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Impact of Land Degradation on the Physicochemical Properties of Obosi Land

Nweke I A[1] and Ejikeme C S[2]

[1]Department of Soil Science, Chukwuemeka Odumegwu Ojukwu University, Anambra State.

[2]Anambra State Polytechnic College of Agriculture, Mgbakwu, Nigeria.

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ABSTRACT

The unwise use of the natural environment due to ignorance and greed of man amongst others has led to the degradation of the environment. An approximately total area of 25.58km2 of Obosi land were surveyed and examined. Based on the morphology and the relief of the surveyed area, three mapping units, MU1-lowland areas, MU11-upland areas and MU111- gullied area were established. Profile pit samples collected from these three mapping units were used to study the impact of land degradation on the physicochemical properties of Obosi land. The findings from the study showed that the texture of the soils varied from sandy loam to loamy sand. The soils reaction (pH) is extremely acidic through moderate acidity to alkaline, ranging from 4.8-8.0. The organic matter content of the soils is very low, 0.32-1.34gkg^{-1}, the nitrogen content and exchangeable acidity of the soils were observed to be low, while exchangeable A1^{3+} was found to be totally absent in all the horizons of profile C except 35-65cm, AB horizon with a record value of 0.2cmlkg^{-1}. The C/N of the soils were observed to vary from 2.14-29.29 with an exceptional high value of 54.06 at profile pit B, horizon AB 35-90cm. The available phosphorous (P) of the soils was observed to be completely absent in profile pit A and B and some horizons of profile pit C and D. In those horizons where values were obtained the recorded value was low and range from 0.94-14.93mgkg^{-1}. Generally the findings from the study revealed that the impact of land degradation was great on the soils of Obosi as the nutrient element studied were below their critical level. The causes of the prevailing land degradation processes in Obosi land were found to include massive de-vegetation of the entire area, industrialization, undulating topography and relief of the area and the high erodibility of the soils.

Introduction

Land is natural heritage and ultimate object of environmental protection. According to Ezeaku (2011), it is the key to the sustainable development calculus by not only giving a place to either components of geo-physical environment but constituting the fundamental factor of production and socio-economic resources. Man was created from the soil and from that creation man had depended on soil for prosperity and survival. Hence, good soils; anywhere in the world could be said to be dependent on the kind of people, their culture and way of lives, the climate and topography of the place and the use they make of the soils. With the improvement in science and technology, increasing the rate of mining of mineral resources, urbanization and growth of population (Sheoran et al., 2010) accelerate land degradation processes.

Soil erosion are of the major land degradation processes, is a systematic removal of soil and all its components from the land surface by different agents of denudation such as water and wind. According to the report of Akamigbo (1998) it involves the massive movement of the soil from areas of higher ground to the areas of lower grounds due to the fact that water always moves down streams. This occurs in an area when soil is removed through the agents of denudation more than its rate of formation. The history of soil erosion is however an integral part of agricultural activities all over the world where man started the agricultural operation, Suresh, (2006) argued that there exists the problem of soil erosion in some extent. Soil degradation is said to have occurred when there is reduction in the capacity of the soil to provide goods and services and do not assure its functions over a period of time. Thus soil is said to be degraded when it loses its capability to sustain optimum productivity. Soil degradation as reported by Mbagwu (2003) can result from temporary or permanent lowering of productive capacity of soil caused by overgrazing, deforestation, over exploitation of fuel wood leading to desertification, in appropriate agricultural practices and other man – induced activities. Soil degradation affects large areas and many people in dry land regions (FAO, 2013) as well as tropical areas like Nigeria and particularly south east, Nigeria. Indiscriminate use of soil by man has led to the degradation of soil resources.

Information obtained through detailed survey and soil characterization provides a systematic basis for the study of crop and soil relationship with a view to increasing productivity and helping in soil conservation and reclamation (Akamigbo, 2010). Soil reclamation is a process by which derelict or highly degraded soil are returned to productivity and by which some measures of biotic function and productivity is restored (Kavamura and Esposito, 2010).

Tele:
E-mail address: nweksoniyke@gmail.com

Thus the essence of this study is to investigate the impact of land degradation on the physicochemical properties of Obosi land and management strategies for prevention of soils been eroded or becoming physically and chemically altered by over-use as well as reclamation processes.

Materials and Methods

Study area

Obosi is in Idemili-North Local Government Area of Anambra State. It is located approximately by longitude 06^0 38^I and 06^0 50^IE and latitude 05^0 50^I and 06^0 12^I N (Duze and Afolabi 1981). It is bounded in the east by Nkpor and Umuoji, in the North by Nkwelle –Ezunaka and Onitsha, in the west by Ogbaru and in south by Ojoto (Figure 1)

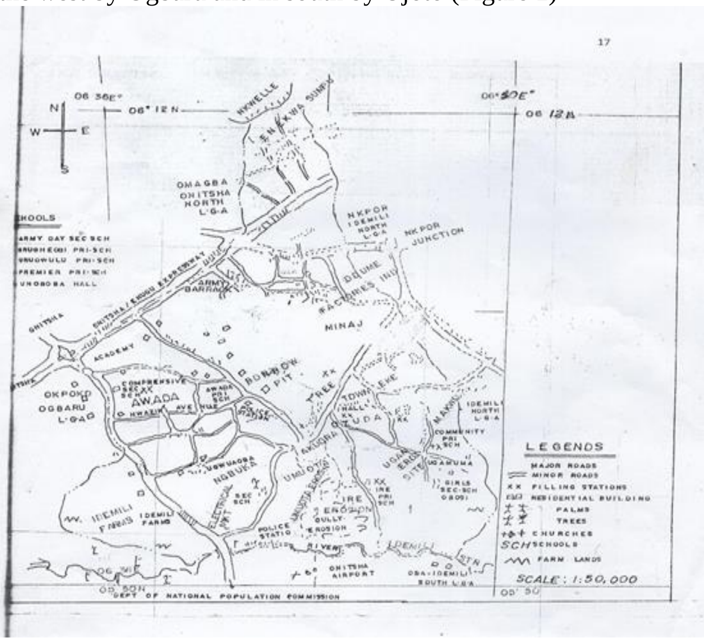

Figure 1. Map of Obosi Community

Climate

Obosi has two climatic seasons in a year; the rainy season and the dry season the rainy season last from April to October with about 2000 – 3000mm average per annum, while the dry season is from November to March. The relative humidity of Obosi falls between 75% and 95% with the mean annual temperature fluctuating between 25^0 – 27.5^0 (Oboli, 1980).

Topography and Vegetation

Obosi has an uneven landform, which rise in elevation as one enters the town either through Nkpor junction, or Idemili bridge end off Owerri road. This gives an impression that most parts of Obosi land are located on plateau or on a hilly area. However, the entire land configuration of the area lies within an average elevation of below 200m (Duze and Afolabi 1981).The town falls within the rain forest agro ecology of south eastern Nigeria. Most tropical crops, with the exception of those that require flooding thrive well in the area.

Soil

The soils of Obosi is predominantly sedimentary, and belongs to the red – yellow ferralitic soils of the humid tropic (Duze and Afolabi 1981) and USDA Typic Iso-thermic udult (ultisol)

Soil Sampling

Out of an approximated total area of 39.78km^2 of Obosi land, 25.58km^2 (about 65% of the entire area) was covered by the survey work. The entire north east to south east of Obosi land comprising of Odume, army Barracks, Awada, Umuota, Ire, Ugamuma, Urowulu and Nmakwum was covered. A flexible grid survey type was used for the study. The transverse used were the major roads and footpaths. The sampling points were sited at the areas where there appeared to be difference in the soil. As a result of the physical similarities of the soils, the land form and the congested activities on the land observed during the field work, four profile pits were dogged and sampled. The samples were subjected to a routine analysis.

Laboratory Analysis

All the samples collected were air dried, sieved with 2mm sieve and then subjected to standard methods of soil analysis at the Department of Soil Science Laboratory University of Nigeria Nsukka as indicated below.

Soil pH Determination: The pH values were determined in both distilled water and in 0.1N potassium chloride solution using a soil/liquid ratio of 1:2.5. The pH values were read using a Beckman Zerometic pH meter (Peech, 1965).

Particle size Analysis: This was carried-out using the hydrometer method of Bouyoucous (1951).

Organic matter: This was determined by Walkley and Black method (1934). The percentage organic matter content was calculated by multiplying the organic carbon value by the conventional “Van Bernmeler” factor of 1.724.

Total nitrogen: Total nitrogen was determined by macro kjeldatic method of Bremnner and Mulvancy (1982), using sodium sulphate catalyst mixture.

Exchangeable Acidity: The exchangeable hydrogen and aluminium were determined by titrimetric method using potassium chloride extract (Mclean, 1982)

Available phosphorus: This was determined by using Bray II method (Bray and Kurtz, 1945).

Results

Using relief, drainage and morphological properties as criteria the survey area was grouped into three mapping units. These units were; MUI -lowland area, MUII -upland area, MUIII -gullied land area (Bad Lands). The soil mapping units are explained in figure 2

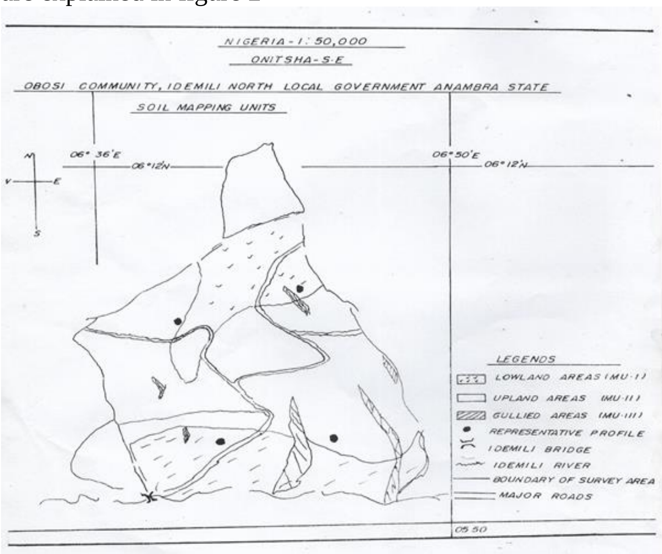

Figure 2. Soil mapping units of Obosi

Physical and chemical properties of low land areas (mapping units)

The result of particle size analysis presented in Table 1 showed that the textural class of the horizon studied were sandy loam. The ranges in particle sizes are; clay 120-140gkg^{-1}, silt 10-90gkg^{-1}, sand 770 – 810gkg^{-1} for profile A. The result of clay and find sand in profile A indicated that horizon AB, Bt1 and Bt2 recorded the same result 140gkg^{-1}

(clay) and 190gkg^{-1} (fine sand) respectively. Also sand particle size decreased as the depth increased indicating that the upper layer (surface) had more sand content than the lower layers of the profile (A). For the profile pit B, all the depth and horizon considered in this study recorded the same clay content (160gkg^{-1}), the silt content ranged from 90gkg^{-1} - 110gkg^{-1} and sand 730gkg^{-1} -750gkg^{-1}. The silt and sand sizes recorded in horizon A and AB, and Bt1 and Bt2 are of the same value. When the profile A from CSSO and profile B from Urowulu are compared, the 640gkg^{-1} clay and silt 400gkg^{-1} sizes of Urowulu were higher compared to clay (540gkg^{-1}) and silt (300gkg^{-1}) sizes of CSSO. The pH of the soil range from 4.8-4.9 in water and KCL 4.0-4.2 (profile A) the range of soil pH in profile B in water is 5.1 -5.2 and in KCL 4.0 -4.4. The result of the soil pH indicated, increase as the depth increased and decreased as the depth increased with regard to pH in water and KCL respectively in profile A. For profile B the pH ranges from 4.9 – 5.2 in water and 4.0 – 4.4 in KCl, the result of the soil pH showed that the soils of CSSO are extremely acidic and that of Urowulu are moderately acidic except for the soil of 35 – 90 cm depth of AB horizon that is very acidic. The OM content vary from 0.49gkg^{-1} at the top to 0.40gkg^{-1} at 200cm depth (profile A), while it varies from 1.03gkg^{-1} at surface to 0.3gkg^{-1} at 200cm depth (profile B). The nitrogen content varies from 0.004 to 0.028gkg^{-1} (profile A) and 0.042 to 0,014gkg^{-1} (profile B). The OM and N content result indicated that profile B had more OM (2.22gkg^{-1}) and N (0.126gkg^{-1}) content than the profile A that recorded 1.75gkg^{-1} OM and 0.086gkg^{-1} N. The result of C/N ratio indicated higher values in all the depths and horizons considered with an exceptional high value of 54.06 at profile pit B, horizon AB (35-90cm). Al^{3+} result indicated higher value 1.6cmolkg^{-1} in horizon AB (40-80cm) while the rest of the depths recorded the same value 0.8cmolkg^{-1} in profile A. In profile B, Al^{3+} was totally absent at the top horizon A (0-35cm), while 35-90cm and 90-130cm depths recorded the same value 0.4cmolkg^{-1} with an increase 0.6cmolkg^{-1} in 130-200cm depth. The H^+ result varies from 1.2cmolkg^{-1} at the top to 2.8cmolkg^{-1} (profile A) and 0.6cmolkg^{-1} at the top to 1.6cmolkg^{-1} (profile B). The Al^{3+} and H^+ content recorded indicated higher values across the depths in profile A compared to their recorded values in profile B. The result of available P showed completely absent in all the depths and horizons of both profile A and B.

Physical and chemical properties of upland areas

The texture of the soils (Table 2) ranges from loam to sandy loam. Their particle sizes range are clay 40gkg^{-1} – 160gkg^{-1}, silt 50gkg^{-1} – 70gkg^{-1} and sand 770gkg^{-1} – 910gkg^{-1} (profile C). Among all the depths in profile A, 65-98cm, horizon Bt1 recorded the least value of clay 40gkg^{-1} and silt 50gkg^{-1} content. In profile D, clay content vary from 80gkg^{-1} – 140gkg^{-1}, silt 50gkg^{-1} – 90gkg^{-1} and sand 770gkg^{-1} – 870gkg^{-1}. The clay content recorded in profile C and profile pit D are of the same value 540gkg^{-1}, but they differed in their silt and sand content of which profile C recorded 320gkg^{-1} and 4140gkg^{-1} and profile D 330gkg^{-1} and 4130gkg^{-1} respectively. The soil pH recorded in profile C across the depths indicated neutrality to alkalinity and slightly acidic to alkaline in water and KCl respectively. The pH in water varies from 7.1 – 8.0 and 6.2 – 7.4 in KCl. For the case of profile pit D, the soil pH varies from 5.2 – 6.9 in water and 4.3 – 6.5 in KCl. The result showed that soil of profile D vary from moderately acidic to slightly acidic in water and extremely acidic through moderate to slightly acidic in KCl. The soil samples from burrow pit Awada are more acidic than the soils of Ire. The OM and N content of the soil is generally low and decreases with depth down the profile horizon in both C and D profiles. OM range from 0.40gkg^{-1} – 1.34gkg^{-1} (profile C) and 0.6gkg^{-1} – 1.19gkg^{-1} (profile D). The N content is fairly constant with value range of 0.014 – 0.028gkg^{-1} in both profiles C and D (Table 2). The C/N ratio recorded showed higher values in all the depths and horizons with an exceptional lower value (2.14) obtained in 0 -35cm AP horizon in profile C. The value range for profile C is 2.14 -27.86 and 19.29 – 29.29 in profile D. With the exception of 0.2cmolkg^{-1} Al^{3+} recorded in profile C, 35 – 65cm, AB horizon, the parameter is completely absent in the other depths. The value of the parameter in profile D decreased with attendant increase in depth with lowest value of 0.2cmolkg^{-1} recorded in 115 – 200cm, Bt3 horizon. The parameter however is absent in 0 – 15cm, horizon AP and 80 – 115cm, horizon Bt2. The exchangeable H^+ ranges from 0.4 – 0.6cmolkg^{-1} (profile C) and constant in 0-15cm, 80 – 115cm and 115 – 200cm (profile D) but vary from 0.8 – 1.2cmolkg^{-1}. The exchangeable H^+ is however found completely absent in 0 – 35cm horizon AP profile C. The available P result of the soils showed generally very low in value except for the moderate value 14.93mgkg^{-1} recorded in profile D, 15 – 40cm horizon AB. It is completely absent in profile C, horizons AP and Bt3 and profile pit D, horizon AP, Bt2 and Bt3. Generally it ranges from 0.94mgkg^{-1} to 14.93mgkg^{-1} (Table 2).

Gullied land area (MUIII)

The erosion affected parts of the surveyed area is the soil mapping unit III. The mapping unit caught across parts of the lowland area (MUI) and the upland area (MUII); The soil unit is represented in this study by Ugamuma Gully site, Ire-Umuota Gully site, Odume-Gully site and Owell aja-Awada Gully site.

Ugamuma gully erosion

This is the most developed gully site in Obosi of which caught across the residential areas of people the gully have claimed many farm lands and engulfed many houses. People living within the locality use the gully site as a refuse dump. Common vegetation or plant cover seen in these area are those mainly drawn by land-slide into the gully, like oil palm trees, bambos, gmelina trees, neem, *irvingia gabonensis* etc.

Ire–Umuota Gully Erosion

Common vegetation found in this gully site are the drawn or sank trees as a result of land slide, and some bamboos planted as a measure in trying to check it like in the above case. It is commonly used by people living around it as a refuse dump. The Ire – Umuota gully is second to the Ugamuma gully. Many hectares of land are involved, and it had led to the resettlement of many indigenes over the years. Its expanse stretches from almost the Obosi town hall to the Idemili River.

Odume gully erosion

This particular gully site can be said to be at its medium stage because it is not as developed and extensive as Ugamuma and Ire-Umuota gully erosion sites. Bamboo trees are planted extensively and seen growing wild in it. People living within the vicinity also dump refuse there.

Owelle Aja-Awada gully erosion

This gully site is not as deep as others it is the least developed of the four gully sites described above. All kinds of plants are seen growing wild in it. It also forms the major refuse dump site of the people living around the locality.

Table 1. Physical and chemical properties of low land areas (mapping unit 1) profile pit samples

Description	Depth cm	Horizon	pH		OM	N	C/N	Exch. acidity $cmolkg^{-1}$		P $mgkg^{-1}$	Clay →	Silt	Fine sand gkg^{-1} ←	Coarse sand	Textural class
			H_2O	KCl	gkg^{-1}	gkg^{-1}		Al^{3+}	H^+						
Profile A CSSO	0-40	A	4.8	4.0	0.49	0.004	10.91	0.8	1.2	-	120	70	280	530	Sandy loam
	40-80	AB	4.9	4.2	0.39	0.026	13.21	1.6	1.6	-	140	70	190	600	Sandy loam
	80-130	Bt1	4.9	4.1	0.47	0.028	9.64	0.8	2.8	-	140	90	190	580	Sandy loam
	130-200	Bt2	4.8	4.1	0.40	0.028	8.21	0.8	1.6	-	140	70	190	600	Sandy loam
Profile B Urowulu	0-35	A	5.2	4.4	1.03	0.042	14.29	-	0.6	-	160	110	360	370	Sandy loam
	35-90	AB	4.9	4.0	0.47	0.042	54.06	0.4	1.6	-	160	110	360	360	Sandy loam
	90-130	Bt1	5.1	4.2	0.40	0.028	9.21	0.4	1.2	-	160	90	370	380	Sandy loam
	130-200	Bt2	5.2	4.3	0.32	0.014	12.86	0.6	1.0	-	160	90	360	390	Sandy loam

Table 2. Physical and chemical properties of upland areas (mapping unit 1I) profile pit samples

Description	Depth cm	Horizon	pH		OM	N	C/N	Exch. acidity $cmolkg^{-1}$		P $mgkg^{-1}$	Clay →	Silt	Fine sand gkg^{-1} ←	Coarse sand	Textural class
			H_2O	KCl	gkg^{-1}	gkg^{-1}		Al^{3+}	H^+						
Profile C Ire-Umuota	0-35	Ap	7.8	7.2	1.03	0.028	2.14	-	-	-	100	70	280	550	Loamy loam
	35-65	AB	7.1	6.2	1.34	0.028	27.86	0.2	0.4	3.74	120	70	240	570	Sandy loam
	65-98	Bt1	7.8	7.3	0.55	0.028	11.43	-	0.8	4.64	40	50	300	610	Sandy loam
	98-133	Bt2	7.9	7.3	0.55	0.014	22.86	-	0.6	2.80	120	60	280	540	Sandy loam
	133-200	Bt3	8.0	7.4	0.40	0.14	22.86	-	0.6	-	160	70	220	550	Sandy loam
Profile D Burrow pit Awada	0-15	Ap	6.9	6.5	1.19	0.028	24.64	-	0.8	-	80	50	360	510	Loamy sand
	15-40	AB	5.3	4.4	1.11	0.028	22.86	0.8	1.0	14.93	120	70	240	570	Sandy loam
	40-80	Bt1	5.2	4.3	0.60	0.014	26.43	0.6	1.2	0.94	80	50	320	550	Loamy sand
	80-115	Bt2	5.3	4.4	0.71	0.014	29.29	-	0.8	-	120	70	260	550	Sandy loam
	115-200	Bt3	6.3	5.5	0.47	0.014	19.29	0.2	0.8	-	140	90	280	490	Sandy loam

Discussion

Obosi land varies significantly in their morphology and topography and has soils of sedimentary materials. Using the topography the land was mapped out into three units low land areas (MUI), upland areas (MUII) and gullied land areas (MUIII). The soils of these units were found to be highly weathered and very deep probable due to the soils were derived from false bedded sandstones that are sedimentary in origin. The soils were highly permeable, well drained and lack mottles in their horizons. The soil colour varies from brownish to reddish probable as a result of iron (Fe) oxidation in the area. Also there is complete absence of cutan, lithic or paralithic layer(s).

In low land areas the soils were mainly sandy loam textural class and there is little evidence of clay translocation from the top soil to the subsoil as was evidence in profile A, 0 – 40cm horizon A, which is 120gkg^{-1} and 140gkg^{-1} in 40 – 80cm, AB horizon. The upland areas which is mainly loamy sandy to sandy loam, there is increase in clay content along the vertical cross section of all pedons except horizon Bt1 in both profile C and profile D hence the existence of argillic horizons. The increased sand fraction suggests fragility and low content of colloidal materials which eventually might give rise to the susceptibility of the soils to erosion. The extreme acid to slightly alkaline nature of the soils could be attributed to their parent material and high leaching prevailing in the area. The low OM content of the area may be attributed to high temperature and relative humidity of the area which favour rapid mineralization of OM. The decrease in OM with depth may be due to lack of pronounced influence on the organic horizon by the parent material (Stutter et al., 2003; Manjoka et al., 2007) probable because the soil is greatly affected by the biocycling of nutrients that involve litter decomposition. Eshett et al., (1990) attributed this decreasing trend of OM with depth primarily to the effect of nutrient biocycling. Soils of Anambra State of which Obosi land is one of them are characterized by low organic carbon (Ezeabasili et al., 2014; Ejikeme and Nweke, 2016). FAO (1979) emphasised that crop production cannot be sustained in soils where OM content is below the critical level of 3%. This indicates lack of cohesion and instability of the soils. Soil OM is the main source of N in the soil hence the N level observed in this study was directly proportional to the OM content in the soil of the study area. Thus the observed low value of N could be as a result of loss through leaching of nitrates as well as rapid mineralization of OM. The obtained result suggests that exchangeable Al^{3+} contribute to the acidity of Obosi soils. The low content of available P and its complete absence in all the horizons of profile A and B of low land area and some horizons of profile C and D of upland areas may be due to phosphate fixation. The observations made by Nweke and Nsoanya (2012), Ejikeme and Nweke (2016) in their respective studies showed that the scenario is not restricted to any particular soil kind. Phosphorous retention is a characteristic problem of ferralsols according to report of World Reference Base for Soil Resources (2006). In those horizons were available P was recorded it was observed to have a direct relationship with the soil pH. It is noted that when pH of the soil increased to near 6.5 according to Lee et al. (2007) P availability occurs in most soils.

Studies have shown that the environmental factors such as vegetation, geology, geomorphology, soil erodibility and climate were major contributively factor to soil erosion problem and development. Anthropogenic influences arising from misuse of land, poor farming systems, rapid deforestation and numerous abandoned roads network under construction all contributed immensely to the accelerated runoff and gully erosion development. Thus Getachew and Demele (2000) opined that environmental problems will be more prevalent in the rural areas where the bulk of the population live and whose livelihood depends on agriculture and related activities. Izibili (2005) summed up his fears when he opined that damage to the environment is no respecter of frontiers and damage done to one generation has the consequences of affecting the future generation. Environmental degradation affect many earthly activities and cycles but most importantly the sustainable relationship between the ecosystem and the livelihood of the people. Land degradation probable might have occurred in Obosi as the people tend to adjust to their seemingly endless wants and desire for food, shelter, recreation, and infrastructural facilities and so on to the land and other resources available to them as was put forward by NEST, (1992). In personal communication with Ikenna Ekwulugo (2013) a member of Obosi works committee, he observed that Obosi gully erosion problem is associated to the town’s location and the type of soils in Obosi. Slope is an important element among the factors that affects soil erosion. The topographic configuration of the terrain of an area can constitute a natural environmental problem. Akamigbo, (1996) was of the opinion that soils on a steep slope are susceptible and vulnerable to erosion leaching and landslides.

Conclusion

Environmental problem such as land degradation, erosion, desertification, over population, industrialization etc is caused by man’s misuse of natural resources. Hence the obvious soil degradation of the Obosi land area is both manmade and natural. The soils of Obosi are good for agricultural activities but they need a high addition of OM to upgrade the loose soil colloids and improve their nutrients retention and release to crops for a better yield. Mulching, crop rotation, integrated intercropping and well managed alley-cropping or agro forestry are some of the ways to be adopted to keep the soil uneroded. Since Obosi is now an urban area densely populated, there is need for massive construction of underground concrete water storage tanks within house hold or compound in Obosi. This will help in harvesting of rainfall and reduce its degrading force or effects. They should provide catchment pit around their houses as a way of reducing the amount of water that get out to the public drain or flows unchecked.

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