy finishes on the various paper products [29].

There is an increasing demand for information on soil as a means of food production [15]. According to [26] lack of detail information on soil and land characteristics had been one of the factors limiting agricultural development in the tropics. Agriculture is the predominant economic activity in Nigeria, therefore soil characterization and classification has become necessary to know the prospects of the soils and also to unravel some unique soil problems in an ecosystem [21].

Soil characterization provides the information for our understanding of the physical, chemical, mineralogical and microbiological properties of the soils we depends on to grow crops, sustain forests and grasslands as well as support homes and society structures [24]. According to [27], in a small region of uniform climate, the nature of the parent materials is probably more important than any other single factor in determining the characteristics and productivity of a soil. This means that, soil development is caused by climate and living matter acting upon parents material (weathered mineral or organic matter from which the soil develops), as condition by topography over time [6]. Land is an important economic factor of production and it is the basic resource for human needs, food, shelter and clothing [4]. Therefore, soil classification and soil mapping provides a powerful resource for the benefit of mankind especially in the area of food security and environmental sustainability [21].

Soil classification on the other hand, also helps to organize our knowledge, facilitates the transfer of experience and technology from one place to another and also to compare soil properties [13]. On soil science resource, experience has shown that a natural system approach to classification, i.e. grouping soils by their intrinsic property (soil morphology), behavior or genesis result in classes that can be interpreted for many diverse uses. Some different uses of soil characterization data include to aid in correct classification of soil and enable other scientist to place the soil in their taxonomies of classification systems and to serve as a basis for more detailed evaluation of the soil as well as gather preliminary information on nutrients, physical or other limitations needed to produce a capability class [7].

Soil classification deals with the systematic categorization of soils based on distinguishing characteristics as well as criteria that dictate choices in use. A soil characterization study, therefore, is a major building block for understanding the soil, classifying it and gathering the best understanding of the environment [12].

The observable attribute ordinary in in-situ observation includes the composition form, colour of the soil, structure and organization of the soil and features such as carbonates, iron, manganese and clay, and the consistence of the soil [25]. According to [5], soil taxonomy, provides a hierarchical grouping of natural soil bodies and it is based on soil properties that can be objectively observed or measured, rather than presumed mechanism of soil connotation of the major characteristics in question and that there are six (6) categories of classification in the soil taxonomy, which includes; order, suborder, great group, subgroup, family and series.

Food production has been on an increase in Donga riverbank for sometimes but there is no data of the current nutrient elements capacity and the nutrient levels of the riverbank for future

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agricultural activities. The research was aimed at identifying and keeping the record of the physical and chemical properties of the soil in the riverbank of Donga.

2. MATERIALS AND METHODS

2.1 Description of the study area

Geographically, Donga lies within latitude 70'43"N of the equator and longitude 10oE of the meridian with the land area of approximately 58 square kilometers. It is located in the southern region of Taraba, bounded on the Northeast by Kurmi Local Government Area, on the Northwest by Bali Local Government, to the Southwest by Wukari Local Government Area, while to the Southeast by Takum Local Government Area.

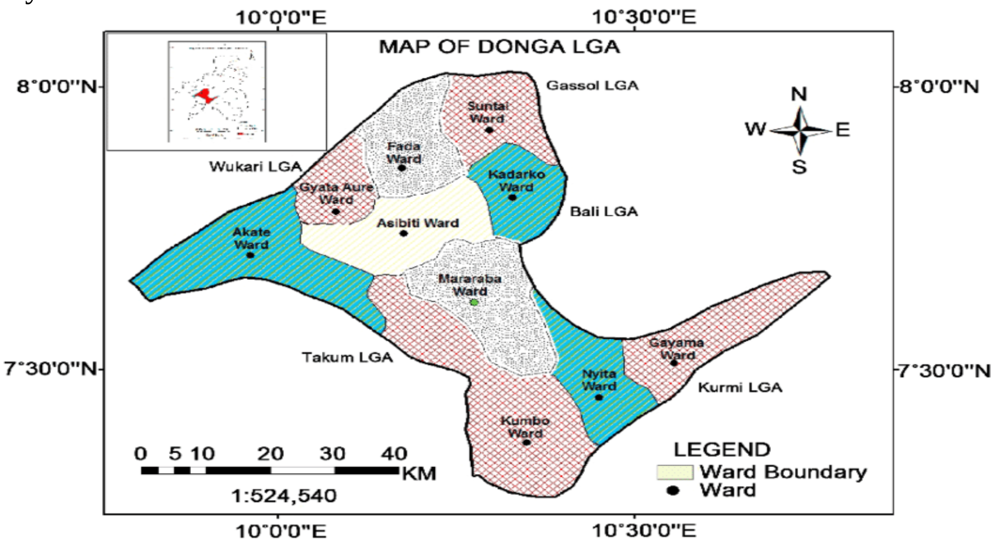

Figure 1: Map of Donga Local Government Area showing the study area
Source: Taraba State Ministry of Land Resources

2.2 Climate and Vegetation of Donga

The area has two marked seasons, the dry and the rainy season. The dry season starts from November to March while the rainy season from April to October. The temperature is generally high with mean annual temperature at 32˚C recorded in April and low temperature which can be as low as 10˚C experienced in December to January, but the mean minimum annual temperature is 22˚C.

Donga Local Government falls within the woodland savannah zone of a distinct type of vegetation, which is a transition between forest and savannah vegetation type. Thus there are both varieties of forest and savannah vegetation in which natural plant cover consist of trees, shrub and grasses, some of them lose their leaves for only short period in the year. A forest variety such as oil palm is formed scattered all over the area.

2.3 Geology and Soil

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Donga is underlain by sedimentary rock of post Cambrian land era, and mainly consists of gentle undulating land with plains. It has a river and the basin constitutes one of the fertile arable lands of the mid region of Nigeria. The hilly undulating land stands at an altitude of 120 - 130 meters above sea level.

2.4 Field Work

Field reconnaissance was done with physical attributes of the study area. The site for sitting the profile pits were decided after physical observation. The profile pit was described and samples were also collected according to guidelines of [14]. Soil samples were collected from different horizons observed inside the profile pit for data analysis. The soil samples collected were dried at room temperature, sieve with 2mm sieve and then taken to the laboratory in well labeled containers for laboratory analysis.

Table 1: Coordinate and Elevation of land use

LAND USE	COORDINATE	ELEVATION
Pedon one Frequently cultivated area (FCA)	7^0 43'36.62''N 10^0 02'18.25''E	120metres
Pedon two Frequently cultivated Area (FCA)	7^0 43'37.34''N 10^0 02'15.94''E	
Pedon three Frequently cultivated Area (FCA)	7^0 43'38.04''N 10^0 02'10.16''E	

2.5 Laboratory Analysis

2.5.1 Physical Properties

Bulk density

This was determined by hydrometer method described by [3], using sodium hexametaphosphate.

Particle size analysis

This will determine by hydrometer method described by [3], using sodium hexametaphosphate.

2.5.2. Chemical Properties

Soil pH

The pH values were determined in duplicates, both in distilled water and 0.1N KCl solution, using a soil: liquid ratio of 1: 2.5. After stirring for 30 minutes, the pH values were read using pH meter.

Exchangeable acidity

This is the amount of hydrogen ions and aluminum ions found in the soil. This was determined by titrimetric method [36].

Available Nitrogen

This is the amount of extractible nitrogen found in the soil. The amount of nitrogen was determined by using alkaline permanganate method [31].

Available Phosphorus

This is the amount of extractible phosphorus found in the soil. The amount of phosphorus was determined by Bray p1 method [8].

Soil Organic Carbon

This is the amount organic carbon found in the soil. The soil organic carbon was determined by [34].

Cations Exchangeable Capacity

This is the ability of the soil to supply the number of cations (Na, K, Ca and Mg) that are needed by the plants. It was determined by Ammonium acetate method of [9].

Exchangeable Bases

Exchangeable bases are commonly defined as the akali and alkaline earth metals (principally Ca, Mg, K and Na) attached to the clay and organic constituents of soils and which can be exchange with each other and other positively charged ions in the soil solution [10]. Exchangeable bases were determined by using the complexometric titration method [19].

Soil Micro-Elements

These are elements needed by the plants in little quantities. Examples are; Molybdenum (Mo), Zinc (Zn), Iron (Fe), Boron (B) Manganese (Mn) etc.

Available Iron, Manganese, Copper and Zinc will be determined by DiethyleneTriamine Penta acetic acid (DPTA) using atomic absorption spectrometer method of [23].

Available Boron was determined by using hot water of [2] while available Molybdenum was determined by Acid ammonium oxalate method of [17] and [18].

2.6 Statistical analysis

The measured variables are analyzed using statistical method to obtain the mean values. Coefficient of variability among soil properties will be measure using coefficient of variation (CV) and rank according to the procedure of [35], statistical analysis will be done using Gestate.

The statistical analysis was carried out to establish the relationship of the profile mean values has with the parameter means and standard error between the profile pits.

3. RESULTS AND DISCUSSION

3.1 Morphological properties of the soil

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The morphological characteristics of the soil in the study site are shown in table 2. All the horizons were well drained in all the land use. The surface was loose at the three pedons. The pedons have crumbic, platy, sub-angular and blocky structure at all the horizons.

The various physiographic position have different colour matrix range, which are described as follow: at the FCA it was observed that across the horizon the colour matrix range from light yellowish 10YR6/4, yellowish brown 10YR5/4, dark brown 7.5YR5/3, strong brown 7.5YR5/6, to very pale brown 10YR7/4 at moist condition. At FCA the colour matrix range dark reddish brown 5YR3/4, dark brown 7.5YR3/4, dusky red10YR3/3, to reddish brown 2.5YR5/3, at moist condition and at FCA light gray 7.5YR7/1, light gray 10YR7/2 very pale brown 10YR7/4, yellow 10YR 8/6, to reddish yellow 7.5YR6/8, at moist condition. The drainage condition and physiographic position may have influence the observed change in the colour matrix in the land uses. The internal class of the Land use appears clear to very clear, it showed clear for all the horizons of the FCA. However the texture classes of the land use disagree with the findings of [33] that attributed differences in soil texture to the variation in parent materials.

Table 2: Morphological Properties of the Soil in the Study Area

Horizon	Depth(cm)	Munsell colour	Structure	Mottle	Horizon Boundary	Texture	Consistence	Vegetation	Root Presence
Sweet Potatoes Land Use (Pedon 1)									
Ap	0-20	Light yellowish 10YR/6/4	Crumbic	No	Clear	Sandy loam	Friable	SR	Very fine
AB	20-31	Yellowish Brown 10YR5/4	Crumbic	No	Clear	Sandy loam	Friable	SR	Very fine
Bt	31-52	Dark Brown 7.5YR5/3	Crumbic	No	Diffuse	Sandy loam	Friable	SR	Fine and medium
Bt1	52-76	Strong Brown 7.5YR5/6	Crumbic & Sub-angular	No	Diffuse	Sandy loam	Loosely firm	SR	Fine, medium & coarse
Bt2	76-100	Pale Brown 10YR7/4	Crumbic & Sub-angular	No	Diffuse	Sandy loam	Loosely firm	SR	Very fine & medium

Sweet Potatoes Land Use (Pedon 2)									
Ap	0-32	Dark Reddish Brown 5YR3/4	Sub-angular blocky	No	Smooth & clear	Sandy loam	Hard	SR	Very fine
AB	32-48	Dark Brown 7.5YR3/4	Sub-angular blocky	No	Smooth & clear	Sandy loam	Friable	SR	Fine
Bt	48-73	Dusty red 10YR3/3	Sub-angular blocky	No	Smooth & clear	Loam	Firm & sticky	SR	Fine and medium
Bt1	73-100	Reddish brown 2.5YR5/3	Sub-angular blocky	No	Smooth & clear	Sandy loam	Firm	SR	Medium
Rice Land Use (Pedon 3)									
Ap	0-15	Light gray 7.5YR7/1	Crumbic	No	Clear	Loam	Firm	SR	Very fine
AB	15-30	Light gray 7.5YR7/2	Platy	No	Clear	Sandy loam	Sticky	SR	Very fine
Bt	30-53	Pale Brown 10YR7/4	Sub-angular blocky	No	Clear	Sandy loam	Sticky	SR	Medium
Bt1	53-68	Yellow 10YR 8/6	Blocky	No	Clear	Sandy loam	Sticky	SR	Medium
Bt2	68-100	Reddish yellow 7.5YR6/8	Sub-angular blocky	No	Clear	Loam	Firm & sticky	SR	Medium

3.2 Physical properties of soil pedons studied

Soil physical properties are important indicators to evaluate agricultural practices. The soil porosities of different sizes are crucial factors with a direct impact on crop root growth and

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nutrient transport. The particle size distributions of the soil of the studied area are presented in (Table 3).

The sand percent mean value range from 65.08%, 58.20% and 52.68% for all FCA. It was observed that the percentage sand increased with increase in the three systems. Thus have high percent of sand in the area. This could be attributed to parent materials, climate and land use. These factors influence the pedogenesis and properties of soil [1].

Clay has a mean value of 7.28%, 16.10% and 15.44% in the FCA. The clay content decreases and increases within horizons depth in the FCA, which could be attributed to sorting of soil minerals by biological and agricultural activities, clay migration or surface by runoff or combination of these soils, it equally decreases and increases in depth in the FCA.

Silt content was observed to have a mean of 27.84%, 25.70% and 31.88% in the FCA. It decreases and increases irregularly with depth. Comparing the soils under investigation it was observed that the soils are highly weathered and pedologically mature.

The textural class of the area range from sandy loam to loamy sand.

Table 3: Physical Properties of the Soil in the Study Area

Horizon	**Depth**	**% Sand**	**%Silt**	**%Clay**	**SCR**	**Bulk density (g/cm^3)**	**%Porosity**	**Textural class**
	(cm)	g/kg	g/kg	g/kg				
Sweet Potatoe Land Use (Pedon 1)								
Ap	0-20	65.2	34.2	0.6	57	0.28	10.57	SL
AB	20-31	64.2	25.4	11.4	2.23	0.26	9.81	SL
Bt	31-52	65.2	30.2	4.6	6.57	0.26	9.81	SL
Bt_1	52-76	61.2	27.6	11.2	2.46	0.26	9.81	SL
Bt_2	76-100	69.6	21.8	8.6	2.53	0.25	9.43	SL
Mean		**65.08**	**27.84**	**7.28**	**14.16**	**0.26**	**9.89**	
CV		**4.63**	**16.90**	**63.65**	**169.60**	**4.18**	**4.21**	
Sweet Potatoe Land Use (Pedon 2)								
Ap	0-32	67.2	18.2	14.6	1.25	0.23	8.68	SL
AB	32-48	67.2	24.2	8.6	2.81	0.23	8.68	SL
Bt	48-73	43.2	32.2	24.6	1.31	0.22	8.3	L
Bt_1	73-100	55.2	28.2	16.6	1.69	0.25	9.43	SL
Mean		**58.2**	**25.7**	**16.1**	**1.77**	**0.23**	**8.77**	
CV		**19.74**	**23.24**	**41.04**	**40.99**	**5.41**	**5.40**	
Rice Land Use (Pedon 3)								
Ap	0-15	43.2	34.2	22.6	1.51	0.21	7.92	L
AB	15-30	59.2	30.2	10.6	2.85	0.26	9.81	SL

Bt	30-53	45.6	38.4	16.0	2.4	0.29	10.94	L
Bt_1	53-68	69.8	20.2	10.0	2.02	0.24	9.06	SL
Bt_2	68-100	45.6	36.4	18.0	2.02	0.27	10.19	L
Mean		**52.68**	**31.88**	**15.44**	**2.16**	**0.25**	**9.58**	
CV		**21.76**	**22.60**	**34.14**	**23.09**	**12.01**	**12.01**	

Key:SCR=silt clay ratio, TC=textural class, MC=moisture content, BD=bulk density, Po=total porosity,L=loamy sand, SL= sandy loam.

3.3 Soil chemical properties in the studied area

Table 4 displays the laboratory chemical analysis of the soil from the area study. The mean value of pH across the area is 6.44, 5.82 and 5.67 in the FCA. This shows that the soil is slightly acidic. The acidic condition of various land use types could be attributed to severe leaching by the high tropical rainfall and low organic matter content.

The soil organic matter content has a mean value (1.11, 2.46 and 3.15) for all FCA respectively. All show low content of organic matter, lower than the maximum level (5%) for tropical soils. This can be attributed to management practices such as frequent bush burning, continuous farming and erosion runoff. Organic matter have a positive influence on soil PH, cation Exchange capacity, base saturation, water holding capacity and ECEC [1].

Table 4 shows that the total nitrogen content was increased by the land uses over the critical values of 0.15%. It has been observed that the main cause of nitrogen deficiency in tropical soil is intense leaching and erosion due to high tropical rainfall and absorption of some nutrients by the plants.

The content of available phosphorus in the alluvial soil showed an overall increasing trend 17.56, 18.02 and 17.64 which depicts a high level occurrence >18mg/kg. This could be attributed to organic manner or inorganic fertilizer application. The mean value obtained exceeded the critical limit of 8.0 mg/kg Bray 1-P established for crops in Nigeria [16] and the critical level of 15 mg/kg Bray 1 extractable P recommended by [32] cited by [28]. This indicate that the available phosphorus were high in the soil.

Exchangeable bases values showed that Sodium (Na) and Potassium (K), Calcium (Ca) and Magnesium (Mg) were low in the soils. The mean values of Ca, Mg, K, and Na are as indicated respectively (4.54cmol/kg, 0.81cmol/kg, 0.26cmol/kg and 0.23cmol/kg), (4.59cmol/kg, 0.82cmol/kg, 0.27cmol/kg and 0.23cmol/kg) and (4.66cmol/kg, 0.81cmol/kg, 0.26cmol/kg and 0.23cmol/kg) for all FCA. The rating indicated that Ca, K, Mg and Na were very low to low in the studied land use types. The low values in basic cations could be attributed to the type of parent material, high rainfall, erosion, and leaching [11]. The changes in the soil properties are mainly attributable to the management activities such as cultivation and fertilizer application.

The total exchangeable acidity (TEA) recorded mean values of 0.27cmol/kg, 0.26cmol/kg and 0.21cmol/kg respectively. Therefore, it can be speculated that the changes of physico-chemical properties observed in the study were the results of different cultivations and fertilizations.

Base saturation percentage (%BS) can be regarded and the extent to which the adsorption complex of a soil is saturated with exchangeable cations other than hydrogen and aluminium. A high base saturation indicates that the exchange sites on a soil particle are dominated by non-acidic ions and vice versa. The results from observed profiles showed that percentage base saturation values for all soils were high. Therefore, as the base saturation was above 50% in almost all cases, the soils have high fertility potential which forms the separating index between fertile soils and less fertile soils as stated by [20]. Generally, the percentage base saturation values varied from 95.60%, 95.75% to 96.60%. The high base saturation is probably associated with the presence of weathered minerals which release nutrients into the soil and their alluvial nature.

Table 4: Chemical Properties of the Soil in the Study Area

Horizon	**Depth**	**Ph**	**O.M**	**O.C**	**TN**	**CN**	**AVP**	**TEA**	**Ca**	**Mg**	**K**	**Na**	**TEB**	**ECEC**	**%BS**	**Ca/mg**
	(cm)	**H_2O**														
AP	0-20	7.05	1.24	0.72	1.8	0.4	17.65	0.15	4.5	0.81	0.27	0.24	5.82	5.97	97.49	5.56
AB	0-31	6.75	0.47	0.27	1.8	0.15	17.67	0.35	4.61	0.81	0.26	0.24	5.92	6.27	94.42	5.69
Bt	31-52	6.6	1.17	0.68	1.6	0.43	17.49	0.25	4.5	0.82	0.26	0.22	5.8	6.05	95.87	5.56
Bt_1	52-76	5.85	0.85	0.49	1.8	0.27	17.64	0.35	4.5	0.81	0.26	0.23	5.8	6.15	94.31	5.56
Bt_2	76-100	5.95	1.83	1.06	1.6	0.66	17.35	0.25	4.6	0.81	0.26	0.22	5.89	6.14	95.93	5.68
Mean		**6.44**	**1.11**	**0.64**	**1.72**	**0.38**	**17.56**	**0.27**	**4.54**	**0.81**	**0.26**	**0.23**	**5.85**	**6.12**	**95.60**	**5.61**
CV		**8.08**	**45.32**	**45.52**	**6.37**	**50.06**	**0.78**	**30.99**	**1.27**	**0.55**	**1.71**	**4.35**	**0.95**	**1.58**	**1.37**	**1.22**
Sweet Potatoe Land Use (Pedon 2)																
AP	0-32	5.98	4	2.32	1.7	1.36	18	0.15	4.6	0.82	0.28	0.24	5.94	6.09	97.54	5.61
AB	32-48	5.85	1.24	0.72	1.8	0.4	18.02	0.35	4.6	0.81	0.28	0.22	5.91	6.26	94.41	5.68
Bt	48-73	5.75	2.5	1.44	1.6	0.9	18	0.2	4.6	0.81	0.26	0.22	5.82	6.02	96.68	5.68
Bt_1	73-100	5.7	2.1	1.22	1.5	0.81	18.04	0.35	4.55	0.82	0.26	0.23	5.86	6.21	94.36	5.55

Mean		**5.82**	**2.46**	**1.43**	**1.65**	**0.87**	**18.02**	**0.26**	**4.59**	**0.82**	**0.27**	**0.23**	**5.88**	**6.15**	**95.75**	**5.63**
CV		**2.12**	**46.89**	**46.91**	**7.82**	**45.41**	**0.11**	**39.27**	**0.55**	**0.71**	**4.28**	**4.21**	**0.90**	**1.79**	**1.68**	**1.11**
Rice Land Use (Pedon 3)																
AP	0-15	5.7	5.1	2.96	1.7	1.74	17.74	0.15	4.6	0.82	0.27	0.22	5.91	6.06	97.52	5.61
AB	15-30	5.65	5.1	2.96	1.7	1.74	17.68	0.2	4.5	0.81	0.27	0.24	5.82	6.02	96.68	5.55
Bt	30-53	5.65	1.57	0.91	1.7	0.54	17.59	0.2	4.9	0.81	0.26	0.22	6.19	6.39	96.87	6.05
Bt_1	53-68	5.7	1.9	1.1	1.5	0.73	17.58	0.25	4.72	0.82	0.26	0.23	6.03	6.28	96.02	5.76
Bt_2	68-100	5.65	2.1	1.22	1.7	0.72	17.61	0.25	4.6	0.81	0.25	0.22	5.88	6.13	95.92	5.68
Mean		**5.67**	**3.15**	**1.83**	**1.66**	**1.09**	**17.64**	**0.21**	**4.66**	**0.81**	**0.26**	**0.23**	**5.97**	**6.18**	**96.60**	**5.73**
CV		**0.48**	**56.69**	**56.69**	**5.39**	**54.35**	**0.39**	**19.92**	**3.29**	**0.67**	**3.19**	**3.96**	**2.46**	**2.52**	**0.68**	**3.41**

OC=Organic carbon, OM= organic matter, TN= total nitrogen, AV.P=available phosphorus, TEA=total exchangeable acidity, TEB= total exchangeable bases, ECEC=effective cation exchange capacity, BS=base saturation, C/N=carbon nitrogen ratio.

The result from table 5 indicated that OM is negatively correlated with pH with a value of -0.47 which is non- significant.

OC is negatively correlated with pH with a value number of -0.47 and is also positively correlated with OM with a value number of 1.000** which is highly significant at 1% probability level. TN is non-significant with pH and Na with the value numbers of 0.37 and 0.28 which is correlated positively and is also negatively correlated with OM and OC with the same value number of -015.

C/N is highly significant at 1% probability level and positively correlated with OM and OC with the same value number of 0.997**

TEA is negatively correlated and significant at 5 % probability level with OM, OC and C/N with the value number of -0.616*, -0.616* and -0.605*. While K is positively correlated with AV.P with a value of 0.50 which is non-significant at probability level

ECEC is positively correlated and highly significant at 1% probability level with TEB with a value number of 0.779** and is also positively correlated with TEA with a value 0.51 which is non-significant at probability level.

BS is positively correlated and significant at 5% probability level with OM, OC and C/N with the value numbers of 0.609*, 0.609* and 0.597* and is also negatively correlated and highly significant at 1% probability level with TEA with a value number of -0.999**

Ca is negatively correlated and non-significant at probability level with pH with a value number of -0.37 and is also positively correlated and highly significant at 1% probability level with TEB and ECEC which has a value numbers of 0.966** and 0.753**. While Mg is negatively correlated and significant at 5% probability level with TN with a value number of -0.578*

Sand is non-significant at probability level and is positively correlated with pH with a value number of 0.45

Silt is positively and negatively correlated and is non-significant at probability level with TN, TEA, K, ECEC, and BS with the value numbers of 0.20, -0.28, -0.37, -0.15 and 0.28.

Clay is negatively correlated and high significant at 1% probability level with pH with a value number of -0.664**

Silt and clay ratio (SCR) is positively correlated and highly significant with pH with a value number of 0.696**

Bulk density (BD) is positively correlated and non-significant with pH with a value number of 0.33 and is also negatively correlated and non-significant at probability level with OM, OC, C/N, AV.P and K with the value numbers of -0.47, 0.47, -0.49, -0.52 and -0.42. while Porosity is positively correlated and non-significant with pH with a value number 0.33 and is also negatively correlated and non-significant with OM, OC, C/N, AV.P and K with the value numbers of -0.47, -0.47, -0.49, -0.52 and -0.41

Ca/Mg ratio is highly significant at 1% probability level and positively correlated with TEB and ECEC with the value numbers of 0.909** and 0.733**.

Table 5: Correlations among soil physico-chemical properties studied

	Ph	**OM**	**Na**	**OC**	**TN**	**C/ N**	**AV.P**	**TEA**	**K**	**TEB**	**ECEC**	**BS**
OM	-0.47	-	-	-	-	-	-	-	-	-	-	-
Na	0.42	0.12	-	-	-	-	-	-	-	-	-	-
OC	-0.47	1.000**	0.12	-	-	-	-	-	-	-	-	-
TN	0.37	-0.15	0.28	-0.15	-	-	-	-	-	-	-	-
CN	-0.49	0.997**	0.10	0.997**	-0.22	-	-	-	-	-	-	-
AV.P	-0.23	0.24	0.14	0.24	0.02	0.24	-	-	-	-	-	-
TEA	-0.02	-0.616*	-0.07	-0.616*	0.04	-0.605*	0.09	-	-	-	-	-
K	0.09	0.39	0.33	0.39	0.37	0.36	0.50	-0.27	-	-	-	-
TEB	-0.30	-0.05	-0.17	-0.05	-0.10	-0.04	-0.11	-0.14	-0.02	-	-	-
ECEC	-0.28	-0.43	-0.19	-0.43	-0.06	-0.42	-0.03	0.51	-0.19	0.779**	-	-
BS	0.02	0.609*	0.07	0.609*	-0.04	0.597*	-0.09	-0.999**	0.27	0.18	-0.47	-

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Ca	-0.37	-0.09	-0.32	-0.09	-0.16	-0.08	-0.10	-0.13	-0.16	0.966**	0.753**	0.18
Mg	-0.09	0.33	0.01	0.33	-0.578*	0.36	0.18	-0.16	0.16	0.06	-0.05	0.17
Sand	0.45	-0.33	0.44	-0.33	0.04	-0.33	-0.20	0.27	0.34	-0.14	0.05	-0.27
Silt	-0.02	0.05	-0.33	0.05	0.20	0.03	-0.13	-0.28	-0.37	0.03	-0.15	0.28
Clay	-0.664**	0.45	-0.36	0.45	-0.24	0.47	0.43	-0.14	-0.19	0.18	0.07	0.15
SCR	0.696**	-0.22	0.37	-0.22	0.33	-0.24	-0.13	-0.35	0.18	-0.24	-0.42	0.34
BD	0.33	-0.47	0.20	-0.47	0.23	-0.49	-0.52	0.09	-0.42	0.19	0.22	-0.08
Porosity	0.33	-0.47	0.20	-0.47	0.23	-0.49	-0.52	0.09	-0.41	0.19	0.22	-0.08
Ca/Mg	-0.28	-0.22	-0.36	-0.22	-0.04	-0.22	-0.20	-0.08	-0.23	0.909**	0.733**	0.12

*=Significant at 5 % probability level,** =Significant at 1% probability level

3.4. Taxonomic Classification of the soils

The soil of the study area was classified using USDA soil taxonomy system [30] and correlated with World Reference Base. In classifying these soils, certain criteria were considered. This include the nature of the epipedon, the types of diagnostic master horizon, the clay content, the organic matter, the percentage base saturation, the presence or absence of concretion (plinthites, duripan), the soil moisture content, and the temperatures regimes and the colours of the soils i.e. the study area is classified based on the morphological and physio-chemical characteristics of all pedons. The study areas were classified up to sub-group level.

PEDON 1 AND 2

FEATURES; sandy particle size class, isohyperthermic temperature regime, Endo horizon, ustic moisture regime, very high saturation in all the pedons (BS>90%), evidence of clay illuviation, minimum thickness of the surface horizon is 20cm

Order; Alfisols

Sub-order; Ulstalfs

Great group; Haplustalfs

Sub group; Typical Haplustalf

PEDON 3

FEATURES; loamy sand throughout layer extending from the mineral soils surfaces of the kandic horizon at the depth of 68cm, ustic soil moisture regime, very high BS>90% in all pedons evidence of clay illuviation.

Order	Alfisols
Sub-order	Ustalfs
Great group	kandiustalfs
Sub-group	Arenickandiustalfs (Hypereuticlixisels)

4. CONCLUSION

This study was designed to determine the characterization and classification of soils along river Donga in Donga local government area of Taraba State. Three profile pits were dug on the flat terrain for the physio-chemical properties of the soils.the pits were described and samples were collected for routine laboratory analysis for the selected physio-chemicals properties. Data collected were analyzed statistically using analysis of variance (ANOVA)

The result of the laboratory analysis of the physical and chemical properties indicated that particle size distribution of sand particle dominated other fraction of fine earth materials. This can be attributed to the parent materials that gave rise to the soil.*B.D,PO.The pH (H2O) was slightly acidic in reaction in all the pedons studied (6.44, 5.82 and 5.67). The organic carbon content ranges from very low to low compared to the maximum level (5%) for tropical soils. Available phosphorus obtained exceeded the critical limits of 8.0 to >18mg/kg, which indicates that the available phosphorus were high. The exchangeable bases (Ca, Mg, K & Na) as indicated in the table 3 that Ca, Mg, K & Na were low in all the pedons studied. The results obtained from analyzed profile samples showed that percentage (%) base saturation values for all the pedons were high. The Correlation was done to determine non-significant and significant values among soil physio-chemical properties studied at 5% and 1% probability level. The correlations amongsoil physico-chemical properties studied are mostly negatively correlated.

However, after the profile description and examination of the soil properties of the study area. The soils were classified using USDA soil taxonomy (2014). There should be a cost effective measure to enlighten the local farmers of the best land management practices to conserve and protect the fertility of the ecosystem in order to ensure food security.

REFERENCES

[1.] Akamigbo, F.O.R. (1999), influence of land use on soil properties on humid tropical agroecology of southeastern Nigeria. Agric.J.30:59-76.

[2] Bingham, F.T. (1982). Boron In: method of soil analysis; part 2 chemical and microbiology properties (2nd edition). Publisher American society of Agronomy, Inc and Soil Science of America. Inc, Madison, Wisconsin and USA. pp. 431-447.

[3] Bouyoucous,G.J (1927). The hydrometer method for mechanical analysis of soils. Soil Sci: 23; 343-353

[4] Brady, N. (1990) The nature and properties of soils. 10th Edition, Macmillan Publishing Company, Cranbury.

[5] Brady, N.C and R.R, Weil. (2014). The Nature and Properties of Soils, 14th Edition ISBN-13: 978-0132279383, ISBN-10: 013227938X

[6] Brady, N.C. and R. R. Weil.(2002). The Nature and Properties of Soils 13th edition, Pearson Prentice Hall inc. Pte.Ltd. Indian Branch, Delhi, India.pp.976.

[7] Brady, N.C. and R.R. Weil. 2005. The nature and properties of soil. 13th edition, New Jersey: Prentice-Hall, Inc. 887, 902, 905 and 960p.

[8] Bray, R. H. and L. T Kurtz (1945). Determination of total organic carbon and available forms of phosphorus in soils. Soil Sci. 59; 39-45.

[9] Chapman, H. D and Prat, P. I. (1961) Method of Analysis for Soils and water: University of California Riverside.

[10] Chapman, H.D (1965) Total Exchangeable bases In; Black C.A. (ED) Methods of soil analysis part II Am. Soc. Agronomy. Madison, WI pp 902-904.

[11] Chude, V.O, Nafiu, A.K, Togun, O.A and Abiodun,M.O (2011). Effects of NPK fertilizer on growth, dry matter production and eggplant in Southwestern Nigeria. Agriculture and Biology Journal of North America, Vol. 2(7), pp. 1117-1125

[12] Esu, I.E (2005). Soil characterization and mapping for food security. A Keynote Address at the 29th annual conf. of SSSN held at University of Nigeria, Abeokuta, from 6th to 10th Dec. 2004

[13] Eswaran, H. (1977). Soil Analysis for Soil Surveys. In: Soil Resource Inventories. A proceedings of a workshop held at Cornell University, Ithaca, USA, pp 315-324

[14] FAO/ISRIC (2006).World References Base for Soil Resources. World Soil Rep., 103. Rome 128 p

[15] Fasina, A.S., Omolayo, F.A., Ajayi, SO., and Falodun, A.A. (2007).Influence of Land Use on Soil Properties in Three Mapping Units in Southwestern Nigeria-Implications for Sustainable Soil Management.In Uyovbisere, E.O, Raji, B.A, Yusuf, A.A, Ogunwale, J.O, Aliyu, L. and Ojeniyi, S.O (Eds).Soil and water management for poverty alleviation and sustainable Environment Proceedings of the 31st annual conf. of SSSN/ABU Zaria Nig. Nov. 13th to 17th, 2006.FAO.(1969). Soil and Water Resources Survey of the Sokoto Valley, Nigeria. Final Report, Vol. 5. FAO/SF, Rome

[16] FPDD (The Federal Procurement and Distribution, 1989). Fertilizer Use and Management, Federal Ministry of Agriculture, Water Resources and Rural Development, Lagos, Nigeria. Pp. 163

[17] Grieg, J.L. (1953). Determination of available Mo of soils. N.Z.J. Sci.Tech. Sect. A-34:405-414.

[18] Gupta, U.C and Mackay, D.C. (1966).Procedure for the Determination of Exchangeable Copper & Mo in Podzol Soils. Soil sci.101:93-97.

[19] Jackson, M. C. (1958) soils chemical analysis. An advance causeUniveresity of Wisconsin U. S. A.

[20] Landon, J.R. (1984). Booker Tropical Soil Manual: A Handbook for Soil Survey and Agriculture Evaluation in the Tropics and Sub-Tropics. Longman, Harlow

[21] Lekwa, M.U., Anene, B.O. and Lekwa, G. (2004).Chemical and Morphological Soil Characteristics in Drainage Toposequence in Southeastern Nigeria. In Ojeniyi, S.O., Ano, A.O., Awasalam, D.O. and Chukwu, G.O. (Ed) Land Degradation, Agricultural Productivity and rural poverty, environmental implications proceedings of the 28th Annual Conference of the Soil Science Society of Nigeria, held at National Root Crops Research Institute, Umudike, Abia State. Nov. 2003, 4th – 7th pp. 316-322

[23] Lindsay, W.L and Norvell, W.A. (1978). Development of a DTPA soil test for Zinc, Fe, Mn& Cu. Soil Sci. Soc. Am. J. 42:421-428.

[24] Ogunkunle A.O. (2005). Soil Survey and Sustainable Land Management. Invited paper at the 29th annual conf. of SSSN held at University of Nigeria, Abeokuta, from 6th to 10th Dec. 2004

[25] Ojo-Atere, J. O., Ogunwale, J. A. &Oluwatosin, G. A. (2011). Fundamentals of Tropical Soil Science. Evans Brothers(Nigeria Publishers) Ltd. ISBN 978-978-020-976-6, Pp 101, 260, 261 & 262

[26] Okusami, T.A.; Rust, R.H.; Juo, A.S.R.(1987). Properties and classification of five soils on alluvial landforms in central Nigeria.

[27] Olaitan, S. O. and Lombin, G.(1984). Introduction to tropical soil science

[28] Onyekwere, I.N, Chukwu, G.O and Ono, A.O. (2009). Characteristics and Management of Soils of Aakamkpa area, Cross River State, Nigeria for increased cocoyam yields. Nigeria Agricultural Journal, Vol. 40 (1-2)

[29] Schoonover, J. E. and Crim, J. F. (2015). An Introduction to Soil Concepts and the Role of Soils in Watershed Management

[30] Soil Survey Staff. 2014a. Keys to Soil Taxonomy, 12th edition. U.S. Department of Agriculture, Natural Resources Conservation Service, Washington, DC.

[31] Subbiah, B.V and Asija, G.L (1956).A rapid procedure for the estimation of available nitrogen in soils. Current sci. 25:259-260

[32] Thomas, W.G and Peaslee, E.D (1973). Testing Soils for Phosphorus. Soil Testing and Plant Analysis, Soil Science Society of America, Inc. Madison, New York, USA

[33] Tomer, M.D. and Anderson, J.H (1995).Variation of Soil Water storage across a sand plain hill lope. Soil Science Society American Journal. 38;109-110.

[34] Walkey, A and I.A, Black. (1934). An examination of Degtjareff method for determining soil organic matter and a proposed modification of the chronic acid titration method. Soil sci. 37:29-37

[35] Wilding, L.P, Bouma, J. and Don, W.G (1994). Impact of Spatial Variability on Interpretive Modeling. Quantitative Modeling of Soil Forming Processes. Vol. 39, Chapter 4. 61-75

[36] Yuan, T.L (1959). Determination of exchangeable hydrogen in soils by titration method. Soil sci. 88:164-167