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ASSESSMENT OF SILT DEPOSIT AND SOIL PHYSICAL PROPERTIES ALONG RIVER BENUE BANK, ADAMAWA STATE

***Adaeze, J.E., Tella, I.O., Saka, M.G., Yarduma, Z.B., Njobdi, L.A., Lumboyi, C.A. and Yekini, N.**

Department of Forestry and Wildlife Management,
Modibbo Adama University of Technology, Yola, Nigeria.
***Corresponding author:** *enebuseja@gmail.com; enebusea@yahoo.com;* +234(0)7063390422

ABSTRACT

This research was aimed at assessing the presence of silt deposit and soil physical properties along the River Benue bank, Shinko area in Yola North Local Government Area of Adamawa State, Nigeria. This was to determine the soil textural classes which are important when transplanting and going into farming in the area. Three plots of 20m x 20m were randomly established at the solid waste area (SWA), silt + solid waste (SSW), silted (SA) and no-silt; no-waste (NWS) areas. Soil samples were collected at various depth levels (D_1 – 15cm, D_2 – 30cm, D3 – 60cm) of the three plots laid in each of the four areas at a distance of 5m, 15m and 25m. 4x3 Factorial Experiments in Randomized Completely Block Design (RCBD) was used. Mechanical analysis tests for soil textural classes were also carried out. The result shows mean sizes of soil textural classes at 5m, 15m and 25m distances and at different depth levels of the study areas. At $\alpha = 0.05$, the mean value of pH was significantly different at the various sampling locations. The silted area textural class shows sandy-loam, sandy and loamy-sand at 15cm, 30cm and 60cm depth level at 5m distance. To prevent future impacts and to curtail silt deposition, various measures should be considered in an attempt to reduce the effects of deforestation on the environment. Artificial regeneration should be encouraged in areas with trait of flooding and tree planting should be considered as part of all developmental projects.

Keywords: Siltation, River Benue, Soil, Flood and Deforestation.

INTRODUCTION

The origin of the increased sediment transport into an area may be erosion on land, or activities in the water. In rural areas the erosion source is typically soil degradation due to intensive or inadequate agricultural practices, leading to soil erosion, especially in fine-grained soils such as loess. The result will be an increased amount of silt and clay in the water bodies that drain the area. A main source of silt in urban rivers is disturbance of soil by construction activity. A main source in rural rivers is erosion from ploughing of farm fields, clear-cutting or slash and burn treatment of forests. In water the main pollution source is sediment spill from dredging, from the transportation of dredged material on barges, and the deposition of dredged material in or near water Nahon and Trompette; (as cited in Crouvi, *et al*, 2010).

Silt is easily transported in water and is fine enough to be carried long distances by air in the form of dust. Silt and clay contribute to turbidity in water. Silt is transported by streams or by water currents in the ocean (Wright *et al*., 1998). Silt, deposited by annual floods along the Nile River, created the rich, fertile soil that sustained the Ancient Egyptian civilization. Silt deposited by the Mississippi River throughout the 20th century has decreased due to a system of levees, contributing to the disappearance of protective wetlands and barrier islands in the delta region surrounding New Orleans. Any form of sustained human activity result in some modification of natural environment. The modification will affect the relative abundance of species and in extreme cases lead to extinction of certain plants and animals (Groombridge, 1992).

In ecological terms, 'environment' mean essentially physical and biological. Environment in this sense encompasses an array of ecosystem. An ecosystem consists of both living (including man) and non-living components and their physical surrounding: land, water, air etc. (Muhammed, 2004). The rapid environmental degradation taking place in Nigeria is increasingly becoming a major threat and is gradually changing the landscape, destroying the sources of livelihood (Ola, 2012). Exploitation of forest resources often causes deforestation, which has been a big problem in this Nation. Nigeria destroys 600,000 ha of forest annually whereas only 25,000ha are replenished Food and Agricultural Organization (FAO, 1983). This is often done to service wood base industries apart from fuel. However, a huge sum of N180 Billion is lost annually to deforestation (Eboh, 2005).

River Benue

The River Benue is a river in Africa. It is the major tributary of the River Niger. The river is about 1,400 km long. It starts in the Adamawa Plateau of northern Cameroon. It flows west, and through the town of Garoua and Lagdo Reservoir, into Nigeria south of the Mandara mountains. Then it goes through Jimeta, Ibi and Makurdi before meeting the Niger at Lokoja. Large tributaries are the Gongola River and the Mayo Kebbi. Other tributaries are Taraba River and River Katsina Ala (Udvardy, 1975). There is a high level of vertebrate species richness in the Benue Basin. In the catchment area there is a very high level of plant endemism. Plant endemism in the upper catchment of the Benue is very high, with typical trees including trees such as *Anogeissus leiocarpus*, *Kigelia aethiopica*, *Acacia seyal* and tree species of *Combretum* and *Terminalia*. Grass cover often features the statuesque tussocks Elephant Grass (*Cenchrus purpureum*). The lower basin of the River Benue can be construed as the region below the joining of the Gongola River at the Numan town, northwest (downstream) of Yola (Jimeta). In this northern part of this area the terrestrial ecoregion is characterised chiefly by the sprawling floodplain of the West Sudanian savannah, while Guinean forest-savannah mosaic covers much southern part of the lower basin. Flood stage is not uncommon, as exemplified by recent lower basin flows in the year 2012. The River Benue flooded in October 2012, resulting in a large increase in the population of venomous snakes in the Duguri District, Alkaleri Local Government Area, Bauchi State. Seasonal flooding is common in the lower Benue Basin, with attendant wildlife invasions of villages, disease outbreaks and loss of life and property (Happold, 1987 and Stuart *et al.*, 1990).

MATERIALS AND METHODS

Study Area

The study was carried out along Doubeli bypass road, in Shinko Ward of Yola North Local Government Area, Adamawa State. Geographical coordinates are between latitudes $9^o\ 7'\ 30''$ and $10^o\ 50''$ N, and longitude $11^o\ 40''$ and $13^o\ 20''$ E. Figure (1), is Jimeta map showing River Benue, Figure (2) satellite image showing the map of the study area. This area is comprised of both indigenous and exotic flora species and fauna species (Adefioye, 2013).

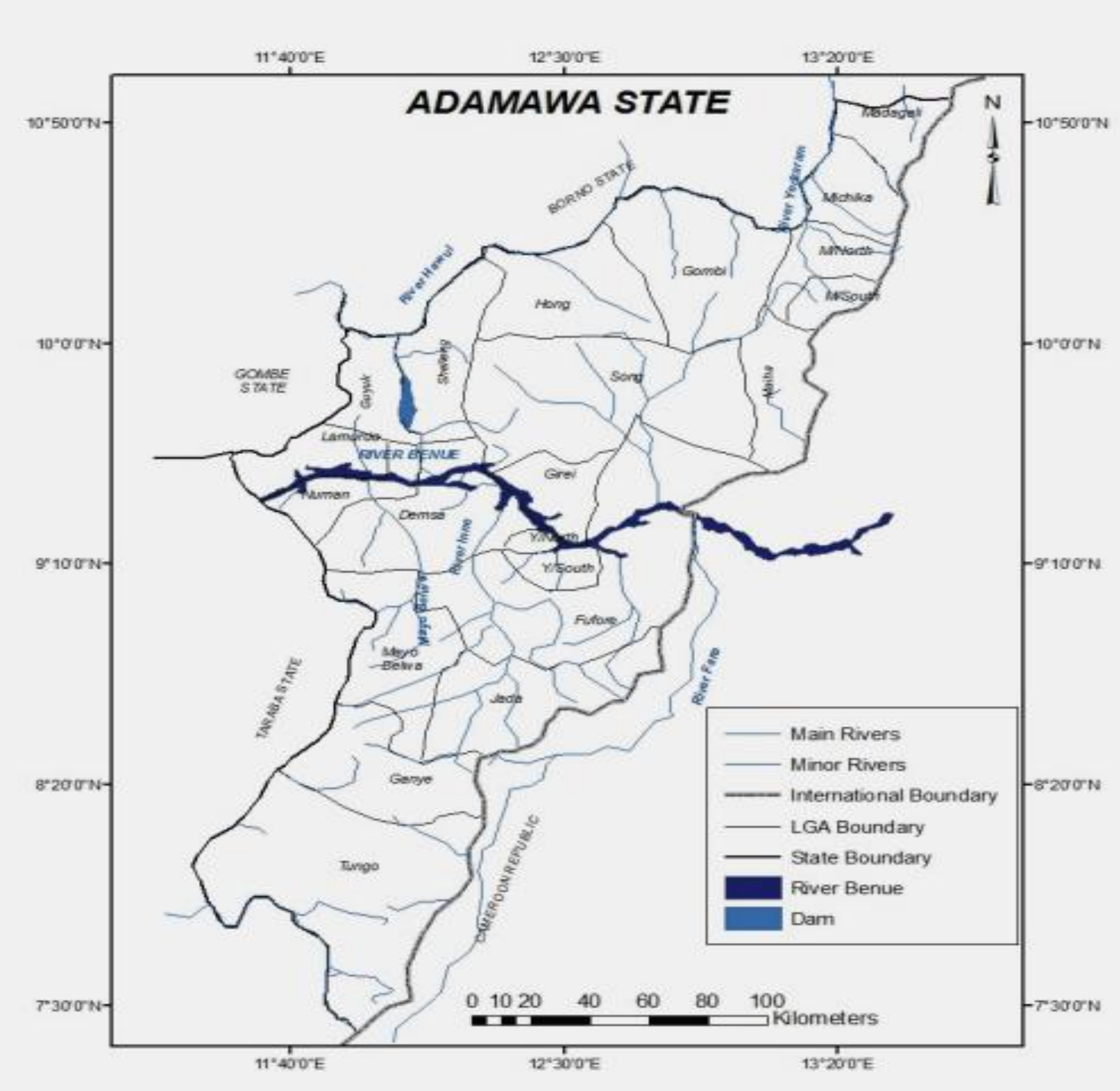

Figure 1: Map of Adamawa State Showing River Benue
Source: Ikusemoran, *et al*. (2013).

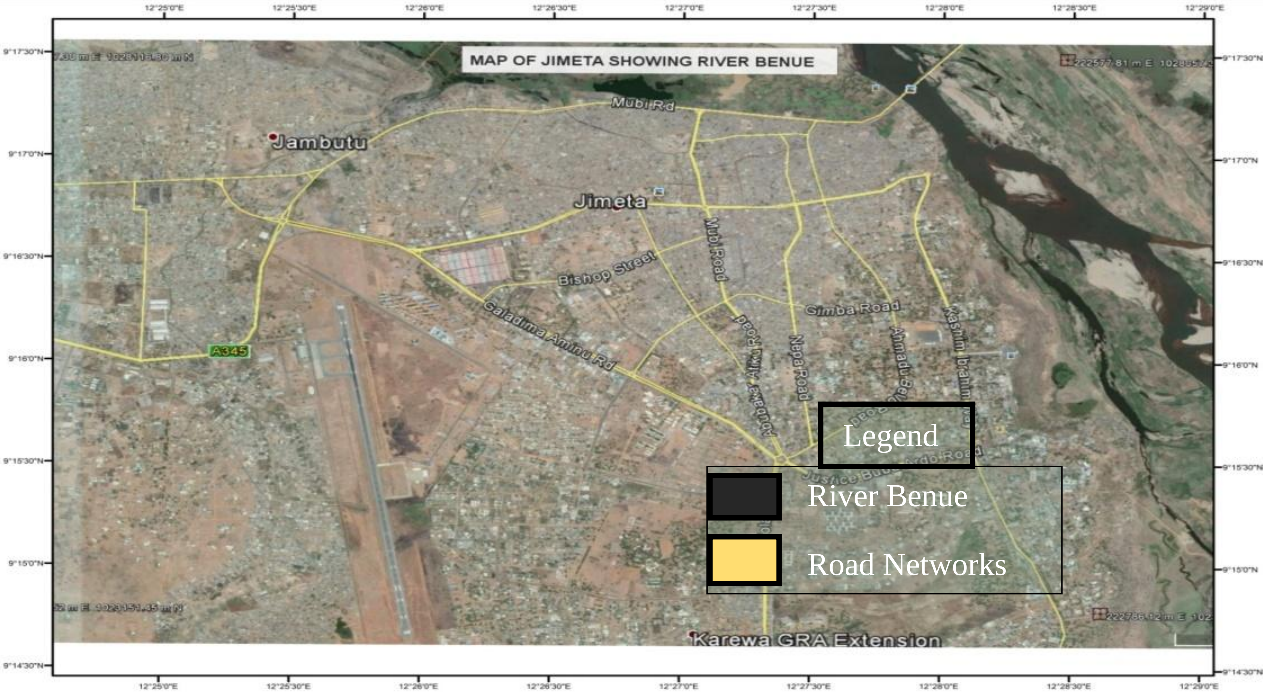

Figure 2: Satellite Image of Jimeta Map Showing River Benue
Source: Google Earth

Experimental Design:
The sampling technique used is stratified random sampling. 4 x 3 Factorial Experiments in Randomized Completely Block Design (RCBD) was used. Factor (A) is the sampling locations at 4 levels; solid waste area (SWA); silt + solid waste area (SSW); silted area (SA); and no-silt; no-solid waste area (NSW). Factor (B) is the distance from the waste dump at 3 levels (5m, 15m and 25m). The Analysis of Variance (ANOVA) model is given as follows.

$$Y_{ij} = \mu + A_i + B_j + AB_{Ij} + £_{ij} \quad \ldots\ldots\ldots\ldots\ldots 1$$

Where:
Y_{ij} = individual observation
μ = overall mean
A_i = Effect of factor A
B_j = Effect of factor B
AB_{ij} = Effect of interaction AB
$£_{ij}$ = Experimental error normally distributed around the zero mean.
The treatment combinations are shown in Table 1.

Table 1: Treatment Combinations

B1			B2			B3			B4		
W_1D_1	W_2D_1	W_3D_1	W_1D_1	W_2D_1	W_3D_1	W_1D_1	W_2D_1	W_3D_1	W_1D_1	W_2D_1	W_3D_1
W_1D_2	W_2D_2	W_3D_2	W_1D_2	W_2D_2	W_3D_2	W_1D_2	W_2D_2	W_3D_2	W_1D_2	W_2D_2	W_3D_2
W_1D_3	W_2D_3	W_3D_3	W_1D_3	W_2D_3	W_3D_3	W_1D_3	W_2D_3	W_3D_3	W_1D_3	W_2D_3	W_3D_3

B1= solid waste area (SWA); B2= silt + solid waste area (SSW); B3= silted area (SA); and B4= no-silt; no-solid waste area (NSW). Levels of Depth (Siltation) = D_1 – 15cm, D_2 – 30cm, D_3 – 60cm; Levels of distance (Waste Effluents) = W_1-5m, W_2-15m, W_3-25m.

Data Collection and Analysis:
Three plots of 20 m x 20 m were randomly selected in each of the sites using Clegg *et al.*, (1996) and Barbour *et al.*, (1987) methods. The study area was divided into four natural representative areas; Solid waste area, silt + solid waste area, silted area and no-silt; no-solid waste area. A 1m x 1m quadrat was laid at an interval of 5m within each plot as described by James, (1996). Soil samples were collected in each of these laid quadrats at 15cm, 30cm and 60cm depth levels using the soil auger. Below is a layout of the sampling points (Figure 3).

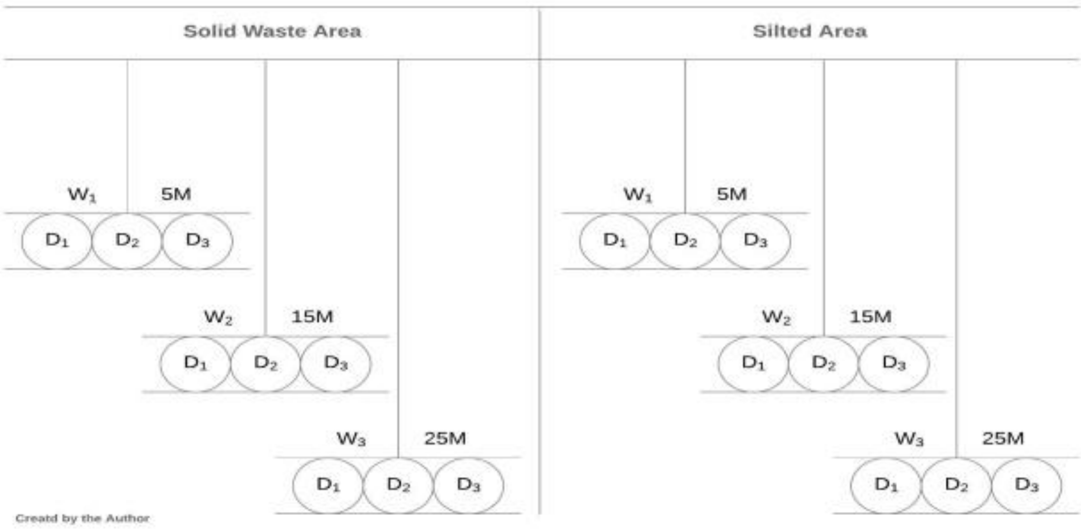

Figure 3: Layout of Sampling Points

Soil Textural Class in the Study Area:
Mechanical analysis tests for soil textural classes were carried out in the laboratory using the following procedure: The soil samples were dried; particles greater than 2 mm, such as gravel and stones, were removed. The remaining part of the sample, the fine earth, was finely grounded to separate all the particles. The total weight of the

fine earth was measured. The fine earth was passed through a series of sieves with mesh of different sizes, from 3 mm mesh down to about 0.5 mm mesh sieve. The weight of the contents of each sieved soil were calculated separately and expressed as a per cent of the total initial weight of the fine earth. The weights of the very small particles of silt and clay which have passed through the finest sieve were measured by sedimentation. They were also expressed as a per cent of the total initial weight of the fine earth. The procedure is based on that described by Metson (1971).

The Influence of Siltation in the Study Area:

Soil samples were taken at 5 m, 15 m and 25 m distance apart; starting from the edge of each of the study sites (solid waste, silt + solid waste, silted and no-silt; no-solid waste areas) and the various depth levels of silt were recorded. The textural class was analysed using the United States Department of Agriculture (USDA) system.

Determination of Soil pH:

Soil pH was determined by mixing 10g of soil sample into 25 ml beaker. 20ml of distilled water was added and stirred, then left for 30 minutes to settle down. Then the reading was taken from the pH meter also known as the electronic probe method. The electrode was immersed in the solution and the meter read the pH value. The method is based on that described by Blakemore *et al*., (1987).

RESULTS

Soil pH and Textural Classes at the Various Sampling Locations

Table 2 shows mean sizes of soil textural classes at 5m, 15m and 25m distances at the study areas. At $\alpha = 0.05$, the mean value of pH was significantly different at the various sampling locations (Figure 4). However, LSD shows that the highest value of pH (6.930) was found at 15m distance at silted area (SA). The lowest pH value (5.640) (which is a neutral pH) was found 25m away at silt + solid waste (SSW) area. It was however not significantly different from values obtained 5m away at solid waste (SWA) areas (5.693) and (5.980) at no-silt; no-waste (NSW) areas. The mean value of percentage sand was highest (97.600) at 15m at silted area (SA). The lowest (36.933) percentage sand was found 25m at NSW area. A similar result was obtained at 5m showing percentage clay (38.133) at SWA. The lowest (1.133) clay was obtained at 15m and 25m SA. More so, at NSW silt was highest (29.600) percentage at 25m and lowest (14.600) percentage at 15m distance.

Table 2: Mean Values of Soil pH and Textural Classes at the Various Sampling Locations

Distance	pH	% Sand	% Clay	% Silt
SWA				
5m	5.693^{cd}	43.600^{cd}	38.133^{a}	18.267^{bc}
15m	5.750^{cd}	89.267^{ab}	6.133^{d}	4.600^{de}
25m	6.330^{b}	95.600^{a}	2.133^{ef}	2.267^{e}
SSW				
5m	6.170^{bc}	87.933^{a}	6.467^{de}	5.600^{de}
15m	6.017^{c}	83.933^{b}	7.800^{d}	8.267^{d}
25m	5.640^{d}	92.267^{a}	2.800^{d}	4.933^{de}
SA				
5m	6.293^{bc}	89.933^{ab}	2.800^{ef}	7.267^{de}
15m	6.930^{a}	97.600^{a}	1.133^{f}	1.267^{e}
25m	5.840^{c}	97.267^{a}	1.133^{f}	1.600^{e}
NSW				
5m	5.980^{cd}	54.933^{c}	21.727^{c}	23.267^{b}
15m	6.293^{bc}	75.933^{b}	9.467^{d}	14.600^{c}
25m	6.513^{a}	36.933^{d}	30.133^{b}	29.600^{a}

LSD Values (α: 0.05): pH = 0.352, Sand = 9.781, Clay = 5.359, Silt = 5.324

Means followed by similar alphabets are not significantly different at 5% level of significance.

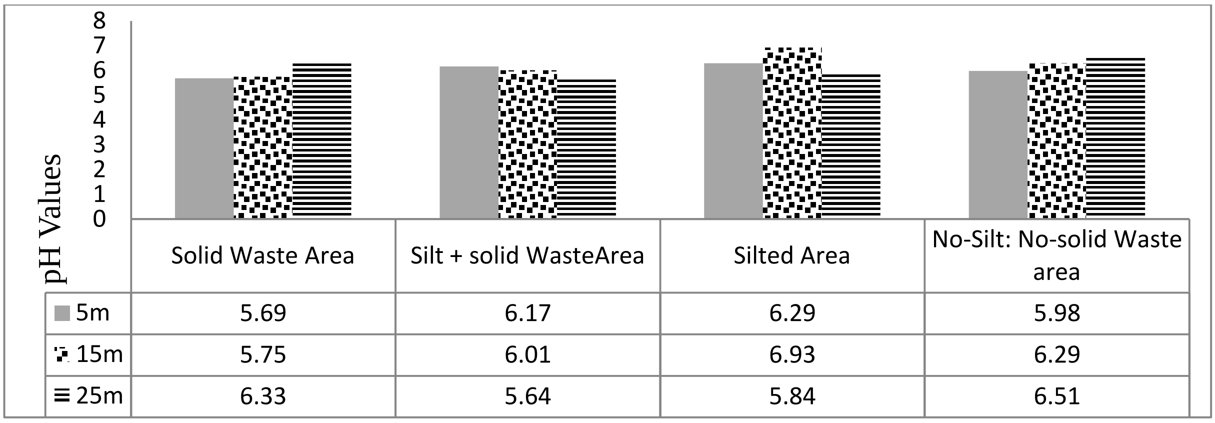

Figure 4: Shows the pH Levels at the Various Sampling Locations.

Table 3: Depth of Silt at the study Area

Distance	Solid waste area	Silt + waste area (cm)	Silted area	No-silt; no-waste area
5m	-	40	65	40.2
15m	43.6	57.2	58.7	45
25m	33.4	46.8	64.5	-

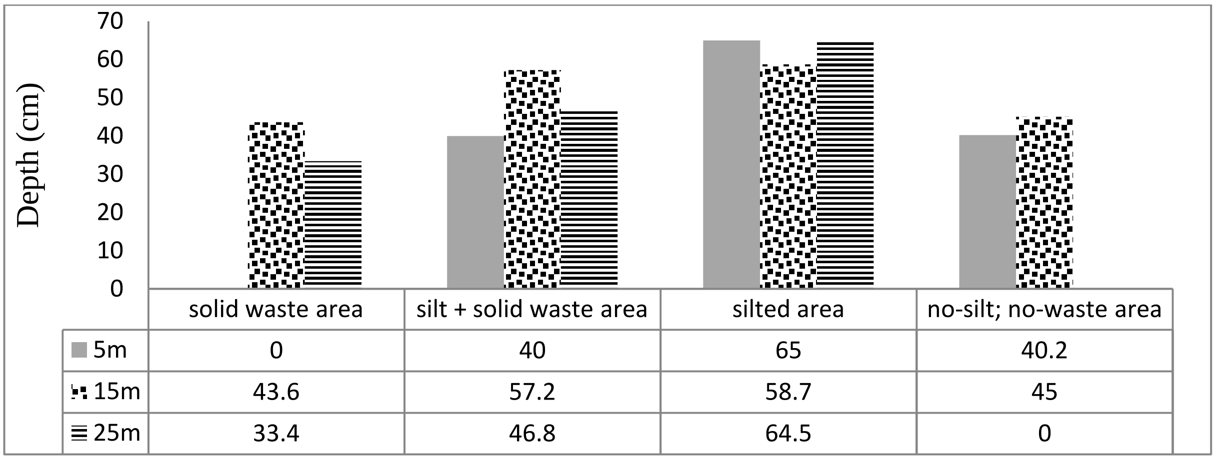

Figure 5: Depth of Silt at the Various Sampling Locations

DISCUSSION

Soil pH and Textural Classes at the Various Sampling Locations:

The pH level was not different at the various distances, but different within the sampling areas. This perhaps could be attributed to the waste effluents migration from the dumpsite and silt deposits from the river Benue during high rainfall that result in flooding and or when the river over flow its banks. However, pollution by heavy metals might also be a contributory factor influencing the pH levels at the various sampling location as observed during the study.

However, textural classes (TC) differed in the sampling locations. At 5m distance, SWA had textural class clay-loam, loam and sandy soil while sandy-loam and sandy soils were found at 15m and 25m distances. The silted area textural class shows sandy-loam, sandy and loamy-sand at 15cm, 30cm and 60cm depth level at 5m distance. While at 15m and 25m at silted area, the textural class shows sandy soils at 15cm, 30cm and 60cm depth levels. While no-silt; no-waste area had sandy-clay-loam, loamy and sandy-loam soils at 15cm, 30cm and 60cm soil depth respectively at 5m distances. While at 15m, the textural class for NSW were sandy-loam, sandy-clay and sandy soils. At 25m, the textural class were clay-loam and loamy soils. Loamy soils as obtained in the studied area are highly desirable for cultivation (Nagajyoti *et al.*, 2010).

The presences of sandy soils are characterized with good aeration and drainage; this was a trend which was observed in the study area similar to Chesworth (2008) report. The clay soils which were depicted in the study are best in nutrient retention; these areas also hold too much moisture and drain poorly (Voroney, 2006). The findings in this study revealed that there are clayey soils at SWA and NSW areas which therefore portray characteristics stated by Voroney as observed during the study. Textural classes with sandy-loam and clay-loam soils are ideal for garden soil or farming purposes as reported by Bruce (1997). This was observed in the study sites (SWA, SSW, SA, and NSW) as there were cultivated farmlands. Also, the result obtained from the four areas (SWA, SSW, SA, and NSW) suggests that NSW area is a more suitable site for harbouring of different plant species since the chemical analysis and textural class obtained suggests moderate availability of nutrients and clay-loam respectively in this site.

Depth of Silt at the Various Sampling Locations:

The depth of silt is shown in Table 3 and Figure 5. At 5m and 25m distances, silt was not recorded at 15cm and 60 cm depths in the solid waste (SWA) and no-silt; no-solid waste (NSW) areas respectively. This was due to the clayey nature of some parts of solid waste and no-silt; no-solid waste areas. These areas were muddy. There was difficulty in digging with soil auger. Figure 5, suggests that the depth of silt is high at the silted area followed by the silt + waste area. The solid waste area shows a low level of silt deposited at 25m distance (33.4cm).

The presence of silt in the area has caused harm to the habitat and the ecosystem at large. As Wolman (1971) stated in his paper on "The Nation's Rivers, 'we are particularly weak in our ability to detect subtle initial changes from a natural to a polluted condition'. The effect of siltation in the area cannot be over emphasized, if we are to have a healthy habitat for biodiversity. Individual plant species and macro-faunas in the study area varied as observed during the study at the SWA, SSW, SA and NSW areas in other reports. This suggests that siltation has effect on the diversity and distribution of macrofauna, and plant species in the study area. The silt depth level in the area could be among the factors threatening and causing variations in plant species diversity in the area as seen in the report. The land use system (farming) which is involved with the use of some fertilizers, in the NSW area could also be the reason for inadequate natural regeneration in the area as these chemical content may be harmful to some flora and fauna species.

CONCLUSION

Flooding has accentuated the rate and volume of siltation over the years in the study area; the accumulation of silt and the anthropogenic activities such as farming, nomadic pastoralism and fuel wood harvesting does not encourage biodiversity increase in some areas as observed during the study. This study has provided information on the physical properties of soil which is important when transplanting and going into farming in the area. The findings of this study can enhance the practice of agro-forestry in the study areas; as both indigenous and exotic tree species were present. Also, this study points to the hazards caused due to deterioration of the habitat as well as the ecosystem because of the silt that is deposited and solid waste pollution in the area.

Recommendations

If the current trend of deforestation at the expense of the natural environment continues, and no active response to the deteriorating pattern of land cover and environmental changes is initiated, the effects would be greater than the intending benefits of the product. More research is needed so we can understand changes in biological systems due to changes in environment. Artificial regeneration should be encouraged in areas with trait of flooding and tree planting should be considered as part of all developmental projects

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