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Characterization of floodplain soils in Southern Guinea Savanna of North Central Nigeria

O.T. Ande *, K.S. Are, O.D. Adeyolanu, O.A. Ojo, A.O. Oke, A.O. Adelana, A.O. Adetayo, G.A. Oluwatosin

Institute of Agricultural Research and Training, Obafemi Awolowo University, Moor Plantation, Ibadan, Nigeria

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ABSTRACT

The study was set up to characterize floodplain soils of Southern Guinea Savanna in North Central Nigeria for sustainable land use. The flexible grid method was adopted to identify the soil units. Soil map was produced in a GIS environment, using morpho-physical and soil chemical properties. The major morphological expressions are ferrolyses and gleization. The variation in cation exchange capacity recorded (1.29–21.64 cmol kg^{-1}) could be attributed to effects of various deposits of soil regoliths from time to time. The phosphorus distribution is generally low (0.8–11.8 mg kg^{-1}) while nitrogen content is >0.15% at the surface. The major pedogenetic processes include cummilization, ferrolyses and gleization. The soil units identified were classified as Fluvaquentic Epiaquept, Aquertic Ustifluvent, Kandic Ustifluvent, and Aeric Ustipsamment. The mapping units suggest two possible management units based on texture and chemical properties. The soils are generally suitable for rice production due to epi-saturation.

1. Introduction

Nigeria spends about 365 billion naira annually importing 2 million metric tonnes of milled rice (FMARD, 2013). To reduce this capital outflows from the nation's economy, the Federal Government of Nigeria through the Agricultural Transformation Agenda (ATA) called for increased crop production by resource poor farmers through bringing more floodplains into rice production in Nigeria. A floodplain is a wide, flat plain bordering a stream which seasonally experiences periodic flooding (Andriesse, 1986); it is comprised of levees, flood basins, point bars, and ox bow lakes. These are potentially productive ecosystems (Mitsch and Gosselink, 2000) due to the frequency of inundation and duration of flooding that brings in nutrient-rich-sediments from surrounding watersheds to the floodplain. Floodplains serve as an alternative to crop production on uplands which are usually subjected to moisture stress, now compounded by climatic variability, especially the arid and semi-arid zones. Despite the potentials of floodplains to support yields of arable crops, the soil morpho-physico-chemical dynamics of most floodplain soils are not well understood, and this has limited their use and productivity. Prolonged water saturation and seasonal wetting and drying of floodplain soils affect soil chemical and morphological properties. Saturation affects the supply of oxygen to the soil, and oxidation state of important elements (Osunde et al., 2001). The oxidation state of iron, manganese and sulfur strongly affects their solubility and color, which explains the brown, gray, blue, black and yellow mottles often seen in seasonally waterlogged hydromorphic soils. Redox processes often involve production or consumption of H^+ and thus affect soil pH (De Datta, 1986). Altogether, floodplain dynamics affect the physico-chemical properties, fertility status, nutrient releases and morpho-genetic activities in the soils.

Rice is predominantly grown under wetland conditions. It is important to understand the unique properties of flooded soils for better management of fertilizers for this crop. When a soil is flooded, major chemical and electrochemical changes take place. According to De Datta (1986), the changes include: depletion of molecular oxygen; increase in pH of acid soils and decrease in pH of calcareous and sodic soils; increase in specific conductance; reduction of Fe^{3+} to Fe^{2+} and Mn^{4+} to Mn^{2+}; reduction of NO_3^- to NO_2^- and N_2/N_2O; reduction of SO_4^{2-} to SO_3^{2-}; increase in supply and availability of N, P, Si and Mo; decrease in concentrations of water-soluble Zn and Cu; generation of CO_2 and methane and reduction in toxic products such as organic acids and hydrogen sulfide. These reactions usually have profound influences on soil nutrient transformations and availability to rice grown under wetland conditions.

Rice production on floodplains in Nigeria is below the genetic capacity of the varieties grown due to lack of appropriate information for management and sustainable land use (Ande and Senjobi, 2014). There is therefore an urgent need to characterize the soils

* Corresponding author.
E-mail address: funmiande67@gmail.com (O.T. Ande).

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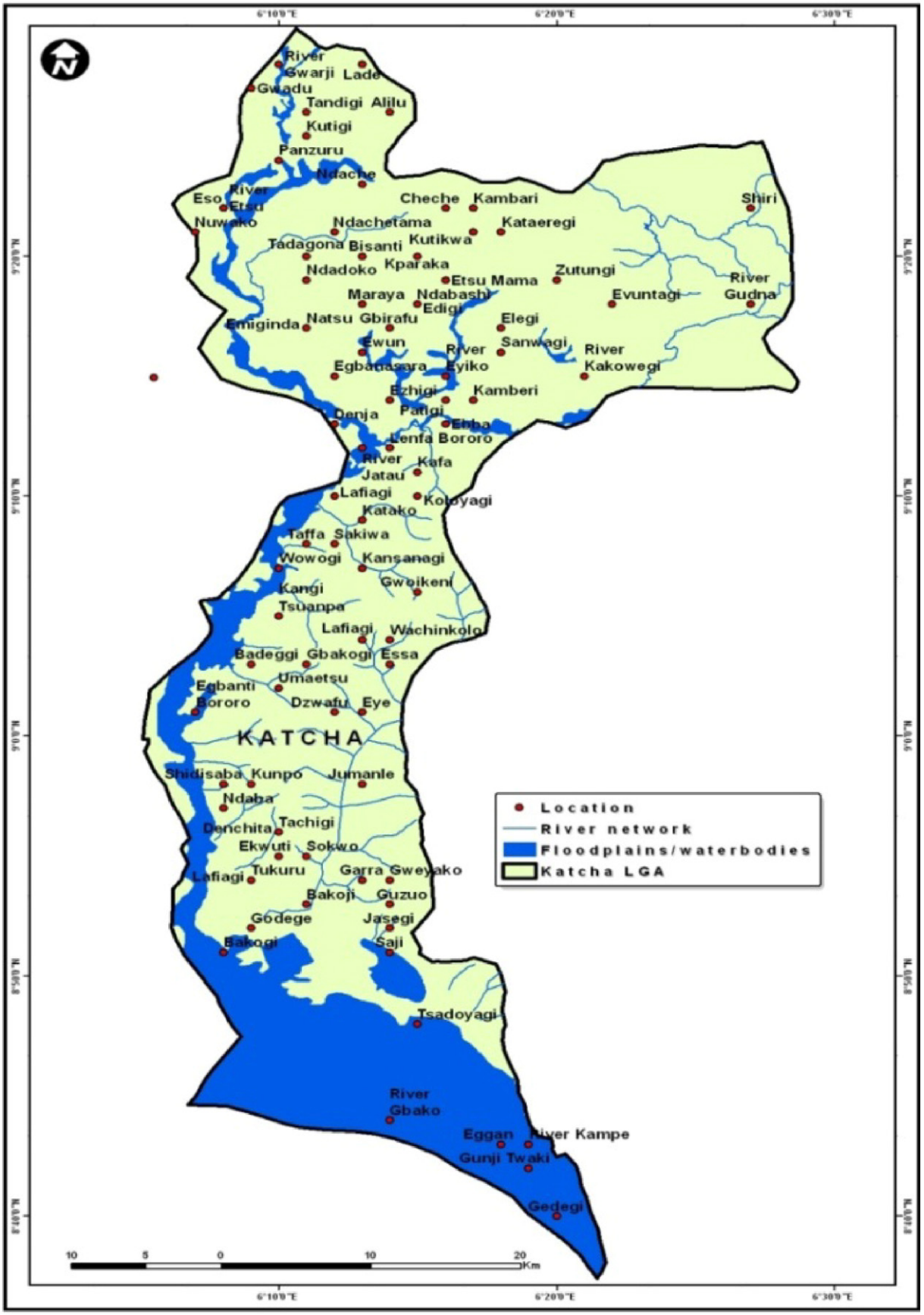

Fig. 1. Administrative map and floodplain in Southern Guinea Savanna, Katcha LGA, Nigeria.