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Menace of Soil Erosion on Urban Structures in Ikare-Akoko, Ondo State

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Abstract: ***Ikare-Akoko is a settlement surrounded by hills. The landscape therefore influences erosive activities such that the lower lying region of this settlement is always at the mercy of soil erosion. This research therefore examined the menace of soil erosion on urban structures with special focus on Ikare-Akoko, Ondo State. Field observation and field survey methods were adopted to generate the needed data for this study. Random balloting method without replacement was used to sample five streets from each of the five paramount quarters of the study area and thereafter, systemic sampling method at an interval of four houses was used to sample twenty houses in each of the sampled twenty five streets and purposive sampling method was used to sampled five hundred house hold heads that were finally administered questionnaire for this study. The subjective notions of the respondents were converted to objective notions using 3-points Likert scale of "To no extent" (1) "To a little extent" (2) and "To a large extent" (3) while the Mean Weight Value (MWV) for each response and the General Mean Weight Value (GMWV) were both calculated and used to determine the major acceptable variable (s).Thereafter, Pearson Product Moment Correlation and Students t-test Statistical Analyses were used at p = 0.05 to determine the relationship and significance of relationship between the variables in each of the stated hypotheses. The study revealed that paved roads and unpaved roads, building foundations and areas adjourning buildings are the areas prone to erosion in the study area while areas along the foot of Hill and or slopes are not because these areas are mostly covered by buildings. At p= 0.05, factors encouraging erosion in the study area are: poor design of buildings and roads; construction of roads and buildings along slopes and hilly areas and absence and or narrowness of drains to accommodate runoff. With a significant but high positive correlation of 0.993, usage of inferior materials to construct and pave drains induces or encourages urban soil erosion on road drains to the tune of 98.45% in the study area while usage of inferior materials to construct buildings with a high positive correlations of 0.998induces/ encourages soil erosion on buildings to the tune of 97.64% in the study area. The resultant menace of erosion in the study area are; blockage of roads, washing away of road drains, traffic congestions, accidents, exposure of housing foundations, sagging of building walls and collapse of buildings. In order to mitigate the menace of soil erosion in the study area, this study recommends; good design and usage of quality materials for the construction of roads and building of buildings and drains. Similarly, in the study area annual clearance of drainages should be done before the onset of rain while periodical clearance of drainagess should always be done during the raining season every year.***

Keywords: Mean Weight Value (MWV), General Mean Weight Value (GMWV), Urban structures, Acceptable Variable (s), Menace of erosion

1. Introduction

Soil erosion refers to the actions of exogenic processes which remove soil from one location on the Earth's crust, then transport it just over a few millimeters or thousands of kilometers to another location where it is deposited (Wikipedia Dictionary, 2014) . While erosion is a natural process, human activities have increased the rate at which erosion is occurring globally by 10-40 times, making excessive erosion one of the most significant environmental problems world-wide (see Blanco and Lal, 2010). Each year, due to high density of human activities, particularly urbanization and as noted by Zuazo, et al (2009),about 75 billion tons of soil is eroded from the land—a rate that is about 13-40 times as fast as the natural rate of erosion. Uurbanization has major effects on erosion processes—first by denuding the land of vegetative cover through site clearing and grading thereby altering drainage patterns, and covering the land with an impermeable layer (asphalt, concrete, constructions of structures , foundations and roadways) during construction and finally compact the soil unintentionally due to movement of heavy equipment on urban soil.

Even though these human activities are unintended, these actions not only change the soil profile and soil structure but also affect the stability of the soil aggregates and the water infiltration rate thereby making urban soil to be fragile and subjected to intensive erosion. Unfortunately, in the process of urbanization, natural environment are cleared, paved and turned into cities. The foregoing shows that human influence is a main aspect of urban soil erosion. The foregoing as noted by Bullock and Grergory (1991) have made urban areas to contain a wide variety of open spaces, yet much of this has evolved under the pressures of human population with minimal management.

Urbanization is not new in developing countries, especially Nigeria, but the every indication thatthe trend will continue for a long time, adding approximately two billion people to the urbanpopulation of the presently less-developed nations at an interval of 3 decades or less (UnitedNations Environment Programme, 2002).

With more and more people living and moving to cities un-abated, urban soil erosion will result in more damage to urban environment. As affirmed by Murck, et al, (1996), soil erosion is the single major process responsible for the loss of over 25 billion tons per year worldwide. Hughes et al, (2001) observed the mean annual rate of erosion in Australia to be about 1.5 tons per hectare per year. Nigeria is not an exception, for instance, Enabor (1988) estimated that 30 million tons of soil were lost on annual basis from both rural and urban environments. Jeje (2005) estimated that

531,417.6 and 329,436.5 tons of sediments were removed from gullies in Auchi and Ikpoba slope, Benin City respectively.

The menace of urban soil erosion include, loss of aesthetic value, loss of scenic value, ruggedness of land surface, blockage of road by deposited debris, washing away and blockage of road drains, traffic congestions and accidents, exposure of housing foundation, sagging of building walls and collapse of houses.

Nigeria like many other developing nations of the world is experiencing rapid rate of urbanization and this process of urbanization among other man's activities has considerable exacerbated erosion in urban area (Jeje, 2005).

Ikare-Akokothe study area is one of the urban centers in Nigeria where soil erosion especially, during the rainy season, renders a lot of commercial activities impotent. Most of the time, eroded debris block drainage channels and eventually submerge culverts while roads and houses that are built in low lying areas and foot of slopes are respectively blocked and covered by eroded soil debris. In so doing, highly valued buildings and roads are damaged thereby respectively causing homelessness and obstruction to the easy passage of human and damage of vehicles plying the damaged roads in the study area.

Urban Soil erosion, and its associated impacts, is one of the most important (yet probably the least well-known) of today's environmental problems (Goudie, (2000), Jeje, (2005) and Jimoh,(2005). As noted, the last 40 years have seen problems of varying severity begin to appear, including contamination, erosion, acidification and compaction,. These problems have brought attention to the importance of the soil cover, the need for better understanding it, and the need for its protection (Bullock and Grergory, 1991).

Thus, with increasing urbanization and expansion, the menace of soil erosion call for prompt in-depth enquiry in to the understanding and proper management of the factors promoting urban soil erosion. Acknowledging the fact that soil erosion problem is wide spread in most cities of Nigeria and within the rapidly expanding built-up area of Ikare-Akoko, this study intend to identify areas plagued with intense soil erosion and the perceived factors encouraging urban erosion in the study area. The study will also examine the factors encouraging urban soil erosion and determine its effects on roads and housing in the study area as well as proffer solution to this menace.

2. The Study Area

Ikare Akoko, is the headquarters of Akoko North-East Local Government Area. Ikare-Akoko lies between Latitudes 7° 30' and 7° 34' North of the Equator and between Longitudes 5° 43'and 5° 46' East of Greenwich Meridian. Ikare-Akoko is about 100 km from Akure, the Ondo State capital and about 250km to Abuja, the Federal Capital of Nigeria. Ikare-Akoko extends over 41Km^{2}to encompass five paramount quarters namely; Okela, Okoja, Oyinmo, Ekan and Okegbe.

The study area is locatedin an undulating highland surrounded by hills and ridges that are made up of basement complex rock. Around Ilepa-Agboriki-Okela in the South East, theuplands are about 750m above the sea level and from here therelief extendedto about 800m above the sea level around Iku - Okorun,Okoja and Okegbe in the South Western area. Thereafter, the foregoing highlands descended to about 600m above the sea level in thecentral plain and from here further descended to lowlands that are relatively below 400 m around Agolo in the North West through Semisemiin the North to Iboropa area in the North East.

Ikare-Akoko has a tropical sub humid climate with two distinct seasons, namely wet and dry season. The wet season usually lasts seven months starting from April and ending in October. The annual rainfall total ranges from 1,300mm to 1,650mm while mean monthly temperatures is 23^{0}C (Agro-MetDiv. ODSG, 2013).The vegetation of the study is of derived savannah while its soils are ferruginous lateritic soils because they developed from basement complex with sandstone and ferruginous rocks. The soil of Ikare – Akokoare very sticky when wet, but hard when exposed.

Ikare-Akoko, because of its nodal position, is one of the major commercial centers in OndoState. The population of Ikare-Akokoaccording to the 1963 census was put at 61,669; this grew up to 76,876 and 126,625 in 1991 and 2006 census respectively. The high rate of the influx of people to Ikare-Akoko in recent year has not only resulted in to socio-economic development but has ironically resulted in to daily increase in pressure on Ikare-Akokoland thereby causing a lot of environmental problems of which soil erosion is prominent.Though, land use in IkareAkoko include residential, agricultural, educational and religious land use among others but the highest portion of Ikare-Akokoland is under residential use with more than 50% housing density being observed in the core area (Tomisin, 2012).

3. Materials and Method

This research adopted both field observation and field survey methods to generate the data on the menace of soil erosion in Ikare-Akoko. Using the five basic quarters of the study area as the sampling frame, random balloting method without replacement was used to sample five streets in each of the five quarters while systematic sampling method at an interval of four houses was adopted to select twenty houses in each of the twenty –five sampled streets (Table 1). Thereafter, household head in each of the sampled houses was administered copy of questionnaire designed for this study. Thus, five hundred respondents (0.4% of 2006, Population of Ikare-Akoko) were interviewed for this study (Table 1).

Table 1: Summary of the Sampled Streets and sampled Respondents

Quarters	Names of Sampled Streets	Sampled Respondents
Okela,	1. AgboOke Street	20
	2. OdoAgbara Street	20
	3. OkeEmeje Street	20
	4. AgboIsaleStret	20
	5. Owalukare Street.	20
Okoja,	1. Sasere Street.	20
	2. Kutelu Street.	20
	3. Ilepanugbor Street.	20
	4. Bada Street.	20
	5. Alafin Street.	20
Oyinmo,	1. Akinnigbagbe Street	20
	2. Olumofin Street	20
	3. Okega Street	20
	4. Okeledo Street	20
	5. Okeriye Street	20
Ekan,	1. Odeke Street.	20
	2. Odagun Street	20
	3. Ilasepo Street	20
	4. Ododo Street	20
	5. Ebinrinoko Street.	20
Okegbe,	1. Oketun Street	20
	2. Emeje Street	20
	3. Aloko Street	20
	4. Arunwa Street	20
	5. Terere Street.	20
5 Quarters	25 Streets	500 Respondents

Source: Researcher Field Work, 2012.

Subjective notions of the respondents were converted to objective notions using 3-points Likert scale of —To no extent" (1) "To a little extent" (2) and "To a large extent" (3). The Mean Weight Value (MWV) for each response and the General Mean Weight Value (GMWV) for grouped responses were both calculated and used to determine the acceptable variable (s) (Ogunbodede2000 and Sunmola, 2005). Kendal Tau Statistical Analytical Technique was usedat p = 0. 5to determine the relationship between respondents' responses.

4. Results and discussion

1) Areas Prone to Erosion in IkareAkoko

The calculated GMWV for the perceived areas prone to erosion in Ikare-Akokois 2.23(Table 2). Thus, the study established that paved roads (2.32) and unpaved roads (2.31), building foundations (2.30) and areas adjourning buildings (2.24) are the areas that are prone to erosion in Ikare-Akoko because their MWVs are more than the GMWV or the cutoff point (2.23).

However, areas along the foot of hill and or slopes are rejected because their mean weight value (1.99) is below the General Mean Weight Value or the cutoff point (2.23). This is becausethe hill and slope areas in Ikare-Akoko due to city expansion have become built-up areas and in so doing, most of the hills and slope surfaces have been covered by buildings.

Table 2: Areas Prone to Soil Erosion inIkare-Akoko

Perceived Areas Prone to Erosion	To no extent" (1)	—To a littl extent" (2)	To a large extent" (3).	Total					Decision
Paved roads	32	37	81	150	74	243	349	2.32	Accepted
Unpaved roads	32	40	78	150	80	234	346	2.31	Accepted
Building foundations	35	35	80	150	70	240	345	2.30	Accepted
Other areas adjourning buildings	41	32	77	150	64	231	336	2.24	Accepted
Areas along / foot of Hill / slopes	33	85	32	150	170	96	299	1.99	Rejected
						GMWV		2.23	

Source: Field Work, 2014.

2) Factors Inducing /Encouraging Soil Erosion in Ikare-Akoko.

The GMWV for perceived factors encouraging erosion in the built-up areas of Ikare-Akoko is 2.21 (Table 3). The study identified poor design (2.39) and usages of inferior materials to construct structures (roads and buildings) (2.31) as the major perceived factors inducing soil erosion in the study area. It is equally noted that absence of road drainage and narrowness of drainage width where present to accommodate volume of runoff (2.33) encourage soil erosion in the study area because their MWVs are above the calculated GMWV of 2.23.

But, factors such as exposure of cleared land/ quarrying and excavation of gravel, sand and soil along slopes (2.11) and repeated compaction and loosing of slopes surfaces by the movement of people and vehicles/machines (1.92) were rejected because their MWVs is below 2.23 the calculated GMWV for factors encouraging erosion in the study area.

Table 3: Factors Encouraging Erosion in the Study Area

Factors Encouraging Erosion	1 To no extent	2 To a little extent"	3 To a large extent	4 Total	Linkert 3Points Rating Scale			5 Total	6 = 5/4	Decision
					1	2	3			
Poor design and erection of roads and buildings	23	45	82	150	23	90	246	359	2.39	Accepted
Absence of drainage and narrowness of drainage width	32	37	81	150	32	74	243	349	2.33	Accepted
Usage of Inferior materials to construct and pave drainage	32	40	78	150	32	80	234	346	2.31	Accepted
Exposure of cleared land/ quarrying and excavation of gravel, sand andsoil along slopes for building	26	81	43	150	26	162	129	317	2.11	Rejected
Repeated compaction and loosing of slopes surfaces by the movement of people, and vehicles/machines.	35	92	23	150	35	184	69	288	1.92	Rejected
GMWV	**2.21**									

Source: Field Work, 2014.

3) Effects of soil erosion on Road transport

The GMWV for perceived effects of soil erosion on road transport in Ikare-Akoko is 2.21(Table 4). Because their MWVs are above the GMWV of 2.21, it is further suggested thatblockage of road by deposited debris (2.48), washing away and blockage of road drains (2.34), traffic congestions and accidents (2.31) are the major effects of soil erosion on road transportin the study area.

Factors such as washing away of substantial parts of road portion (2.13) and puncturing of tyres by sharp objects imbedded inside deposited debris (1.77) are noted in some other places (Jimoh, 2010, Ogunbodede and Sunmola, 2014) but they are rejected because their MWVs are below the calculated GMWV (2.21). Thus, they are not perceived effects of soil erosion on road transport in the study area.

Table 4: Effects of soil erosion on Road transport

Effects of soil erosion on Road transport	1 To no extent	2 To a little extent	3 To a large extent	4 Total	Linkert 3Points Rating Scale			5 Total	6 = 5/4
					1	2	3		
Blockage of road by deposited debris	22	34	94	150	68	282	372	2.48	Accepted
Washing away and blockage of road drains.	30	39	81	150	78	243	351	2.34	Accepted
Traffic congestions and accidents	24	56	70	150	112	210	346	2.31	Accepted
Washing away of substantial parts of road portion	32	66	52	150	132	156	320	2.13	Rejected
Puncturing of tyres by sharp objects imbedded inside deposited debris.	65	54	31	150	108	93	266	1.77	Rejected
GMWV2.21									

Source: Field Work, 2014.

4) Effects of soil erosion on Buildings in the Study Area.

Table5 shows that the GMWV for the perceived effects of soil erosion on buildings in IkareAkoko is 2.38. Thus, the effects of soil erosion on buildings are mostly felt on the exposure of housing foundation (2.58), sagging of building walls (2.57) and collapse of houses (2.50) in the study area.

Cutting off of linkage routes to residential areas (2.27) and washing away of spaces between buildings (1.98) are not perceived as effects of soil erosion on buildings in the study area because their MWVs are below the GMWV 2.38) for perceived effects of soil erosion on buildings in the study area.

Table 5: The Perceived effects of soil erosion on housesin IkareAkoko

Effects of soil erosion on housing	1 To no extent	2 To a little extent	3 To a large extent	4 Total	Linkert 3Points Rating Scale			5 Total	6 = 5/4
					1	2	3		
Exposure of housing foundation	11	41	98	150	82	294	387	2.58	Accepted
Sagging of building walls	15	34	101	150	68	303	386	2.57	Accepted
Collapse of buildings	21	33	96	150	66	288	375	2.50	Accepted
Washing away of spaces between buildings	23	63	64	150	126	192	341	2.27	Rejected
Cutting off of linkage routes to residential areas.	54	45	51	150	90	153	297	1.98	Rejected
GMWV	= 2.38								

Source: Field Work, 2014.

5) The Relationship between factors encouraging soil erosion and effects of soil erosion on Road transport and Housing in IkareAkoko

The results of the analyses carried out on the hypotheses that there is no significant relationship between factors encouraging soil erosion and effects of soil erosion on Road transport and buildings in the study area shows that at p= 0.05, factors encouraging erosion has a very high positive and significant correlations of about 0.992 and 0.988 respectively with the effects of soil erosion on housing and road transport in the study area.

The foregoing shows that factors encouraging erosion have 98.4% and 97.6% variation on the effects of erosion on roads and buildings in the study area. The foregoing signifies that poor design and usages of inferior materials to construct roads have 98.5%influences on erosion to cause blockage of road, washing away and block road drains and eventual traffic congestions and accidents in the study area.

Moreover, poor design and usages of inferior materials to build houses have 97.6% influences on erosion to cause exposure of housing foundation, sagging of building walls and eventual collapse of houses in the study area.

Table 6: The Relationship between factors encouraging soil erosion and effects of soil erosion on Road transport and buildings in Ikare-Akoko

Variables	R	R^2	R^2 x 100	α	Df	Cal. t	Tab. t	Decision
factors encouraging erosion and effects of soil erosion on housing	0.992	0.984	98.4%	0.05	n-2 =5-2 =3	14.03	3.19	H_o was rejected
factors encouraging erosion and effects of soil erosion on Road transport	0.988	0.9764	97.6%	0.05	n-2 =5-2 =3	11.14	3.19	H_o was rejected

Source: Field Work, 2014.

5. Conclusion

This study has shown that poor design and erection of structures (roads and buildings) with inferior materials (mud and sand) and absence of drainage and or narrow width drains are the factors that use to encourage soil erosion in the study area. Moreover, the effects of soil erosion in the study area are felt in terms of blockage of road, washing away and blockage of road drains, traffic congestions and accidents, exposure of housing foundation, sagging of building walls and eventual collapse of buildings in the study area.

6. Recommendation

This study therefore recommends the need for the use of good designs and quality materials in the construction of buildings, roads and drains in the study area. Moreover, annual clearance of drains must be done before the onset of rain every year and this should be periodically done during the rainy season. Doing this will eventually reduce erosion and its attendant destructive activities on structures in the study area.

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References

[1] Bullock, P and Gregory, P.J (1991): Soils in Urban Environments.(Ontario) Blackwell Publishing
[2] Craul, P. J. (1985): "A Description of Urban Soils and Their Desired Characteristics." Journal of Arboriculture 11: 330–339.
[3] Enabor, E.E and Sagua, V.O.(1988): Ecological Disaster In Nigeria, Soil Erosion , Introduction and Recommendations In Sagna, V.O., Enabor, E.E.Ofomata, G.E.K.,Ologe,K.O And Oyebande(Eds) Ecological Disaster In Nigeria: Soil Erosion . Federal Ministry of Science and Technology, Lagos, Nigeria vii-xx
[4] Gregory, J. H., M. D. Dukes, P. H. Jones, and G. L. Miller.(2006): "Effect of Urban Soil Compaction on Infiltration Rate." Journal of Soil and Water Conservation 61 (3): 117–128.
[5] Guputa, A and Ahmad, R (1999): Urban Steep lands In The Tropics; An Environment Of Accelerated Erosion. GeoJournal Vol. 49., 143-150.
[6] Hughes, A.O, Prosser, I.P, Stevenson, J, Scott, A., Lu. H., Gallant, J. and Morgan, C.J (2001): Gully Erosion Mapping for the National Land Water Resources Audit. Technical Report 26/01,CSRO Land and Water, Canberra, Australia.
[7] Ibitoye, M and Eludoyin, A (2010): Urban Growth and Development of Soil Erosion in Part of Humid Region in Southwest Nigeria.FIG Congress 2010. Facing the Challenges – Building the Capacity, Sydney, Australia, pp11 – 16 .
[8] Ibitoye, M.O. (2012): Evaluation of Urban Gullies Characteristics in South Western Nigeria. An Unpublished Ph.D Thesis Submitted to the Department of Geography, ObsfemiAwolowo University, Ile-Ife, Nigeria.
[9] Ionita, I. (2006): ―Gully Development in Moldarian Plateaus of Romania," Journal of Environmental Management, Vol. 68, No. 2-3, 2006, pp. 133-140.
[10] Jeje, L. K. And Ikeazota, S.I (2002): Effects of Urbanization On Channel Morphology: The Case of Ekulu River In Enugu, Southeastern Nigeria. Singapore Journal of Tropical Geography. Vol. 23 No1, 37-51
[11] Jeje, L.K (2005): Urbanization and Accelerated Erosion: Examples from Southern Nigeria. Environmental Management Journal. vol.2, pp 1-17.
[12] Jimoh, H. I. (2005): ―Tropical Rainfall Events on Erosion Rates in a Rapidly Developing Urban Area in Nigeria," Singapore Journal of Tropical Geography, Vol. 26, No. 1, pp. 74-81
[13] Kaufman, M (2000):. Erosion Control at Construction Sites: The Science-Policy
[14] Murck, B.W., Skinner, B.J and Poter, S.C.(1996) : Environmental Geology. John Wily and Sons. Inc. New York.
[15] Pouyat, R. V., I. D. Yesilonis, J. Russell-Anelli, and N. K. Neerchal. 2007. "Soil Chemical and Physical Properties That Differentiate Urban Land-Use and Cover Types." Soil Sci. Soc. Am. J. 71 (3): 1010–1019.
[16] Sun, H.,Gan, Z., Yan, J.(2001):The impacts of urbanization on soil erosion in the Loess Plateau Region.Journal of Geographical SciencesVolume 11, Issue 3 ,pp 282-290
[17] UN (2007) : State of the World Population". UNFPA. 2007.
[18] Urban Life (2012): Open-Air Computers". The Economist. 2012-10-27. Retrieved 2013-03-20.
[19] USDA. 2000. Erosion and Sedimentation on Construction Sites. Soil Quality- Urban Technical Note. Soil Quality Institute.
[20] World Urbanization Prospects (2005): The 2005 Revision, Pop. Division, Department of Economic and Social Affairs, UN"
[21] Zuazo, V. H.Dand Pleguezuelo, C.R.R. (2009). "Soil-Erosion and Runoff Prevention by Plant Covers: A Review". In Lichtfouse, Eric et al. Sustainable Agriculture. Springer. p. 785.