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# Classification of Some Valley Bottom Soils in University of Ibadan

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**Abstract:** Wetland soils are very abundant in Nigeria, but due to poor understanding of their nature and properties, there is underutilization of these soils in Nigeria. Therefore, a detailed survey was carried out to classify some wetland soils in the Valley bottom of the University of Ibadan. Soil survey was conducted using rigid grid method; soil samples collected from genetic horizons were subjected to laboratory analysis using standard procedure. The soils were classified using the local system (Smyth and Montgomery 1962) at the lower level, while at the higher level using USDA Soil Taxonomy (2010) Soil Survey Staff, and World Reference Base for soil Resources (WRB, 2006) systems. Three soil types were identified from the study area. These include Jago Series (Smyth and Montgomery 1962); Fluventic Eutrudept (USDA Soil Taxonomy, 2010), Fluvic Gleysol (WRB 2006); Matako Series (Smyth and Montgomery 1962), Fluventic Eutrudept (USDA Soil Taxonomy, 2010), Fluvic Cambisol “Eutric” (WRB 2006); and Matako series “browner variation” (Smyth and Montgomery 1962), Fluventic Eutrudept(USDA Soil Taxonomy 2010), Fluvic Cambisol “chromic” (WRB 2006);. The soils are young, poorly drained and susceptible to flooding. Drainage and good soil fertility programme will be useful in managing the soils for increased productivity and crop yield.
**Keywords:** Soil classification, Valley bottom, Wetlands.

## INTRODUCTION

Increasing human population and their need for food, clothing and shelter has added to the already existing pressure on land. Although wet lands are abundant in Nigeria, their utilization has been limited by poor knowledge of the nature and properties of such soil [1]. Consequently, they are generally underutilized for agriculture [2]. Such lands are usually abandoned due to problems such as drainage, susceptibility to flooding and poor soil characteristics. However, Okediran [3] highlighted the advantages of wetland soils as having high nutrient and fertility status due to their physiographic position that allows deposition of materials from the upper slope. In terms of fertility, such soils are usually very fertile but their productivity may be limited by poor drainage. The main constraint to the productivity of the soils is anaerobic condition due to poor drainage and poor workability, salinity and acidity [4-6]. According to Esu [7], a good knowledge of the soil properties in a given environment, their characterization, classification and evaluation are necessary tools` for redressing crop requirement and soil quality. Due to the great demands, placed on wet land soils to meet the need for food and fibre of a rapidly growing population, which requires intensifying cultivation to increase crop yield per unit area, to minimize damages to the environment, the land needs to be properly classified to provides a concise and systematic method for designating various types of soils according to their proposed kind of use for agricultural development. Therefore, this study was carried out to classify some valley bottom soils in the University of Ibadan to enhance proper understanding of their properties for sustainable land use.

## MATERIALS AND METHODS

### Description of the experimental site

The experimental site was located in the University of Ibadan, Organic Agriculture farm, Practical Year Training Plot (PYTP), covering about 1.2 hectares (ha), which lies on latitude 7˚ 27’ 22.2’’N to 7˚ 27’ 26.2’’N and longitude 3˚ 53 ' 32.3’’ E to 3˚ 53 ' 38.5’’ E (Fig-1). The area is generally low lying with elevation ranging approximately between 188m and 195m above sea level. “As revealed by the climatic data obtained from the Department of Meteorological service, Samonda, over the past ten years”, (2000 to 2010) the climate is sub-humid tropical, characterized by a long rainy season starts from March and ends October, with a characteristic short dry spell from end of July to Early September known as “August break”. The month of June and September marks the peak of the rainy season (a bimodal rainfall distribution). There was a considerable variation in rainfall from year to year. The dry period starts in November and ends in February/March with little or no rainfall with January being the driest period. The amount of rainfall determines to a great extent the moisture content of the soils and water available to plants and invariably affects the types of crop that are grown, it also influences the relative humidity of the area. Equally, the temperature experience in the region is higher all year round and fairly uniform, the month of March had the highest means of temperature while month of August was the coldest. Temperature affects the rate of water loss via evapotranspiration and it is affected by relative humidity and sunshine.

The geology is made up of crystalline Basement Complex rocks, mainly magmatite with some granite, gneiss and schist [8]. In addition to the gneisses are many varieties of simple ortho-gnesis. There are no visible rock out-crops on any part of the location.

A field studies was first carried out to know the major features of the terrain in terms of the vegetation, topography and other biophysical features of the landscape. A rigid grid soil survey was then undertaken for the purpose of identification and mapping the soils of the area. A series of parallel traverse lines (10m x 10m) were set out and observation were made at every 10m intervals. Identification of kinds of soils was done using Dutch auger at every 15cm depth intervals down to 120 - 130cm. At each interval the properties examined were mainly soil profile characteristics. The soils were separated based on the three criteria, which are texture, color and inclusions. Areas with similar kinds of soil were put under one mapping unit and areas with dissimilar kind of soil were further examined for accurate location of the boundary between them.

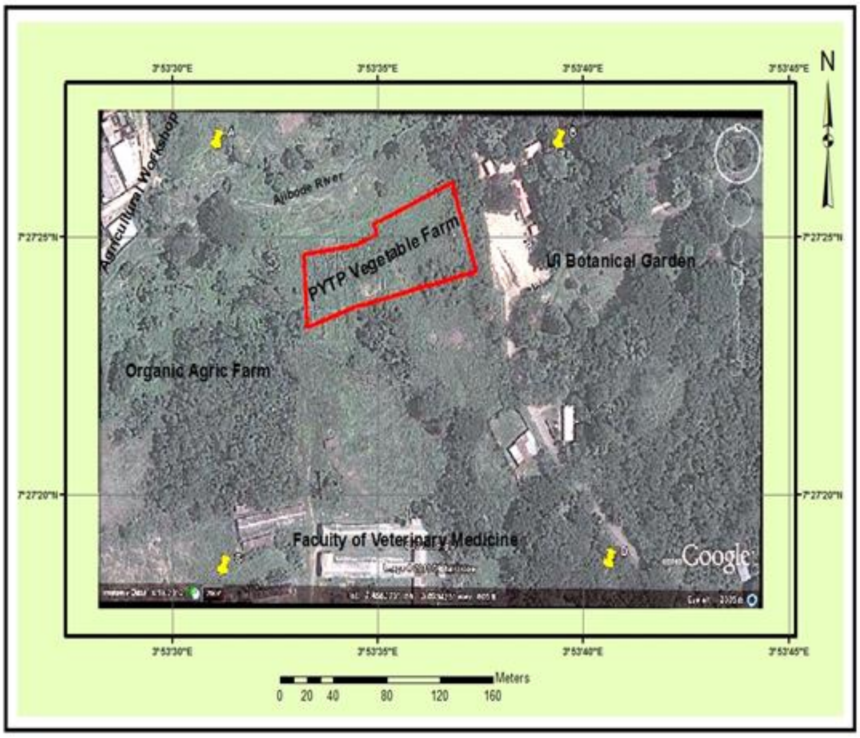


**Fig-1: Aerial View of the study site (Google Earth, 2013)**

Three different kinds of soil were identified and representative profile pits were dug, measuring 1m x 1.5m x 2m with the depth varying depending on the peculiarity of the water table, for the purpose of characterization, sampling and classification in accordance with FAO [9].

### Soil characterization and laboratory analysis

The soils morphological properties were characterized by demarcating each profile into different horizons. The depth of each horizon was measured and described using FAO [9]. Soil samples collected from experimental field were brought to the laboratory for both physical and chemical analyses.

## PROCEDURE FOR THE ANALYSIS

Particle size analysis was carried out by the Bouyoucos [10] hydrometer method as cited in Klute [11]. Bulk density was determined according to [12]**.** Saturated hydraulic conductivity was determined by the method of [13]. Exchangeable acidity was determined by the KCl extraction method [14]. Organic carbon was determined by the dichromate wet oxidation [15] method. Soil pH was determined using pH meter with glass electrode in 1:2 (soil: water). The Micro-Kjehldal method [16] was used to determine Total Nitrogen. Available Phosphorous was determined according to Mehlich 3 (pH 7.0) method [17]. Exchangeable cations were determined using [17]. The Effective Cation Exchange Capacity (ECEC) was taken as the sum of exchangeable cations and the exchangeable acidity [18].The percentage base saturation was calculated as follows:

$$\% \text{ Base saturation} = \frac{(Ca^{2+} + Mg^{2+} + K^{+} + Na)}{ECEC} \times 100$$

### Statistical analysis

The following statistical analyses were carried out on the physical and chemical analysis data generated from field and laboratory investigations.

i. Mean (x)
The mean value of the properties for each pedon was calculated as the average value of the numbers of the population per soil pit.

$$X = \frac{\text{Sum of all individuals}}{\text{Total numbers of individual}}$$

ii. Standard Deviation (SD)
This is a statistical measure of dispersion. It is the square root of variance.

$SD = \sqrt{S^2}$, $S^2$ =variance

iii. Co-efficient of Variance (CV) (%)
The variability of each property or non-uniformity was determined using

$$CV (\%) = \frac{SD}{X} \times \frac{100}{1}$$

### Classification of the soil

Classification of the soil into higher category was according to USDA Soil Survey Staff [19] and World Reference Base for Soil Resources [20] formerly FAO/UNESCO Soil map of world legend, while soils at the lower levels (series), were classified using Smyth and Montgomery [21] and Okusami [22].

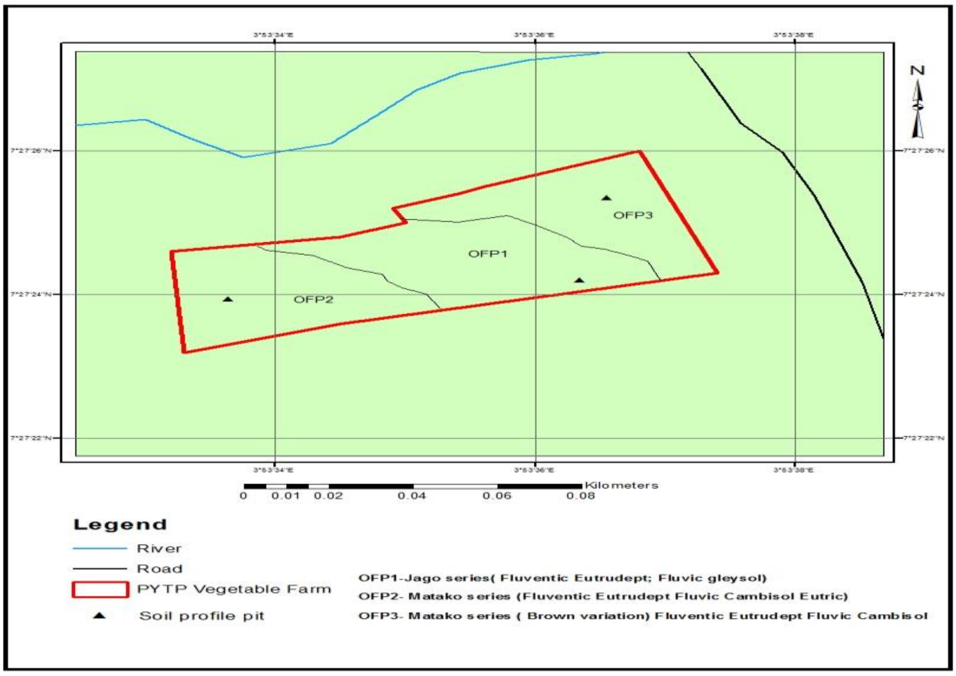


**Fig-2: Soil Map of the study site**

## RESULTS AND DICUSSION

### SOIL CLASSIFICATION

The taxonomic classification of the soils are presented in Table-1. The soil were classified as Jago Series [21]; Fluventic Eutrudept [19], Fluvic Gleysol [23]; Matako Series [21], Fluventic Eutrudept [19], Fluvic Cambisol "Eutric" [23] and Matako series "browner variation" [21], Fluventic Eutrudept [24], Fluvic Cambisol "chromic" [23]. The three soils have fluventic properties with the Matako series having cambic horizons.

**Table-1: Classification and distribution of the soils**

| Profile/ Pedon | USDA [24] | WRB [23] | Local Classification (Series) | Coverage (Ha) | Area (%) | Characteristic [21] |
|---|---|---|---|---|---|---|
| OFP1 | Fluventic Eutrudept | Fluvic Gleysol | Jago | 0.48 | 40 | Sandy Clayey, pale greyish, gley with mottles. |
| OFP2 | Fluventic Haplaustept | Fluvic Cambisol | Matako (Normal) | 0.41 | 34 | Sandy, pale yellowish brown, gley mottling is present. |
| OFP3 | Fluventic Eutrudept | Fluvic Cambisol | Matako (Browner variation) | 0.31 | 26 | it differs from the Normal variation by having a browner color (pale greyish brown) suggesting less severe leaching, |

**Table-2: Physico-Chemical properties of the soils of the study site.**

| Name | HD | Depth | Ph | OC | OM | TN | Av. P | Ca | Mg | Na | K | EA | ECEC | BS | FE | SAND | SILT | CLAY | TC | BD | HC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $H_20$ | g/kg | | | mg/kg | cmol/kg | | | | | | % | mg/kg | | g/kg | | | ($g/cm^3$) | (cm/hr) |
| (OFP1) | A1 | 0 – 29 | 5.9 | 20.1 | 34.7 | 1.8 | 43 | 23.1 | 1.1 | 1.2 | 2 | 0.4 | 27.8 | 98.6 | 524.0 | 790.4 | 90.6 | 110.0 | SL | 1.57 | 18.20 |
| JAGO | A2g | 29 – 45 | 6.5 | 3.7 | 6.4 | 0.3 | 31 | 20.9 | 1.2 | 1.4 | 0.8 | 0.4 | 24.7 | 98.4 | 278.0 | 730.4 | 120.0 | 140.6 | SL | 1.52 | 16.81 |
| SERIES | A3g | 45 – 88 | 6.5 | 2.5 | 4.5 | 0.2 | 22 | 21.6 | 2.6 | 2.1 | 0.9 | 0.4 | 27.6 | 98.6 | 214.0 | 670.4 | 40.0 | 280.6 | SCL | 1.41 | 12.50 |
| | ABc | 88 – 132 | 6.8 | 8.6 | 14.9 | 0.3 | 22 | 22.6 | 5.2 | 1.6 | 0.9 | 0.4 | 30.7 | 98.7 | 105.6 | 710.4 | 40.0 | 240.6 | SCL | 1.44 | 11.20 |
| | Bgc | 132 – 164 | 6.9 | 6.9 | 12.1 | 0.3 | 20 | 28.8 | 4.3 | 1.9 | 0.9 | 0.2 | 36.1 | 99.4 | 99.00 | 630.4 | 80.0 | 280.6 | SCL | 1.40 | 10.10 |
| | Bg | 164 – 180 | 6.9 | 7.4 | 12.8 | 0.1 | 27 | 28.5 | 4.9 | 1.4 | 0.8 | 0.2 | 35.8 | 99.4 | 75.00 | 710.4 | 20.0 | 260.6 | SCL | 1.43 | 10.00 |
| (OFP2) | | | | | | | | | | | | | | | | | | | | | |
| MATAKO | A1 | 0 – 22 | 5.2 | 32.3 | 55.7 | 0.9 | 32 | 21.2 | 1.6 | 1.0 | 0.7 | 0.4 | 24.9 | 98.4 | 106.5 | 870.4 | 20.0 | 100.6 | LS | 1.59 | 22.10 |
| SERIES | A2 | 22 – 50 | 6 | 18.9 | 32.5 | 1.1 | 29 | 18.3 | 0.9 | 1.3 | 0.8 | 0.2 | 21.5 | 99 | 465.0 | 770.4 | 80.0 | 140.6 | SL | 1.53 | 18.20 |
| | ABgc | 50 – 69 | 6.2 | 16.3 | 28.1 | 0.3 | 31 | 21.9 | 6.5 | 1.2 | 0.7 | 0.2 | 30.5 | 99.3 | 506.0 | 650.4 | 200.0 | 140.6 | SL | 1.50 | 17.90 |
| | B1g | 69 – 105 | 7.2 | 13.6 | 23.4 | 0.4 | 19 | 18.3 | 0.8 | 10.7 | 0.6 | 0.4 | 30.8 | 98.7 | 870.0 | 830.4 | 40.0 | 120.6 | LS | 1.56 | 16.40 |
| | B2g | 105 – 170 | 7.1 | 0.8 | 1.42 | 0.3 | 23 | 22.7 | 4.9 | 1.5 | 0.7 | 0.4 | 30.2 | 98.7 | 176.0 | 610.4 | 60.0 | 320.6 | SCL | 1.38 | 16.00 |
| (OFP3) | | | | | | | | | | | | | | | | | | | | | |
| MATAKO | A1 | 0 – 20 | 5.6 | 45.2 | 77.9 | 2.5 | 38 | 30.2 | 2.5 | 11.3 | 1 | 0.6 | 45.6 | 98.7 | 546.06 | 250.4 | 560.0 | 180.6 | SIL | 1.39 | 28.33 |
| | A2 | 20 – 40 | 5.6 | 28.4 | 48.9 | 1.9 | 34 | 21.2 | 1.5 | 1.4 | 0.8 | 0.4 | 25.3 | 98.4 | 529.0 | 490.4 | 340.0 | 160.6 | L | 1.45 | 22.46 |
| SERIES | ABg | 40 - 65 | 6.3 | 7.8 | 13.5 | 0.6 | 30 | 23.5 | 1.4 | 1.4 | 1.7 | 0.6 | 28.6 | 97.9 | 202.0 | 770.4 | 160.0 | 60.6 | LS | 1.64 | 16.33 |
| "Brown | Bg | 65 – 90 | 6.5 | 7.8 | 13.5 | 0.2 | 22 | 20.9 | 1.1 | 1.7 | 0.8 | 0.2 | 24.7 | 990 | 215.0 | 770.4 | 140.0 | 80.6 | SL | 1.60 | 16.14 |
| Variation" | B2g | 90 – 130 | 7.4 | 6.6 | 11.3 | 0.4 | 16 | 18.6 | 2.3 | 1.3 | 2.2 | 0.2 | 24.7 | 990 | 165.0 | 730.4 | 100.0 | 160.6 | SL | 1.50 | 14.42 |
| | B3 | 130 – 160 | 7.6 | 6.9 | 12.1 | 0.1 | 22 | 20.6 | 2.4 | 2 | 0.7 | 0.4 | 25.9 | 980 | 172.0 | 710.4 | 120.0 | 160.6 | SL | 1.49 | 13.31 |

Key: HD= Horizon Designation, OC= Organic Carbon, OM=Organic Matter, TN=Total Nitrogen, Av.P=Available Phosphorous, BS= Base Saturation, TC= Textural Class, BD= Bulk Density, and HC= Hydraulic Conductivity

The soils are found in the valley bottom. The properties of the soils are profoundly influenced by slope and drainage. They are usually developed from fine colluvial materials which are deposited from the soils in the upper slope [24]. Due to poor drainage, there is mottling and a characteristic pale grey colour. The soils are mostly devoid of stones and concretions. According to the lower level, the soil were classified as Jago series, Matako series and Matako Browner variation series, in accordance with Smyth and Montgomery [21] and Okusami [22] classification. At the higher level, the soilwere classified as Inceptisols [19], because they are soils that their profile just began developments, with no accumulation of clays (Table-2).

The Soils Jago and Matako Browner Variation have a Udic Moisture regime, because the soils are moist through out the year and in accordance with [25], they could be classified under the Sub order Udult. Matako normal Variation have a Ustic Moisture Regime, because the soil moisture in the area is Intermediate between Udic and Aridic, it indicates limited moisture but it is present when condition are suitable for crop growth [19], the soil is therefore classified at the suborder level as Ustept. Matako soil have Ustic moisture properties because the soil are located at the upper slope of the study area (Fig-2).

The Soils Jago and Matako Browner Variation have high Base saturation with high CEC (Table-2), with evidence of continues deposits receiving fresh material at regular intervals, and this defines that they have a Eutric subsurface horizon, and it qualifies them to be Eutrudepts meaning inceptisols having Udic Moisture regime with Eutric Properties. Matako Normal variation soil had haplic properties because the soil meets the central concepts of Inceptisols, and it has a minimum development in its horizon, and as results the soil could be classified as Haplustept, at the great group level, meaning Inceptisols having Ustic Moisture regime with Haplic Properties.

The aforementioned soils had fluventic properties, because they are alluvial soils in which there developments is prevented by repeated deposition of sediment in periodic floods, found in valleys with high organic carbon at surface and subsurface level (Table-2), as such the soils Jago and Matako Browner Variation are regarded as fluventic Eutrudept while Matako Normal series is regarded Fluventic Haplustept at the subgroup level of USDA, 2010.

At the family level they were classified at the Sandy to sandy skeletal particke size class, because of the high amount of sand particles recorded in the soils (Table-2) as contained in USDA, 2010. As such the soils are classified as:

I. Jago soil series, Sandy Skeletal fluventic Eutrudept

   Soils formed in Alluvium flood plains along streams and rivers, the content of Organic carbon, base saturation were relatively high and its irregular with depth. The soil have sandy particles across the profile [25].

II. Matako normal soil series, Sandy Skeletal fluventic Haplustept

   Soils formed in alluvium. Slopes are gentle, and coarse particles are common. The content of Organic carbon, base saturation were relatively high and its irregular with depth. The soil have sandy particles across the profile [25].

III. Matako browner variation soil series, Sandy Skeletal fluventic Eutrudept.

   Soils formed in Alluvium flood plains along streams and rivers, the content of Organic carbon, base saturation were relatively high and its irregular with depth. The soil have sandy particles across the profile [25], it is called browner variation because it differs from the Normal variation by having a browner color (pale greyish brown) suggesting less severe leaching, Smyth and Montgomery [21].

According to WRB 2006, the soil Jago is classified as Fluvic Gleysol, because they are soils of recent alluvial deposit with hydromorphic properties within the 50cm of the surface. Matako normal series and Matako Browner Variation were classified as Fulvic Cambisol because they were soils formed from alluvial deposit with evidence of developmental alteration on structural B profile. The differences between the duo soils is; the former was classified at the supplementary level as “eutric” meaning high base saturation, while the later was classified as “chromic” meaning it differs with the former with brighter color.

Jago series is classified as Fluventic Eutrudept USDA, Soil Survey Staff [19], Fluvic Gleysol [23] because of its high base saturation, having Udic moisture regime and gleic properties. Matako series is classified as Fluventic Haplaustept USDA, Soil Survey Staff [19], and Fluvic Cambisol “Eutric” [23]. It has a Ustic moisture regime with Haplic (simple, normal horizon sequence) properties. Matako series (Browner variation) posses chromic properties and was classified as Fluventic Eutrudept USDA, Soil Survey Staff [19] Fluvic Cambisol “chromic” [23].

## CONCLUSION

Three soils were identified in the study area and they were classified as Jago, Matako Series, and Matako series (browner variation) at the local level. The soils of the study area falls into the Inceptisols soils orders of the USDA Soil Survey Staff [19], Jago series is classified as Fluventic Eutrudept [19], Fluvic Gleysol [23]; Matako Series, Fluventic Eutrudept [19], Fluvic

Cambisol "Eutric" [23]; and Matako series (browner variation), Fluventic Eutrudept(USDA Soil Survey Staff, 2010)), Fluvic Cambisol "chromic" [23]. Due to the nature of the soils of valley bottom, the drainage is poor which results in mottling/gleying of soils and causes high accumulation of iron and other elements.

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