EFFECTS OF LAND USES ON THE PROPERTIES OF SOILS FORMED ON MAKURDI SANDSTONES IN NORTH CENTRAL NIGERIA

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ABSTRACT

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This study was conducted in parts of Makurdi to determine effects of three land use practices on some physico-chemical properties. Oil palm plantation, grassland vegetation and built-up area as land use types were studied. Core and disturbed soil samples were collected from all land uses bulked and analysed for physico-chemical properties following standard laboratory methods. Result showed that bulk density, dispersion ratio, total porosity, aggregate stability, pH, soil organic matter, total nitrogen and available phosphorus significantly differed with land use types. However, oil-palm plantation had the lowest (p<0.05) bulk density, dispersion ratio and highest (p<0.05) total porosity, aggregate stability of 1.17 g cm⁻³ and soil organic carbon due to changes in soil moisture content. This study concluded that the reduction in vegetation cover results in decline the soil physico-chemical properties and therefore suggest the utilization of plantations probably in agroforestry system for sustainable soil management in the study area.

INTRODUCTION

Land use change is one of the main drivers of environmental change being a major issue of global environmental change and an important component in understanding the sequence of changes in the characteristics and the interactions of the human activities with the environment. This change influences the basic reserves of land and a variety of natural process, including the soils which are not static and hence more susceptible to change in their nutrient and moisture content. The dynamics soil nature describes the conditions of a specific soil due to land use and management practices (Karlen et al. 2003) Land use influences soil aggregation, aggregate stability and overall soil health (Castro et al. 2002; Herrick et al. 2001). Land use changes have a great influence on many soil physico-chemical properties mostly soil organic matter affecting its quality attributes and fertility. Land use practices affect the distribution and supply of soil nutrients by directly altering soil properties and by influencing biological transformations on the rooting zone (Murty et al. 2002).

Land use and use changes, are also known to be important drivers for soil redistribution, by influencing surface runoff, erosion and sedimentation process. Many researchers have reported that change of land use, implemented locally such as long term cultivation, deforestation, urbanization, or overgrazing cause significant variations in soil properties, terrestrial cycles and reduction of output and that the conversion of natural forest and plantations to other forms of land use can provoke soil erosion and lead to a reduction in soil organic matter content, loss of soil quality and modification of soil structure and its stability (Chen et al., 2001; Conant et al., 2003; Hacisalihoğlu 2007; Khormoli et al., 2009; Saraswathy et al. 2007). Land use change such as forest clearing, urbanization, cultivation and pasture introduction are known to result in changes in soil properties (Houghton et al. 1999), yet the sign and magnitude of these changes varies with cover and management (Baskin and Binkley 1998; Celik 2005). Most changes in land use affect the amount of carbon held in vegetation and soil, thereby, either in releasing carbon dioxide (a greenhouse gas) to, or removing it from the atmosphere. The greatest fluxes of carbon result from conversion of forests to open lands (and vice versa) (Houghton and Groodale, 2004). Sequestration of atmospheric CO₂ into soil and soil organic carbon dictates acquisition of the research data on equilibrium level of soil organic carbon pool under different land use and associated soil management practices and the rate of change of soil organic carbon pool with change with change in land use and management (Hao et al., 2002).

At different spatial and time scales, vegetation cover helps in protecting the soil from harsh climate conditions mostly soil erosion. The presence of dense vegetation affords the soil adequate cover thereby reducing the loss of macro and micro nutrients that are essential for plants growth and energy fluxes (Iwara et al., 2011). The conversion of dense canopy ecosystem to other forms of land cover such as grassland may decrease the stock of soil organic carbon due to changes in soil moisture and temperature regimes, and succession of plant species with differences in quantity and quality of biomass returned to the soil, which also disrupt the richness of nutrient restored to the soil. It is perhaps a known fact that soil erosion intensity and amount of nutrient element loss varies depending on the vegetation type at a particular place and time. This is so because, the rate of nutrient element
loss in both dissolved and sediment bound forms will depend on the ability of vegetation canopy to effectively intercept the direct impact of rain drops that strikes the soil surface (Iwaru, 2011). If the canopy is not dense enough or well developed, low quantity of nutrients will be returned to the soil as well as large quantities of nutrient will be removed from the soil surface during periods of heavy rain storm when the soil is saturated. Offiong et al., (2009) compared soil properties in secondary forest, a rubber plantation and soil adjoining the road in Tinapa area of Cross River State. Results indicated that the levels of organic matter, total nitrogen and cation exchange capacity were substantially higher in soils under dense vegetation than in soil adjoining the road. Urban areas have intensive human activities, and soil quality in urban areas is closely related to human health at food safety (Hu et al. 2006, 2007). In the city’s urban fringe, accelerated urbanization has led to the highly intensified use of lands in those area in recent years, resulting in significant effect on soil properties in these fringe zones (Hu et al. 2004; Pan and Zhao, 2007; Cao et al. 2007). In Makurdi, there are many land use activities which is driven by population growth yet studies are limited on the effects of land use practices on soil properties. Therefore the present study was undertaken to determine the effects of three land use types on selected physico-chemical properties in parts of Makurdi, North Central Nigeria.

MATERIALS AND METHODS

Description of Study Area: The research was conducted in parts of Makurdi. Makurdi is located in Benue State in the southern–agro-ecological zone of Nigeria. The area lies at latitude 07°45′N and longitude 08°41′E; with a mean elevation of 93 cm. Available phosphorus extracted by Bray 1 extractant (Bray and Kurtz, 1945). Soil pH was measured using a glass electrode testronic digital pH meter with a resolution of 0.01pH unit. Soil particle analysis was performed by the walkley-Black method (Nelson and Sommer, 1996). Total Nitrogen was determined by the Kjeldahl method (Brenner, 1996). Soil pH was measured using a glass electrode testronic digital pH meter with a resolution of 0.01pH unit. Available phosphorus extracted by Bray-1 extractant Bray and Kurtz, (1945). Statistical Analysis: Analysis of variance (ANOVA) was used compare the influence of the land use types on the measured soil properties in a randomized complete block design (RCBD). Significant different means were separated using least significant at 5% level of probability.

RESULTS AND DISCUSSION

Effects of land uses on soil physical properties: Table 1 showed the physical properties of the various land uses. The particle size distribution should that there was no significant difference in the textural class of the soils under the different land uses. The textural class was observed to be sandy loam in all the locations. This means that land use did not have effect on texture since texture is largely determined by parent material (Obi, 1999). The effect of land use types was statistically significant on soil density, dispersion ratio, total porosity and aggregate stability.
The lowest (p<0.05) bulk density as observed with oil-palm plantation may be attributed to the improved soil organic matter from plant residue decomposition and improved soil structure. This result is in agreement with Emadi et al (2008) and Khresat et al (2008) who reported that bulk density of surface soil was lowest in plantation soil compared to grassland vegetation because of enhanced soil organic matter. It was observed that total porosity was highest with oil-palm plantation and lowest with mechanic activities. This phenomenon may be attributed to the decomposed plant litter that may have promoted soil faunal activities and may have played a major role in the build-up and stabilization of soil structure and as a result, improved soil granulation and soil porosity as well. These findings are in agreement with Amama et al (2012) and Ceyhun (2004) who reported that soil organic matter increased vegetative cover enhanced which provides enhances. This observation is in line with Emadi et al (2008) and Khresat et al (2008) who reported that bulk density as observed with oil-palm plantation compared to other land uses may also be attributed to the enhanced soil organic matter as a result of the thick vegetative cover which may have reduced soil loss, increased infiltration and its stability. Also oil-palm plantation gave the highest aggregate stability compared to other land use types. This observation may be adduced to the enhanced soil organic matter which may have improved the soil structure and aggregation. Mbagwu and Picolo (1990) reported that increase in soil organic matter was found to increase the aggregation of acid ultisol.

Effect of land uses on soil chemical Properties

Table 2 showed the effects of land use types on soil chemical properties. Soil pH was significantly affected by all the land use types and there were high mean values in oil-palm plantation as compared to the other land use types. This attribute may be a reflection of the enhanced soil organic matter as observed with oil-palm plantation Woomer et al., (1994) reported that increase in soil organic matter increase the capacity of soils to buffer changes in pH. However, soil organic matters, total nitrogen, and available phosphorus significantly differed with all land use types. Oil-palm plantation had the highest (P<0.05) soil organic matter, total nitrogen at available phosphorus compared to other land use types. This is attributable to the increase in plant density and cover which provides large amount of biomass that decomposes to enhance the soil organic matter. These observations is in line with the findings of Robertson et al (2004) who reported that soil organic matter serves as a reservoir of many plant nutrients.

CONCLUSION

This study has shown that increased vegetative cover enhanced the soil physico-chemical properties. However, oil-palm plantation had the lowest (p<0.02) bulk density, dispersion ratio as well as the highest (p<0.05) total porosity, aggregate stability, soil organic matter, pH, total nitrogen and available phosphorus compared to other land use types. The study concluded that the reduction in vegetation cover decline the soil physico-chemical properties and therefore suggest the utilization of plantations probably in agroforestry system for sustainable soil management in the study area.

REFERENCES


