Contents lists available at

Journal of Environmental Management and Safety

Journal homepage: www.cepajournal.com

The Place of Soil Characteristics on Soil Erosion in Nanka and Ekwulobia Communities in Anambra State

Onwuka, S.U.; Okoye, C. O.; Nwogbo, N.
Department of Environmental Management, Nnamdi Azikiwe University;
Email: udojoy@yahoo.com

ARTICLE INFO

Article history

Received 23 December, 2011
Received in revised form 3 January, 2012
Accepted 14 February, 2012
Available online 30 September, 2012

Keywords:

Erosion, Erodibility, Soil Characteristics, Environment, Ekwuluobia and Nanka

ABSTRACT

Despite all approaches to arrest them, soil erosion problems keep aggravating in Anambra State, especially in Nanka and Ekwulobia Communities Consequently, soil characteristics of soils from Nanka and Ekwulobia Gully Erosion Sites were investigated, using experimental design, with a view to ascertaining their implications on the prevalence of soil erosion in the areas. The sites were purposively chosen because of their sizes, locations and different havocs caused on the inhabitants of the area. The result revealed that the soil characteristics of the area play significant roles in the initiation and continued incidence of soil erosion. The data generated were analyzed using Chi-Square statistical technique. The study also revealed that there is a significant difference between the Chemical/Mineralogical, and between the physical and biological characteristics of the soils of Nanka and Ekwulobia. Further research to find environment-friendly chemicals capable of improving the diagenetic properties of the underlying rocks was recommended. It further recommended attitudinal change on the part of the part of the inhabitants of the two communities.

Introduction

According to Egboka (1993), the period between 1920 and now has witnessed, not only the disappearance of arable lands, but also numerous losses of lives and property due to landslides in Anambra State. Out of all the four natural disasters in Nigeria: erosion, flooding, desertification and drought, soil erosion is the worst. This is because, whereas all the others lead to the flight of the area, hunger and death, only gully erosion leads, in addition, to the disappearance of the land itself.

At present, soil erosion is the single most threatening environmental degradation problem in many developing countries (Ananda and Herath, 2003) including the Southeast of Nigeria. Soil erosion, in simple terms, can be defined as the process of detachment and transportation of soil materials by erosion agents such as water, wind and ice (Faniran and Adeola, 1978). Subsequently, soil erosion has been identified as one of the direct causes of environmental degradation and poverty in many parts of the world. It is an environmental problem that can be attributed to both natural and human (anthropogenic) factors, upon which its extent and form is determined (Egboka, 2003; Onwuka, 2008). This is exactly the case of South-eastern Nigeria, particularly in Nanka and Ekwulobia areas.

Soil erosion is an ecological disaster that has plagued many developing countries like Nigeria. In many parts of South Eastern Nigeria, gully erosion sites of various sizes, shapes and depths abound, particularly in Anambra state and mostly in the study area. This has greatly impacted the economy of the area in no small measure. Moreover It has greatly reduced the quality of the built environment. But as Onwuka, (2008) argued, the understanding of the root causes of soil erosion in any place makes its control a reality. To this effect, this paper seeks to ascertain the place of soil characteristics in soil erosion in Anambra State, using the popular Nanka and Ekwulobia Gully Erosion Sites as examples.

The problem of the Study

Out of all the states in South-eastern Nigeria, Anambra State is the most affected by erosion, having about one thousand (1000) active erosion sites in its domain. According to Igbokwe et al (2007), many of these gullies which have destroyed many houses, economic trees, and other invaluable properties, including vehicles, roads and even human lives, cover up to tens to hundreds of metres squared in area in some cases. Ukpaka (2007) reported that these gullies have the greatest potentials to cause both financial and human causalities. In the state, the worst hit includes Nanka, Ekwulobia, among other towns. In fact, due to the extent of the havoc of this monster in the state, Anambra State was declared a state of emergency by the senate in 1999. This declaration became inevitable after a careful analysis of the dangers done as at then in the state.

According to Egboka (2007), the problems resulting from soil erosion in the state are so

many and are varied too. They include, human, material, political, psychological sociological, economic and spiritual, all rolled in one. In addition, it negatively affects and reduces the quality of the built environment. Consequent upon the extent of the havoc done by this monster, several scholars, including Ofomata (1965), Nwajide (1977 and 1979), Egboka (1997) Muoghalu and Ikegbunam (1997), Igbokwe et al (2007) and Onwuka (2008), among others, have embarked on series of studies on the causes and effects, with a view to professing solution to it. Despite the works done, the problem keeps worsening.

One question keeps coming to mind, considering the persistence of the problem despite all the efforts to combat it: **why does the problem worsen by the day?** A critical look at literature reveals that most of these works analyzed the physical properties of the areas, including topography, vegetation, landuse, rainfall characteristics and other climatic variables as the major causes without a proper investigation of the characteristics of the soils of these areas. The persistence of the problem, therefore, prompted the need to approach the problem from another perspective other than merely looking at the physical characteristics of the area. This paper advocates an investigation of the effects of soil characteristics with a view to finding out the causes of incidence and aggravation of soil erosion in Anambra State.

Aims and Objectives

The aim of this study is to analyze the chemical, physical and biological characteristics of the soils of Ekwulobia and Nanka Gully Erosion Sites with a view to ascertaining their relationship with the high erodibility of the soils of the area.

In order to achieve the aim, the following objectives will be pursued:

- to determine the soil characteristics of the sites
- to ascertain if soil characteristics of the soils of Ekwulobia and Nanka cause erosion in the area, and
- to establish whether there is a significant difference between the soil characteristics of the two gully sites,

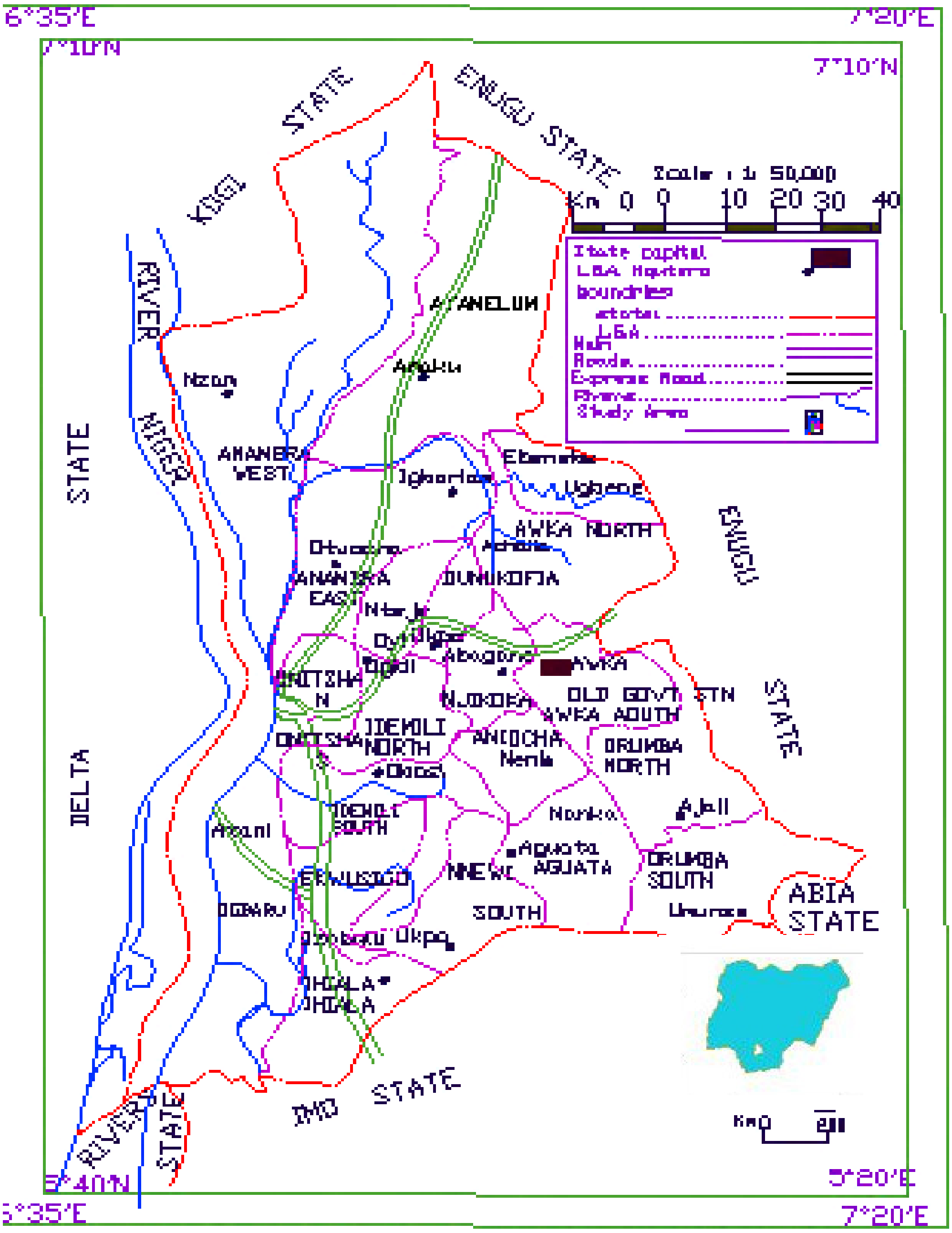
Research Hypotheses

The paper tested the following three hypotheses:

- H_o: The soil characteristics of Ekwulobia and Nanka Erosion Sites do not play significant roles in the initiation and aggravation of soil erosion in the areas.
- H_o: There is no significant difference between the soil chemical characteristics of the gully erosion sites of Nanka and Ekwulobia.
- H_o: There is no significant difference between the soil physical and biological characteristics of the gully erosion sites of Nanka and Ekwulobia.
-

Area of the Study

The study area is Aguata Local Government Area of Anambra State, but specifically, using Nanka and Ekwulobia Gully Sites as case studies. Anambra State lies within latitude 5^{o} 40' N and Longitude 7^{o} 10' E on the South and latitude 6^{o} 35' N and longitude 7^{o} 20' E on the south. (Fig.1).


ENUGU STATE
KOGI STATE
RIVER NIGER
DELTA STATE
ABIA STATE
IMO STATE
AYAMELUM
ANAMBRA WEST
ANAMBRA EAST
AWKA NORTH
DUNUKOFIA
ONITSHA N
ONITSHA NORTH
IDEMILI NORTH
IDEMILI SOUTH
NJIKOKA
ANIOCHA
ORUMBA NORTH
ORUMBA SOUTH
AGUATA
EKWUSIGO
OGBARU
NNEWI SOUTH
IHIALA
AWKA SOUTH
AWKA
OLD GOVT STN

Anambra State falls within the rainforest climatic region. It has a mean temperature of 33^{o}C and high annual rainfall ranging from 1, 400mm in the north to 2, 500mm in the south. The State exhibits two seasons – the rainy and dry seasons. The rainy season occurs from March to September with early rainfall usually in March with full commencement in April, and stops in the months of October each year with one or two showers in November to herald the dry season and the typical harmattan winds. On the other hand, the dry season lasts for four to five months from November to February.

The study area is essentially underlain by Nanka Sands, a friable, loose and unconsolidated sandstone formation. Considering the nature of the formation that underlies Nanka and Ekwulobia, denuding agents like water, wind and man easily act on the resultant soil, leading to the occurrence of erosion prevalent in the area.

From all indications, the presence of erosion in the areas is closely associated with the geomorphology and geology of the area, among other factors, and this may explain why previous works centered mainly on the physical environment.

The Conceptual Framework of the Paper

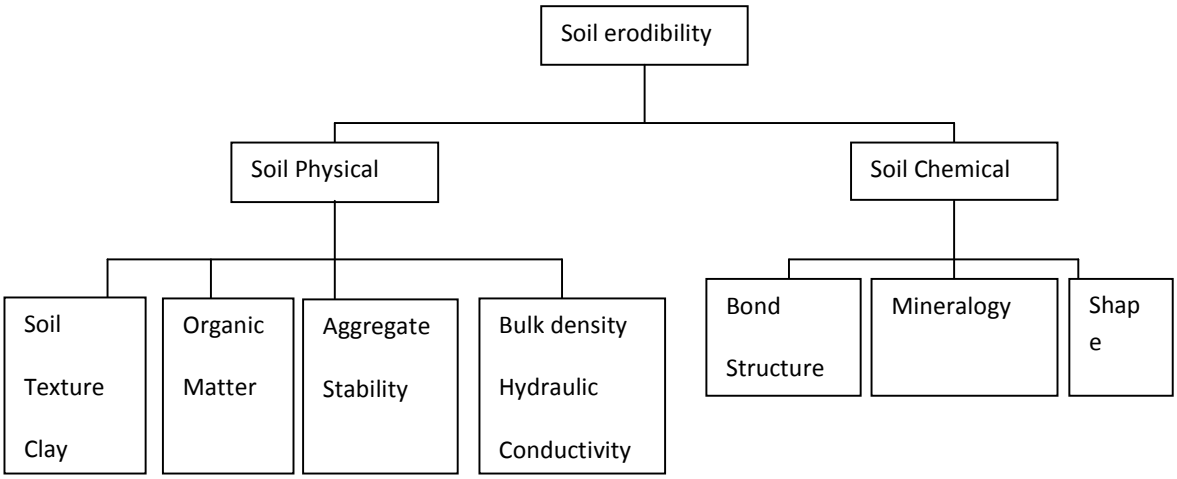
The problem of soil erosion can best be understood when one understands the concept of Soil Erodibility and Erosivity. This is the concept that quickly shows how fast or how slow (degree) to which a particular soil can be eroded and the factors present to cause erosion, for instance climatic factor like rainfall intensity and rainfall magnitude.

Consequently, this work is based on the concept of soil erodibility. This is because soil erodibility is a major factor in determining soil loss or erosivity. It is usually called the K-factor (Agronomy Guide, 2007-2008). It is, in its clearest terms, the ability of a soil to resist erosion based on the physical and chemical characteristics of the soil. It is usually measured using the soil erodibility index which may be done directly or indirectly. Directly, the soil erodibility can be measured using erosion ratio, dispersion rates and aggregate stability determined from the soil characteristics (Middleton, 1930).

Generally, soil differs in their susceptibilities to erosion depending on natural and human factors. Erodibility is influenced by many factors, some of which vary during the year and/or without soil management. Secondly, the erodibility of a soil increases with a decrease in bulk density, hydraulic conductivity and attergberg limits. The presence of a high amount of clay and organic matter would help in improving the soil's aggregate stability and reduce erodibility.

The concept of erodibility conveys the idea that soils with faster infiltration rates, higher level of organic matter and improved soil structure have greater resistance to erosion than sand, sandy – loam and loam textured soils which tend to be less erodible than silt, very fine sand and certain clay textured soils. According to Agbegunde et al (2006), lower organic matter levels cause poor soil structure and result in compaction which contributes to an increase in soil erodibility.

The soil erodibility concept can be represented as shown in the chart below in figure 2.



Sources

Fig 2: Soil Erodibility Chart, (after Weischmeier and Smith, (1969)

Methodology

Experimental design was used to derive information used for the study. Laboratory analyses of the soil samples collected from Nanka and Ekwulobia Gully Sites were carried out. This methodology was chosen because the data needed for the study include chemical/mineralogical parameters of the soil samples.

The soil samples were collected using judgmental sampling technique with the aid of a soil auger and a core sampler. The soils were collected in the forms of distributed soil samples. The distributed soil samples were collected using the soil auger. The collection was made between January and June, 2007. The order of sampling is shown in Table 1 below.

The chemical parameters studied are the pH (hydrogen ion concentration), concentration of exchange acidity and exchange basity such as sodium (Na^{+}, calcium (Ca^{++}), potassium (K^{+}) iron (Fe^{++}), magnesium (Mg^{++}), carbonates (C_{o3}^{2}) silicates ($Si0_3^{2-}$), Nitrates ($N0_3^{-}$) and chloride (Cl^{-}) (Table 2).

The physical parameters studied include the size distribution, the textural class, bulk density, total porosity, soil moisture content, atterburg limits, plasticity index, soil dispersion rate of the soil samples.

In addition, the biological parameters that were studied include the organic matter content, and the carbon content of the soil.

Table 1: Soil sampling order in Nanka and Ekwulobia Gully Sites

Sampling location	Depth of Gully (m)	Sampling Depth (CM)	Sample label	Sample Description
Nanka	950-55	10-30	A1	Brownish in colour, moderately drained.
		50-70	A2	Light brown in colour, imperfectly drained
Ekwulobia	39-80	10-30	B1	Reddish brown in colour, friable and moderately drained.
		50-70	B2	Reddish brown in colour friable and moderately drained.

Source: Authors' Field Work (2011)

The soil samples collected were stored in an airtight polythene bags and carried to the laboratory for analyses.

The exchange bases were leached out of the soil with neutral ammonium acetatic solution. Concentrations of calcium, magnesium, potassium and sodium were determined using the flame photometer after the soil samples were digested with reagents such as Ammonium chloride, Eriochome Black T indicator, Ammonium leachate, potassium chloride.

The particle size distribution was determined using Bouyoucos (1926) hydrometer method. Also, the textural class for each sample was determined by the Black (1965) Triangle Method, in which the percentage size of the soil samples were traced to the soil texture triangle, while the bulk density and the total porosity were determined using the core method of Israelsen and Hansen (1962). Again, the soil moisture content was got using gravimetric method of Hukkeri and Dastane (1968), while the hydraulic conductivity was determined using the variable head permeameter methed. In addition, the liquid limit and the plastic limit were got using the Atterberg (1911) cascagraride method.

Again, the organic carbon content was determined with the Wakley-Black method; and the carbon values were converted to organic matter values by multiplying them by 1.724

Results and Discussions

The discussions were approached from two ways: firstly, the discussion on the implications of the various soil characteristics measured, as shown in Tables 2 and 3 below, and discussions based on the statistical analyses made.

Table 2: Chemical/mineralogical characteristics of Nanka and Ekwulobia Erosion Sites

Sample location	Sample Points	PARAMETER ANALYZED									
		pH	Exchange bases M.E/100g				Cl-	Fe^{2+}	$C0_3^{2-}$	$S0_3^{2-}$	$N0_3^{2-}$	Alkalinity
			Na	K	Ca	Mg						
Nanka	A1	5.2	0.56	0.96	0.4	0.4	1.42	0.18	-	0.72	5.62	1.8
	A2	5.4	0.56	0.96	0.2	0.6	1.06	0.13	-	0.89	1.33	3.0
	Mena value (x)	5.3	0.56	0.96	0.3	0.5	1.24	0.16	-	0.81	3.48	2.4
Ekwulobia	B1	5.3	0.98	0.96	0.2	0.6	1.42	0.14	-	1.63	2.07	2.2
	B2	5.2	0.98	0.96	0.4	0.8	1.42	0.19	-	1.43	2.11	2.6
	Mean Value (x)	5.3	0.98	0.96	0.3	0.7	1.42	0.17	-	1.53	2.09	2.4

Source: Authors' Field Work (2008)

Table3: The Physical and Biological Characteristics of Nanka and Ekwulobia Gully Erosion Sites

Sample Location	**Sample Points**	PARAMETERS ANALYSED													
Nanka		Bulk Density	Hydraulic C Cond	Textual Class	Particles Size Distribution (%)				Organic Matter (%)		Attergberg Limit (%)		TP	SM	DR	ER
	A1	1.76	41.25	Loamy Sand	8	11	14	67	0.52	0.89	-	-	33	3.75	0.47	0.13
	A2	1.72	29.115	Loamy Sand	9	11	11	68	-	-	6.0	0.52	35	6.51	0.65	0.09
	Mena Value (x)	1.74	35.15	Loamy Sand	8.5	11	12.5	67.5	0.52	0.89	6.0	0.52	34	5.13	0.56	0.11
Ekwulobia	B1	1.59	11.32	Sandy Sand	16	11	24	49	0.24	0.41	36.6	2.72	40	8.15	0.55	0.07
	B2	1.77	7.89	Loamy Sand	12	11	24	53	0.39	0.69	-	-	32	2.55	0.47	0.18
	Mean value	1.68	9.6	Sandy Loam	14	11	24	51	0.32	0.55	36.6	2.72	36	5.36	0.51	0.13

Source: Authors' Field Work (2011)

pH Values: Table 2 shows that both soils are acidic in nature. This implies that Nanka and Ekwulobia soils, due to their acidic nature, could easily undergo any chemical reaction which could result in loosening of the soil structure, leaving the soil particles loose, friable and uncemented. Consequently the soil particles would become easily detachable, and could be transported from one location to another by agents of erosion. This explains why the soil in the area is highly erodible.

Carbonates (CO_3^{2-})

From Table 2, it is clear that the soils of Nanka and Ekwulobia contained no carbonates. This confirms that the area is not a limestone terrain. Moreover, it reveals that calcium carbonate ($CaCO_3$) which acts as a cementing material is absent in the soil grains. This explains the reason for the uncemented, loose and unconsolidated nature of the formation. This also buttresses

the reason for the high erodibility of the soil.

Silicates (SiO_4^{2-})

The presence of silicates in both soils as shown in Table 2 signifies that both soils are of the same geologic formation. It also reveals low clay contents, low plasticity and low water retaining capacity of the soils, considering that silicates were clastic but inorganic sedimentary rocks. There is no doubt that this also explains the reason for high erodibility of the soils of the area.

Cations

Some metals, as shown in Table 2, were also measured, which include: sodium, potassium, calcium, magnesium and iron. The table shows that the two soils had considerably high amount of iron and aluminum. The presence of these metals must have brought about the high rate of lateritification (oxidation reaction) of the soils with either water or air. This loosens the overall structure of the soil, making it to be easily weathered chemically, mechanically or even organo-chemically. This high rate of weathering (a deformation process) explains the reason why the soils are easily erodible, unconsolidated, loose friable, detachable, and highly erodible.

In addition, the table also reveals that both Nanka and Ekwulobia soils allows the concentration of exchanged bases and nitrates in them. Hence, although the soils are capable of supporting plant growth, plant with buttress roots might not thrive in the area. The implication is that this would definitely reduce the organic content of the soil, which acts as a binding factor of the soil grains.

From the fore-going, we could deduce that the chemical characteristics of the soils of Nanka and Ekwulobia seriously affect the incidence and aggravation of soil erosion in the area.

Particle size Distribution

Erodibility, which determines the resistance of the soil to both detachment and transportation depends on the properties/ characteristics of the soil (Ashuma,1998).

Table 3 shows that the soil samples of both soils fell under the same textural classes of loamy sand sandy loamy. This indicate that both sites are from he same geologic formation- the Nanka Sands, although their characteristic readings may slightly vary. the high percentages of coarse sands in both sites(67.5% and 51%) shows that the two sites have high sand contents, and little clay (8.5% and 14%). This means, according to Bouyoous (1926) and Morgan(1979), low binding factor in the soil, hence aiding erodibility of the soil. This also explains the unconsolidated, friable and loose nature of the rock, which means high erodibility of the soil at the slightest flow of runoff and detachment by wind.

Organic Matter Content

The organic matter content of both soils as shown in Table 2 is very low. This implies that the soil of the area cannot support the growth of some economic trees with tap root systems which help in obstructing the denuding effects of erosion agents, particularly the linear flow of water which forces runoff to assume a serpentine flow. Secondly, it explains the friable nature of the soil.

Bulk Density

From the Table 2, the bulk density of Nanka and Ekwulobia sites are 1.74g/cm^3 and 1.68g/cm^3 respectively. This shows that both soils are of small bulk density values. The implication is that the soil of the area cannot resist the effect of rainfall of high intensity. Again, according to Ogundimu (2005), and Israel and Hansen (1987), this explains the type of bonding that exists in the soil, which is a covalent bonding type. This type of bonding possesses very weak bond. Hence, the area develops gullies of varying shapes and sizes by little human activities like road and house constructions.

Total Porosity

For total porosity, Table 2 reveals that the soils of Nanka and Ekwulobia sites range from between 33% and 35%, and 32% and 40% respectively. This, again, implies that the soils are highly porous, indicating that they easily allow much inflow of water in them. This favours high infiltration rates and low water retaining capacity. The implication of this is that water easily flows through the soils and lubricates any existing cracks, causing wearing away and cutting of the layers during rainy seasons.

Hydraulic Conductivity

The hydraulic conductivity values of the soils, from the table, are 35.15km/hr (Nanka) and 9.6km/hr (Ekwulobia). Since their hydraulic conductivity values are high, it means that just like bulk density, the y favour high soil erodibility. This also explains why the rate of their erodibility is more in the rainy season than in the dry season. Moreover, the higher value of that of Nanka explains why gully erosion menace is much greater in Nanka than in Ekwulobia; hence the area is characterized by sites that are wider and deeper in dimensions.

Soil Moisture Content

Again, from Table 2, the soil moisture content of Nanka and Ekwulobia soils ranges from 5.18% to 5.36%. This quickly explains why the bulk density of the area (explained before) is low; since low soil moisture content affects bulk density. This again, explains why erodibility factor is high.

Soil Consistency

The soil consistency which relates to the workability or firmness of the soil as influenced by soil water content was measured as shown in Table 2. While there

was no value for Nanka Site, that of Ekwulobia has a value of 36.6% in liquid limit, 2.27% in plastic limit. There is no value for Nanka Site because the soil is not workable, indicating that a slight disturbance of the soil can cause breakdown and dismantling the soil particles. The implication of this is that unguarded urbanization processes in the area trigger or at least aggravate erosion problems. The small values of that of Ekwulobia Site signifies that, although the soil of Ekwulobia will relatively take a longer time to be attacked by erosion, it nonetheless, easily becomes semi fluid that is easily washed off by flood. This then explains why the area starts by rolling away of soil particles, instead of landslides as in the case of Nanka area.

Erosion Ratio

The erosion ratios of Nanka and Ekwulobia, which were used to ascertain their erodibility indexes are 0.11 and 0.113 respectively. Their high values show that the soils can disperse easily due to their low moisture contents. The implication is that Nanka and Ekwulobia are highly erodible, since according to Middleton (1930), soils with index of less than 1 (one) are highly erodible.

From the fore-going, therefore, it is not just that it has been understood that the soils of Nanka and Ekwulobia are highly erodible, but in addition, the cause of the continued incidence and aggravation of soil erosion has become quite clear

Discussions on Statistical Analyses

Hypothesis One:

From the calculations made, considering that the calculated value which is 24.45 is greater than the tabulated, which is 12.59, it shows that there is no significant difference between the chemical/mineralogical characteristics of the soils of Nanka and Ekwulobia.

The implication of this is that the two locations (Nanka and Ekwulobia) belong to the same formation- Nanka Sands. It is clear then why the two areas are equally ravaged by erosion.

Hypothesis Two:

Again, the result of the analysis of hypothesis two showed that the chemical characteristics of the soils of Ekwulobia and Nanka play significant roles in the initiation and aggravation of soil erosion in the area.

This implies that for the problem of soil erosion in the area to be meaningfully managed, soil characteristics of the soil of the area must be taken into consideration. This is to say that proffering solution to the menace in the area from the point of merely looking at the physical characteristics of the area will not bring solution to the problem.

Hypothesis Three

From the calculations made, considering that the calculated value which is 18.345 is

greater than the tabulated, which is 12.59, it shows that there is no significant difference between the physical/biological characteristics of the soils of Nanka and Ekwulobia. This again confirms the findings of hypothesis two

Conclusions and Recommendations

The analyses done showed that the chemical (mineralogical) characteristics of the soils of Nanka and Ekwulobia have serious effects on the incidence and aggravation of soil erosion in the area.

In addition, soil chemical characteristics in Nanka and Ekwulobia play very important roles in the occurrence of soil erosion in Anambra State. This implies two things:

- the problem of soil erosion in the area may not be tackled if the chemical (mineralogical) characteristics of the soil of the area are not taken into consideration; and secondly
- if these soil characteristics of the area are disregarded, particularly in the urbanization processes embarked upon in the area, it will lead to further harm on the inhabitants of the area, their properties and other resources.

Consequently, the paper encourages total involvement of the government, environmental law enforcement agents, NGOs and, indeed, the general public to join hands in combating the problem of soil erosion in the area. In addition, it makes the following recommendations:

- Indiscriminate sand mining in the area should be greatly discouraged.
- Properly guided agricultural practices such as planting of cover crops, mulching and the use of green manures should be encouraged.
- The nutrient level of the soil should be increased to help the growth of trees with good rooting system so as to increase the organic matter content of the soil of the area.
- Considering that the soil of the area is friable, loose and unconsolidated, and of high porosity, the dumping of wastes in the gully sites (as it is major practice now) should be discouraged to avoid the resultant leachete infiltrating to pollute groundwaters of the area.
- Since the soil of the area is highly unstable, and of low shear strength, it is advised that urbanization processes in the area should be greatly monitored.
- Researches should be sponsored to come up with environment-friendly chemical(s) capable of reacting with the rocks of the place to enhance the cementation and lithification (diagenesis) and to reduce the erodibility and erosivity of the soil.

REFERENCES

Agbegunde, A. A. (2003): "The Impact of Erosion on Rural Economy: The Case of Nanka in Anambra State of Nigeria". In ***Urban Finance and Infrastructure Development in Nigeria.*** Yomi Fawchinmi (Ed) Atlantis Books. Pp 227-243.

Agbegunde, A. A., Adeyinka, S. A., M Olawumi, P. O. And Oluodo, O. A. (2006): "An Assessment of the Socio Economic Impacts of Soils Erosion in South Eastern Nigeria" Proceeding Symposium on Shaping in Change, Germany, October 8-9.

Attergberg, A. (1911). Die Plastiziat Der Tonc. Intern Witt Boderk, Vol. 1, Pp 10-43.

Ananda, J. and Herath, G. (2003): "Soil Erosion in Developing Countries; A Social Economic Appraisal". ***Journal of Environmental Management.*** Vol. 68, No. 4, Pp 313-353.

Agronomy Guide (2007-2008): "Soil Management". In Http: Liagude. Gronomy. Edu/Cm/Scc1/Scciid.Cfm).

Bouyoneos, C. I, (1935). "The Clay Ratio as a Cetenoritor Susceptibility of Soil to Soil Erosion:. ***American Society Agronomy Journal,*** vol. 27. Pp 738-741.

Cunningham, P. W. and Cunningham, M. A. (2005): Environmental Sciences: Global Concern Eight Edition, New York Mc Graw Hill.

Egboka, B. C. E. (1993): "***The Ranging War***". A publication of the Anambra State Government of Nigeria, Awka.

Egboka, B. C. E. (2007): "Gully Erosion in Alaigbo". In Http://wwwkwenu.com/publications/ Egboka/2007/4 Erosion Clamity.Htm.

Faniran and Areala, O. O. (1978): Essential of Soil Studies Ibadan: Jeco Publishers. Beijing Time (2002): ***"Soil Erosion, Bigged Global Environmental Probem".***

Geological Survey (2003): ***Geology of Anambra Basin*** Vol. 6. Anambra Nigeria.

Igbokwe, I. Akinyede, J., Ono, Kneji, O. I, And Nnodu, V. C. (2007). " Mapping The Spatial Distribution Of Gully Erosion In South Eastern Nigeria With Satellite Imageries", A Paper Presented At Coasta Rica Capacity Building Conference, Nov. 12. 15th.

Israelsen, O. W. And Hansen, V. E. (Third Edition), (1962): ***Irrigation Principles And Practices***. New York, John Wiley And Bons.

Middleton N. J. (1930): Wind Erosion and Dust Storm Control Technique for Door Redamation, New York: John Willy and Sons

Montgomery: C. W. (2003): ***Environmental Geology***, Sixth Edition, New York: Mc Graw Hill.

Moughalu, L. N. And Ikegbunam, F. I (1997). "Gully Erosion In Some Urbanization Communities Of Anambra State In Nigeria". ***Environmental Review*** Vol. 1, No.2 Pp1-4.

Nwajide, C. S. (1977). "Sedimentology and Stratigraphy of the Nanka Sands, South-East Nigeria". ***The Nigerian Field Journal*** Vol. 43, No. 2, pp 15-64.

Nwajide, C. A. and Hoque (1979). "Gullying Processes in South-Eastern Nigeria". ***The Nigeria, Field Journal,*** *Vol.* 44, No.2, pp 65-74.

Ogundimu, O. O. (2005): Soil Characteristics Along Slopes in Ikorodu Local Government Area of Lagos State". ***Unpublished B.Sc. Thesis University of Ibadan, Oyo State.***

Olori, T. (2006): "Villagers Flee Landslides", In Http://www.onlinenigeria.com/links/adv.as/blurb.68.

Onwuka, S. U. (2005): "Urban Erosion Problems in Nigeria". In Nnodu, V. C. Okoye, C. O. and Onwuka, S. U. (Eds), Urban ***Environmental Problems in Nigeria*** (pp 149-142). Enugu: Rex Charles and Patrick Ltd.

Ofomata, G. E. K. (1965): "Factors of Soil Erosion in Enugu Area of Nigeria". ***Nigerian Geographical Journal*** vol. 8, pp45-59.

Saigo, B. U., Cunnigham, P. W. and Cunningham, M. A. (2005): ***Environmental Science: A Global Concern***. Eight Edition. New York: Mc Graw Hill.

Ukpaka Reports (2004): "Gully Erosion Menance in Anambra State"

Wischmeier, W. H. and Mannering, J. V. (1969). "Relationship of Soil Properties to its Erodibility" ***Soil Science Society America Journal***, Vol. 39, pp285-291.