International Journal of Research in Engineering and Science (IJRES)
ISSN (Online): 2320-9364, ISSN (Print): 2320-9356
www.ijres.org Volume 3 Issue 5 ǁ May 2015 ǁ PP.67-73

Morphological And Physical Properties Of Four Soils Profiles Developed On Basement Complex In Southwestern Dar-Es-Salaam, Tanzania

U.K. Adamu, Jerome P. Mrema and J.J. Msaky
Department of Soil Science, Sokoine University of Agriculture Morogoro, Tanzania

ABSTRACT: The morphological and physical properties of soils were examined in Mazimbu farm Southwestern Dar-es-Salaam, Tanzania, the study was undertaken to investigate the morphological and important physical properties of the soils of Mazimbu farm. Four soil pedons were dug to represent the study area. Soil profiles were described as per FAO 2006 and soil survey staff (2010) soil profile description guidelines. Samples were collected from the four pedons according to the pedogenic horizons identified and analyzed for some physical properties. Soil colour varied from brown (7.5YR 4/2) through dark brown (7.5YR 4/4) to reddish brown (2.5YR 4/6). Soil structure varied from being weak to moderate sub angular blocky with dominant sand texture. The soil textural class was predominantly sandy clay loam/loamy sand/sand clay. The general characteristics of the soils were high sand and low silt contents. Most of the profiles had greater than 60 % sand, 20 % clay and less than 5 % silt. The bulk density (BD) values were generally low and ranged between 1.4 and 1.78 cm^{-3} with values increasing with soil depth gradually from surface to subsurface horizons. Soil moisture value generally varied from 1.42 to 5.77 % in the surface horizon and from 3.38 to 312.51 % in the subsurface horizon of all the profiles. Best soils management strategies such as crop rotation, planting cover crops, reduce overgrazing, burning and complementary use of organic and inorganic manure were suggested to improved soil condition on the farm for sustainable agricultural practice.

Key words: Soil physical properties; Pedons; Horizons; Mazimbu

I. INTRODUCTION

Basement complex rocks are principally composed of igneous and metamorphic rocks (such as granites, gneisses, quartzites, migmatites, schist) and the metamorphosed derivatives of ancient sediments (Maniyunda *et al*., 2014). Nature of parent material is said to profoundly influence development and characteristics of soils (Brady and Weil, 2005). In small regions of uniform climate, the nature of parent material is probably more important than any other single factor in determining characteristics and productivity of a soil (Olaitan and Lombin, 1984). The type of soil formed under a particular set of environmental conditions is a function of parent material and time. The ability of any soil to supply the required quantity of plant nutrients is mostly affected by the soil genetic composition (parent material), the degree to which the parent material has been altered by the forces of weathering and the management of the soil by man. It is no gainsay, therefore, that the soil productive potentials and its resiliencies to amendment and management for sustainable agricultural production depend largely on the soil parent material (Ajiboye, 2010).

In Morogoro, there have been a substantial number of studies on the basic information on soils in the form of soil surveys and soil fertility studies for sound land use planning (Msanya *et al.,* 1991; Msanya and Mgoggo, 1993; Kilasara *et al.,* 1994). These studies have centered on a few selected areas and have not been specific to Mazimbu and some adjacent lands hence the inadequate information on these soils. The parent materials of the studied soils are different from soils of Mazimbu, which are derived from pyroxene granulite's containing plagioclase and quartz-rich veins (Moberg *et al.,* 1982).

More so, each soil type has specific properties which affect directly its functions in relation to support crop growth and performance; and hence, the need to assess the morphological and a physical property of the soils occurring in the area is of utmost important. Specifically the study's objective is to examine the soils morphological and physical properties and suggest appropriate management strategies.

II. MATERIALS AND METHODS

Study location

The study was conducted in Mazimbu village, Morogoro District, about 200 km west of Dar es-salaam, the major business town of Tanzania, covering 100 ha with an elevation ranging between 500 - 600 m above sea level. The area is located between latitudes $6^0$47'S and $37^0$37'E in Mazimbu village. The area receives the yearly annual rainfall ranging between 600 and 1200 mm (Figure 1). The long rains (masika) usually fall in February to June, followed by dry season between July and September. The short rains (vuli) occur in October

to January, but small amount of precipitation usually prevails throughout the year. On the high plateau of the Uluguru Mountains frosts are known to occur and the weather is always cool (Mwango, 2000).

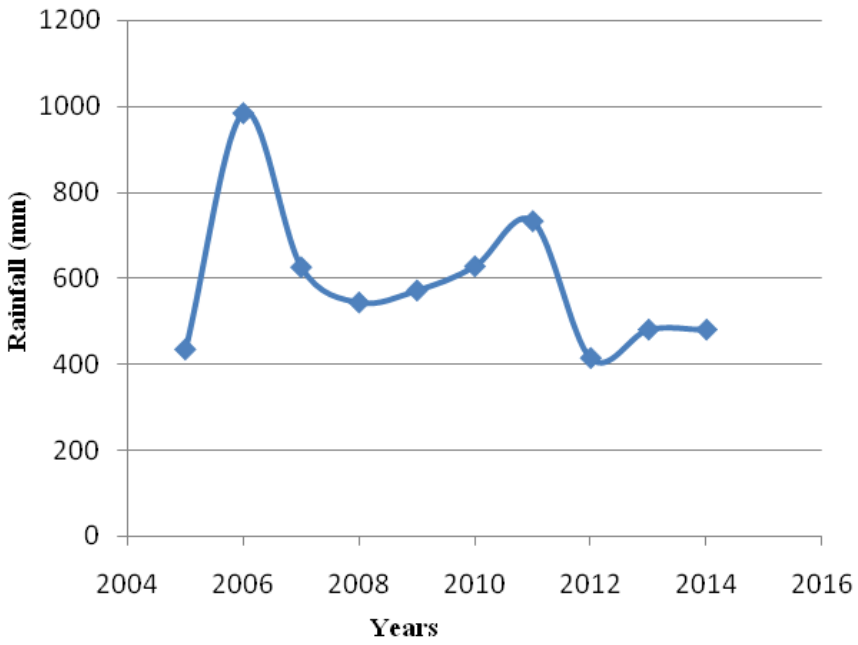

Figure 1: Yearly total rainfall of the study area for 10 years

Field Studies

The study area was soil surveyed using the grid method. Auger point investigations were carried out at 100 m intervals along traverses cut at 100 m apart on the baseline. Four profile pits were sited, dug, studied, described and sampled. Geo-referencing was done with the aid of the portable global positioning system (GPS) receiver (MODEL GARMIN 12 x L). Soil profiles were described as per FAO 2006 and soil survey staff (2010) soil profile description guidelines. The soils were sampled from four profile pits within the study area from identified horizons and carefully labeled for laboratory studies. The collected soil samples were air-dried, gently crushed and sieved to obtain the fine earth fraction (< 2mm) for laboratory investigation. Soil Samples were taken from each horizon for laboratory analysis and also 4 core samples were taken by using cores sampler and geological harmer for Bulk density and moisture characteristics.

Analysis of soil physical properties

Soil texture was determined by hydrometer method after dispersing soil with calgon 5% (NSS, 1990). Bulk density was determined according to core sample method (Blake and Hartge, 1986). Soil moisture retention characteristics were studied using sand kaolin box for low suction values and pressure membrane apparatus for higher suction values (NSS, 1990).

Data Analysis

The soil morphological and physical properties were assessed using descriptive statistics. The differences between soil physical chemical properties were subjected to analysis of variance (ANOVA).

III. RESULTS AND DISCUSSION

Soil Morphological Properties

Tables 1 to 4 give the description of the soils using a representative soil profiles in the whole study area. The soils were described and distinguished on the basis of parent materials and forms macro relief, Geological formation, slope, drainage class, vegetation, and land use, morphological and physical characteristics. Soil profiles representing the area are presented with description of each unit. (Table 1 – 4).

The profile 1 is situated at an average altitude 500 m.a.s.l, with a slope gradient range of 2 - 3% gently sloping. The parent material is colluvium derived from mafic metamorphic rocks (homblende pyroxene granullites) of the Uluguru Mountains with many macro relief and geological formation of sedimentary rocks through weathering of rocks.

Table 1: Morphological Properties of the Pedons no.1 of the studied areas

Horizon	Depth	Description	Diagnostic horizons
Ap	**0 - 27 cm:**	brown (7.5YR4/4) dry, dark brown (7.5YR 3/2) moist; Sand Loam; slightly hard dry, very friable moist, non sticky and non plastic wet; weak, fine subangular and angular blocks; many fine and few medium pores; very few course , few medium many fine and many very fine roots. Very few termite nerst, Abrupt smooth boundary to	Argic
Bt1	**27 -35 cm:**	Reddish brown (5YR4/4) dry, yellowish red (5YR4/6) moist; clay loam; hard dry, friable moist, sticky and plastic wet; moderate, fine angular, medium subangular to course sub angular and angular blocks; few fine clay cutans; many fine and few medium pores; few fine and very few very fine roots; very few termites nersts, clear smooth boundary to	Argic
Bt2	**35-77 cm:**	Red (2.5YR4/6) dry,dark reddish brown (2.5YR3/4) moist; clay loam; slightly hard dry, friable moist, sticky and plastic wet; strong ,medium to course subangular blocks; few faint clay cutans; many fine and few medium pores; very few fine and very fine roots; very few termite nerst, diffuse smooth boundary to	Argic
Bt3	**77-120 cm:**	red (2.5YR4/6) dry, reddish brown (2.5YR4/4) moist; clay loam; slifgtly hard, very friable moist, slightly sticky and slightly plastic wet; strong medium to course sub angular blocks,; many fine and few medium pores, few faint clay cutans; few medium continous quartzts and feldsperars, very few fine and very fine roots. diffuse and smooth boundary to Bt4	
Bt4	**120 -167++ ,**	red (2.5YR4/8) dry, red (2.5YR4/6) moist; clay loam; hard, friable moist, slightly sticky and slightly plastic wet; strong medium sub angular blocks,; many fine pores, few fine and medium faint clay cutans.	

Table 2: Morphological Properties of the Pedons no.2 of the studied areas

Orizon	Depth	Description	Diagnostic horizons
Ap	**0 - 46 cm:**	Ap brown (7YR4/2) dry, brown (7YR 3/2) moist; Sandy; soft dry, very friable moist, non sticky and non plastic wet; weak, fine subangular and angular blocks; few fine and many medium pores; very few course , few medium many fine and few very fine roots. Very few termite nerst, clear smooth boundary to	
Bt1	**46 -120 cm:**	brown (7.5YR5/4) dry, brown (7.5YR4/4) moist; many medium to fine bright scatter reddish.: sandy ; hard dry, very friable moist, non sticky and non plastic wet; weak (soft), few distinct and fine clay cuttans; many fine and common medium pores; very few medium, few fine and very few very fine roots; very few cracks, clear smooth boundary to	Argic
Bt2	**120-162++ cm:**	light brown (7.5YR6/4) dry, brown (7.5YR5/4) moist; many medium to fine slightly bright scatter reddish to grey mottles. sand clay; hard dry, friable moist, slightly sticky and slightly plastic wet; strong , few fine, medium to course subangular blocks; many fine and few medium pores; very few fine and very few medium roots;	Argic

All the four profiles have surface soils of the moderately to well drained. The natural vegetation includes natural grasses, Acacia Eucarlyptus spp and shrubs with a land use systems embraces maize production, human

influence (cultivation and deforestation) and grazing. There were no sealing deposition and runoff problems with very slight sheet erosion. hyperthermic and ustic soil temperature and soil moisture regime in all the soils pedons.

The profiles 2, 3 and 4 are situated at an average altitude of 509, 522 and 521 m.a.s.l., with approximately 200cm++ modified ground water level. The variations in slope form have hard significant influences on characteristics and distribution of soils.

Table 3: Morphological Properties of the Pedons no.3 of the studied areas

Horizon	Depth	DescriptioN	Diagnostic horizons
Ap	**0 - 19 cm:**	brown (7.5YR4/3) dry, brown (7.5YR 4/2) moist; Sand Loam; slightly hard dry, very friable moist, non sticky and non plastic wet; weak, fine subangular and angular blocks; very few fine clay cutans, few fine and many medium pores; very few course , very few medium, common fine and very few very fine roots. Very few termite nerst, Diffuse smooth boundary to	Argic
Bt1	**19 -40 cm:**	brown (7.5YR4/3) dry, brown (7.5YR4/2) moist; sandy loam; slightlyhard dry, friable moist, non sticky and non plastic wet; moderate, fine and medium sub angular and angular blocks; very few fine clay cutans; many fine and few medium pores; very few medium, very few fine and very fine roots; clear smooth boundary to	Argic
Bt2	**40-100 cm:**	Redish brown (5YR4/4) dry, reddish brown (5YR4/3) moist; sandy clay; hard dry, friable moist, non sticky and non plastic wet; moderate , fine to medium subangular blocks; few fine faint clay cutans; many fine and very few medium pores; very few medium and fine roots; very few termite nerst, diffuse smooth boundary to	Argic
Bt3	**100-175++ cm:**	Yellowish red (5YR4/6) dry, reddish brown (5YR4/3) moist; sandy clay ; very hard, friable moist, slightly sticky and slightly plastic wet; moderate fine, medium and course sub angular and blocks,; many fine and very few medium pores, few faint clay cutans; few fine and very fine roots.: very few tremite nersts	

Table 4: Morphological Properties of the Pedons no.4 of the studied areas

Horizon	Depth	Description	Diagnostic horizons
Ap	**0 - 38 cm:**	brown (7.5YR5/3) dry, brown (7.5YR 4/2) moist; Sandy; soft dry, very friable moist, non sticky and non plastic wet; weak, fine subangular and angular blocks; very few fine and many medium pores; few medium,few fine , few very fine roots.Clear smooth boundary to	
Bt1	**38 -79 cm:**	Bt1 Light brown (7.5YR6/4) dry, brown (7.5YR5/4) moist; common fine bright spot reddish mottles, sandy; slightly hard dry, very friable moist, non sticky and non plastic wet; weak, fine angular and sub angular blocks; very few fine and many medium pores; few fine, few medium and very few very fine roots; very few termites nersts, clear smooth boundary to	Argic
Bt2	**Bt2 79-138 cm:**	Light brown (7.5YR6/4) dry, brown (7.5YR5/3) moist; sandy; hard dry, slightly friable moist, non sticky and non plastic wet; moderate ,medium to course subangular blocks; very few fine faint clay cutans; many fine and few medium pores; very few fine and very fine roots; very few termite nerst, diffuse smooth boundary to	Argic
Bt3	**138-161++ cm:**	Pink (7.5YR7/4) dry, light brown (7.5YR6/4) moist; sandy; hard dry, slightly friable moist, slightly sticky and non plastic wet; moderate medium to course sub angular blocks,; many fine and few medium pores,; very few fine and medium roots.	

Soil Physical Properties

The physical properties of the soils are presented in Table 6. The data shows that the surface horizons of all pedons have low clay content (<10 % to < 40 %) and high sand fractions (>60 % -> 90 %). Pedon 3 had high clay content in the Bt1 horizon (26.12 %) which increases with depth to 54.12 % in the Bt3 horizon. The sand fraction increases with depth from surface to subsurface horizons in all the pedons.

The soil textural class was predominantly sandy clay loam/loamy sand/sand clay. The general characteristics of the soils were high sand and low silt contents. Most of the profiles had greater than 60 % sand, 20 % clay and less than 5 % silt. The sandy nature of these soils could be attributed to the nature of parent materials. Lekwa(1992) also reported similar findings in soil of Kano Nigeria. Sand fraction appears to be the dominant size in the surface horizons in all profiles, while silt and clay contents are low and medium. This is in the line with Okanny *et al*. (1999) and Ayolagha and Onuegbu (2002) when stated that the levee crest and levee slopes were dominantly sandy, which the flood plains and back swamps were dominantly clay in textures in their study of soil in Rivers State Nigeria.

The bulk density (BD) values were generally low and ranged between 1.4 and 1.78 cm^{-3} with values increasing with soil depth gradually from surface to subsurface horizons. The low BD indicated that, the soils were non-compacted and its increase with soil depth could be attributed to decrease in organic matter content from surface to subsurface horizons. Soil moisture value generally varied from 1.42 to 5.77 % in the surface horizon and from 3.38 to 312.51 % in the subsurface horizon of all the profiles.

Table5: Some Physical Properties of Soils of the studied areas

		% Particle Size Distribution						
Horizons	**Depth**	**Sand**	**Silt**	**Clay**	**Texture**	**BD(g/cc)**	**Moisture(%)**	
				Profile- MZB 1				
AP	0-27	90.24	1.64	8.12	Sandy	____	_____	
Bt1	27-35	74.24	1.64	24.12	Sandy clay loam	1.56	2.68	
Bt2	35-77	70.24	1.64	28.12	Sandy clay loam	1.52	6.06	
Bt3	77-120	70.24	1.64	28.12	Sandy clay loam	1.55	4.06	
Bt4	120-16	268.24	1.64	30.12	Sandy clay loam	____	_____	
Means		**74.64**	**1.64**	**23.72**			**1.54**	**4.27**
SD		**8.99**	**0.01**	**8.99**			**0.02**	**1.70**

				Profile- MZB 2				
Ap	0-46	84.24	3.64	12.12	Loamy sand		1.64	5.77
Bt1	46-120	74.24	1.64	24.12	Sandy clay loam	1.66	7.17	
Bt2	120-162 60.24	1.64	38.12	Sandy clay		1.64	7.28	
Means		**72.90**	**2.31**	**24.79**			**1.66**	**6.74**
SD		**9.84**	**0.94**	**10.62**			**0.02**	**0.69**
				Profile- MZB 3				
Ap	0-19	86.24	1.64	12.12	Loamy sand		1.54	2.99
Bt1	19-40	72.12	1.64	26.12	Sandy clay loam	_____	____	
Bt2	40-100	54.24	1.64	44.12	Sandy clay		1.54	9.45
Bt3	100-175 44.24	1.64	54.12	Clay		1.51	12.51	
Means		**64.21**	**1.64**	**34.12**			**1.52**	**8.32**
SD		**18.67**	**0.01**	**18.69**			**0.02**	**4.86**
				Profile- MZB 4				
Ap	0-38	86.24	5.64	8.12	Loamy		1.47	1.42
Bt1	38-79	82.24	1.64	16.12	Sandy loam		1.50	3.38
Bt2	79-138	62.24	3.64	34.12	Sandy clay loam	1.78	6.4	
Bt3	138-161 70.64	1.64	28.12	Sandy clay loam	____	____		
Means		**75.34**	**3.14**	**21.12**			**1.58**	**3.73**
SD		**10.96**	**1.91**	**11.70**			**0.17**	**2.51**

Soil Management Strategy

The major problems with the soil morphological and physical properties investigated were weak structure and inadequate moisture retention capacity with low infiltration in some areas. Based on these limitations therefore, it is suggested that, the best soils management practices such as crop rotation, planting cover crops, reduce overgrazing, burning and complementary use of organic and inorganic manure should be determined on the farm to improved soil productivity.

IV. CONCLUSSION

The soils were described and distinguished on the basis of parent materials and forms macro relief, Geological formation, slope, drainage class, vegetation, and land use, morphological and physical characteristics. Soil colour varied from brown (7.5YR 4/2) through dark brown (7.5YR 4/4) to reddish brown (2.5YR 4/6). Soil structure varied from being weak to moderate sub angular blocky with dominant sand texture. The soil textural class was predominantly sandy clay loam/loamy sand/sand clay. The general characteristics of the soils were high sand and low silt contents. Most of the profiles had greater than 60 % sand, 20 % clay and less than 5 % silt. The bulk density (BD) values were generally low and ranged between 1.4 and 1.78 cm^{-3} with values increasing with soil depth gradually from surface to subsurface horizons. Soil moisture value generally varied from 1.42 to 5.77 % in the surface horizon and from 3.38 to 312.51 % in the subsurface horizon of all the profiles. Best soils management strategies such as crop rotation, planting cover crops, reduce overgrazing, burning and complementary use of organic and inorganic manure were suggested to improved soil condition on the farm for sustainable agricultural practice.

REFERENCES

[1] Ajiboye, G.A. and Ogunwale, I.A. (2010). Characteristics and Classification of soils Developed Over Talc at Ejiba, Kogi State, Nigeria. *Nigerian Journal of Soil Science volume* 20 (1), pp 1-14.

[2] Ayolagha, G.A. and Onuegbu, B.A. (2002) *Soils of Rivers State in land and people of Rivers State Centrak Niger Delta.* (Alagoa E.J ed.), Onyoma publication, Choba, port Harcour. pp 19 - 42.

[3] Blake, G.R. and Hartge, K.H. (1986). Bulk density in Klute (eds). *Method of Soil Analysis, Part 1: Physical and Mineralogical Methods.* 2nd Ed. ASA, SSSA. Madison, WI. PP377-382.

[4] Brady, N.C. and Weil, R.C. (2005). *The Nature and Properties of Soils.* Thirteenth Edition. Pearson Printice-Hall Inc. India. PP 881

[5] Food and Agriculture Organization of the United Nations (FAO)./IUSS (2006). *Guidelines for soil description*. 4th edition. rome.

[6] Kilasara, M., Magoggo, J.P. and Msanya, B.M. (1994).Land resource management in Tanzania. In: Tarimo,A.J.P., D.F. Rutatora and A.Z. Mattee (editors). Towards Developing a Programme Research fo rthe Faculty of Agriculture to the Year *2000*.Proceedings of the Faculty of Agriculture Research Workshop held at the Institute of Continuing Education, Sokoine University of Agriculture, Tanzania 21st - 23rd March 1993, Morogoro,Tanzania.

[7] Lekwa, G. (1992). *Characteristic and Classification of Soil Toposequence of Kano State.*Nigeria Soil Science. pp73 - 84.

[8] Maniyunda, L.M., Raji, B.A., Odunze, A.C. and Malgwi, W.B. (2014). Morphological and Physical Properties of Soils on Basement Complex in Northern Guinea Savanna of Nigeria. *Nigerian Journal of Soil Science* **24** (1): 36-50

[9] Moberg, J.P., Msanya, B.M. and Kilasara, M. (1982).Pedological and edaphological properties of thesoils of two soil associations in the Morogoro Area, Tanzania. *Tropical Agriculture. (Trinidad)* 59(2):139-148.

[10] Msanya, B.M., Msaky, J.J., Takamura, Y.T. and Araki, S.(1991). Land use and land evaluation systems research in Tanzania. A project proposal submitted to the Japan International Cooperation Agency (JICA), Tokyo Office, Japan.

[11] Msanya, B.M. and Magoggo, J.P. (1993). Review of Soil Surveys (Soil Resource Inventories) inTanzania. Ecology and Development Programme, The Agricultural University of Norway, ISSN 0804-2144, A0s, Norway.

[12] Mwango, S.B. (2000). automated land evaluation for alternative uses in south western part of the uluguru mountains in morogoro rural district, Tanzania Disertation for Award of M.Sc. Degree at Sokoine University of A griculture, Morogoro, Tanzania, pp1 – 4.

[13] NSS (1990). Laboratory Procedures for routine soil analysis, 3rd ed. Ministry of Agriculture and Livestock ,Development, National soil service (NSS). ARI. Mlingano.

[14] Okanny, I.P., Ayolagha, G.A. and Dickson, A.A. (1999). Geology and Soils of Bayelsa State (Central Niger Delta) in land and people of Bayelsa State. Alagoa, E.J (ed). Onyoma publication port Hacourt.

[15] Olaitan, S.O. and Lombin, G. (1984). *Introduction to Tropical Soil Science.* Macmillan Publisherrs, London. Pp126

[16] Soil survey staff, (2010). keys to soil taxonomy, 11th (Ed). Basic system of soil classification for making and interpreting soil survey Natural Resource Conservation Services Agricultural Dept., soil survey Div, Washington D.C. USA.