The Effects of Gully Erosion on Physical and Socio-Economic activities in Akko Local Government Area of Gombe State, Nigeria

[a]Jibo, A. A., [b]Laka, S. I. and [c]Ezra, A.
[a]Department of Hospitality and Tourism Management, Federal University Wukari, Nigeria
[b]Department of Geography and Planning, University of Jos, Nigeria
[c]Department of Geography, Modibbo Adama University of Technology, Yola, Nigeria
Correspondence email: andrewezra12@gmail.com

Abstract

Gully erosion has become a serious environmental disaster and also a threat to well-being of people. It has threatened and destroyed many of the physical infrastructures, properties, as well as retarding the social and economic growth and development of the inhabitants. The research assesses the effects of gully erosion on physical and socio-economic activities in Akko Local Government Area of Gombe State, Nigeria. Data were obtained through physical observation, interview, google earth, Global Positioning System (GPS), and observation and questionnaire administered to household heads of targeted residents within the study area. The questionnaires were administered based on the issues relating to the effects of gully erosion on physican structures and the socio-economic activities of the respondent. Result of the impact of gullies on the physical infrastructures, it was observed that, the most affected physical facility is identified to be residential houses while result on the impact of gully erosion on socio-economic activities revealed that, farming is the most identified mean of livelihood affected by gully. Result of the gullies control measures revealed that, planting of trees and grasses, sandbag embankment, broken stone embankment and landfills were the method used in controlling gully erosion. The research therefore, recommends channeling of runoff water to less risk areas, planting of trees and other vegetation cover to control gully erosion. In addition, construction of physical structures and farmland along gully side should be discouraged.

Keywords: Effects, Gully Erosion, Physical, Socio-Economic, Akko, Nigeria

INTRODUCTION

Soil is one of the most important natural resources that is available everywhere. It is normally the major determinant of physical activities, for instance farmers considers its types, fertility and texture among others for site suitability in lieu of crops. Civil engineers relate soil types to residential development while, the availability of some mineral resources also largely depend on the soil types. Despite the fact that soil is very paramount to the well-being of the physical and socio-economic activities of man, erosion remains a threat to soil quality and quantity (Mbaya, 2013). Soil erosion is the loss of topsoil under the action of water or wind. Water runoff carries the topsoil away the loss of topsoil reduces fertility because as the soil becomes denser and thinner, it is less penetrable by growing roots and may become too shallow for them; the capacity of soil to retain water and make it available to plants is reduced; and plant nutrients is wash away with soil particles. Erosion leads to the formation of sheets, rills and gullies. Sheet erosion occurs when these soil particles are easily transported in a thin layer, or sheet, by flowing water. If this sheet runoff is allowed to concentrate and gain velocity, it cuts rills and gullies as it detaches more soil particles. As the erosive force of flowing water increases with slope length and gradient, gullies become deep channels and gorges (Poessen, 2011). Gully erosion is defined as

the terminal phase of a four-stage erosion process involving splash, sheet, rill, and gully (Amangabara, 2012). It is also defined as steep-sided channels, often with steeply sloping and actively eroding head scarp landscape usually ranging from 30cm to 30m deep, caused by the intermittent flow of water, usually during and immediately following heavy rains (Poessen *et al*., 2003).

Gullies are perhaps the most devastating and wide spread form of soil erosion (Brooks, 2009). In Nigeria, the World Bank recognized three main environmental problems: soil degradation and loss, water contamination and deforestation of which gully erosion is a subset of each of these problems and causes damage (Agagu, 2009). Furthermore, in 2009, the World Bank Country report on Nigeria listed gully erosion as one of the top five hazards threatening the countries environment (Mbaya, 2013). Gullies could be considered as signals of disturbances and accelerated erosion brought about by climate or land-use change. Erosion by gullies can be an acute problem causing high sediment yield, removal of fertile soil, destabilization of hill slopes, and the lowering of water tables in alluvial aquifers. Apart from the loss in soil fertility and continuous diminutions of cultivable land, there is additional loss of properties to include losses of homes, household belongings, farm crops and utilities (Danladi and Ray, 2014).

Gully erosion is active and at alarming rate due to soil texture and structure, slope, rainfall, human activities such as deforestation, over grazing, excessive cultivation, bush burning and construction works amongst others in Akko (Mbaya, 2013). Another major factor that contributes to erosion is population increase. The population growth rate of Akko Local Government Area was 2.3% according 2006 National Census, and naturally when there is an increase in human population; both human and physical activities will be under pressure (Mbaya, 2012). It is against this background that this paper examines the effects of gully erosion on the physical environment and livelihood of the residents in the study area and mitigation/control measures put in place in the study area.

Study area

Akko Local Government Area is located within latitude 9º48′ to 10º24′N of the equator and longitude 10º41′ to 11º24′E, of Greenwich meridian (Figure 1). It has an area of about 2,627 square kilometers and shares common boundary with Gombe LGA to the north, to the east by Yamaltu Deba LGA, to the south by Billiri and Kaltungo LGA and to west by Bauchi State.

Akko L.G.A has wet and dry seasons with a mean rainfall of 850mm. However, annual rainfall in recent years has declined to less than 850mm (Bulzerek, 2003). The rainfall is concentrated between the months of May to September with its maximum in July and August. Rainfall amount is highest during the month of August and lowest during the month October. Much of the rainfall especially in July and August is associated with storms of high intensity, accelerating gully erosion (Bulzerek, 2003). The mean maximum monthly temperature is 37ºC occurring in March and April, while the mean minimum monthly temperature is 19ºC during the month of December and January, while the mean annual temperature of Akko L.G.A is around 27ºC.

Akko Local Government Area is generally a low lying region of 350m above sea level except for the outcrop like Lijji hill, Gombe hills and hills found in the south-eastern part of the area. The topography of the environment determines the degree of recharge of its aquifers either from run-

offs or directly from rainfall or other forms of precipitation (Agaigbe, 2003). The natural vegetation is shrub woodland that is characterized by the Sudan savanna type, which can be observed in the outskirt of the town. The influence of the increase in population is very clear on the density of the vegetation on the outskirt of the town (Aliyu, 2010).

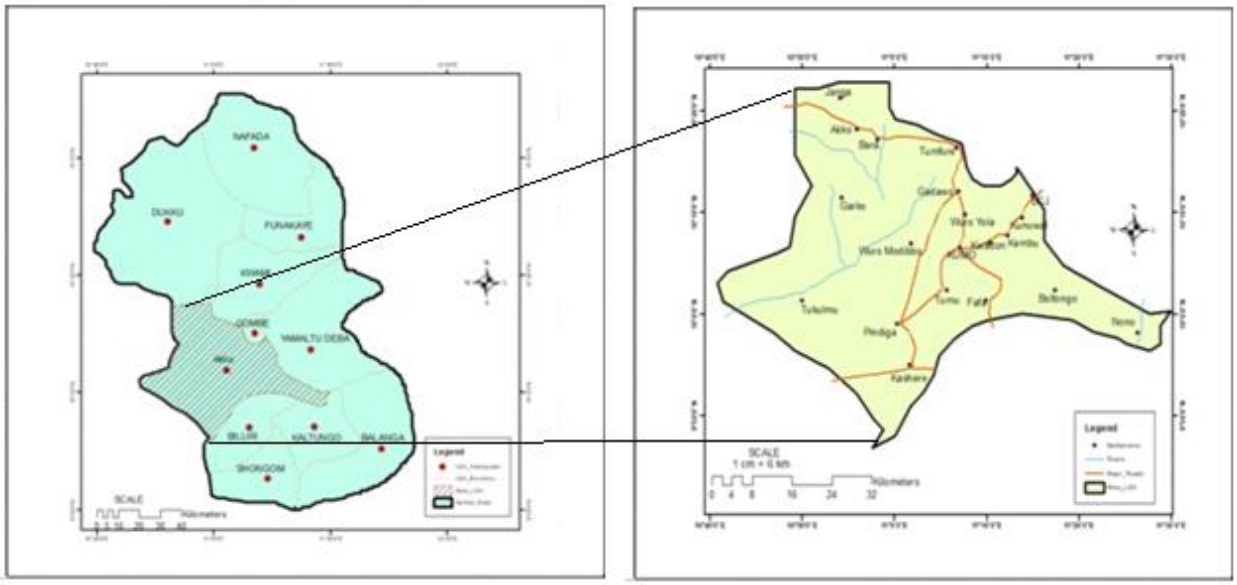

Figure 1: Map of Gombe State Showing Akko Local Government Area

The soil of Akko Local Government Area is that of tropical ferruginuous type. They are brownish reddish in colour and have a pH value ranging from 4-6 depending on the location. The soils are intensively farmed using traditional methods and management practices which reduced their water holding capacity (Aliyu, 2010), with low or reduced water holding capacity these soils allows easy leaching of minerals to the groundwater table as soil with low water holding capacity encourages easy infiltration of water through them. These soils being ferruginous in nature implies they are rich in Iron and Aluminum as these might also be a contributing factor in the concentration of these elements in the groundwater.

METHODOLOGY

The data used in this research are both qualitative and quantitative which are; data on physical structures, gullies location and extent of coverage (distribution), effects of gulling on physical and socio-economic activities, physical and socio-economic components affected by gulling and gully erosion control strategies. Questionnaire was used as an instrument to collect information from the respondents, who are inhabitants of the study area. The questionnaires were administered to respondents in Gadao, Kumo, Wuro Modibbo, Nono, Tukulmu, Pindiga, Kashere, Fafa, Garko, and BCJ. Information collected include; effects of gullies on physical and socio-economic activities, gullies control measures put in place and opinion on how best to manage the effects of gullies within the study area. Observation checklist method was used in data collection through field visitation and appraisal of gullies, in order to answer some questions relating the distribution, effects and management strategies of gullies within the study area.

The study area comprises of all the eleven wards in Akko Local Government Area, because gullies are present in all the wards. The target population of the study was assumed to be the total number of housing forms in the LGA this is premised on the assumption that each housing form represents a household. The total number of housing forms identified along the gully corridors in the eleven study localities stood at 1,362 (Google earth, 2018), these form the target population of the study on which the research work hinged on. For adequate coverage of the study area, the samples collected from the study area is based on a total of 205 questionnaires representing 15% of the study population, but only 197 questionnaires were retrieved from the respondents. Systematic sampling technique was applied in the administration of questionnaires. The questionnaire was administered to the respondents with the help of field assistants and it is expected that the respondent to fill as appropriate and return it to the researcher.

Purposive sampling technique was adopted in the selection of localities where gullying are prevalent within the study area. Purposive sampling is a non-probability sampling which relies on the judgment of the researcher when it comes to selecting the units i.e. piece of data to be studied. Purposive sampling procedure focus on particular characteristics of a population that are of interest, which best answer the research questions of the study. The researcher apply his own criteria purposely when defining sample of gully sites in five selected localities for the study because they possess some characteristics of interest to the researcher during the study. In other to determine a sample size of proportional or percentage Study (prevalence Study), (Ronan 2016) suggested a population size of 146 -333 for a total population of 1,000 - 2,500 with acceptable error margin of 5 -7.5%. Following the nature of this study and with the total population size of 1,362, 205 samples which represent 15% of the total population were considered. The total sample size of the population selected falls within the required population size of 146-333 and acceptance error margin of 5 -7.5% as documented by (Ronan 2016), as such sample size of 15 percent from each sample area was considered in this study.

RESULTS AND DISCUSSION

Results

Impacts of Gullies on Physical Infrastructures

The respondents' perception of the effects of gullies on existing infrastructures is presented in Figure 2. Result of the findings revealed that all the respondents admitted that gullies do exist and gullies affect virtually all the physical infrastructural facilities type that exist in their respective communities and the most affected physical facility is identified to be housing which indicates that human shelter is most threatened by gullies in the study area.

Impacts of Gullies on Socio-Economic Activities

According to the respondents in the sampled localities, the socio-economic activities affected by gulling include; farming, trading, craft work, hunting, among others. From the study, various livelihood means affected by gullies in their respective localities (sample sites) showed that, farming is the most affected with 72.6% , 8.1% identified craft work as being affected, 7.6% identified trading and 6.6% identified hunting. And the least percentage distribution includes, fishing (1%) and other livelihood means such as rearing of animal among among others with 4.1% (Figure 3).

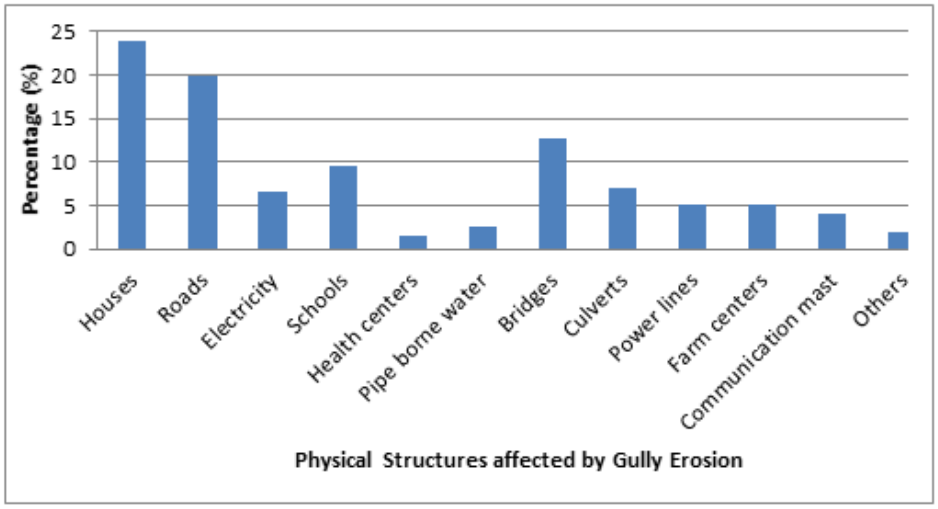

Figure 2: Impact of Gully on Physical infrastructural facilities

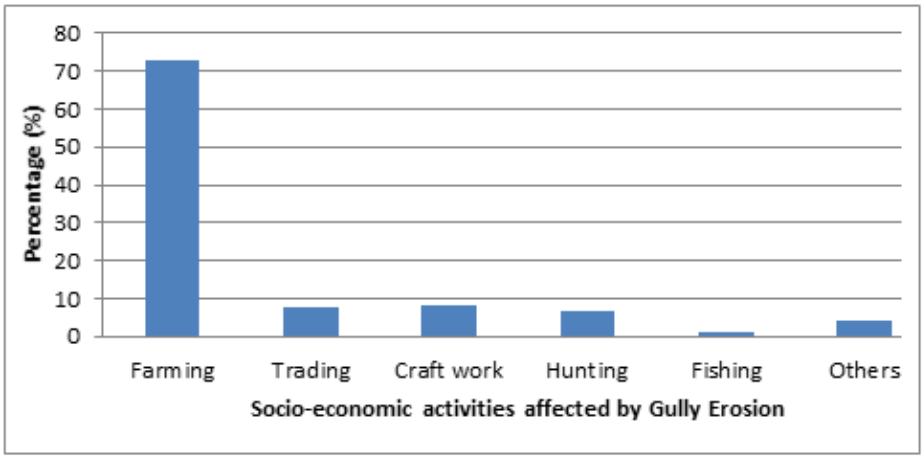

Figure 3: Socio-economic activities

Damages Coursed by Gullies

In Table 1, it was observed that, 49.2% of the respondents indicated that gullies wash away farm land and farm produce, 19.8% of the respondents indicated gullies destroyed grazing fields, 12.2% of the respondents reveal that gullies causes difficulty in farming activities and uprooting of economic trees respectively. Others includes, 4.1% of the respondents reveals that gullies lead to sedimentation of water bodies and 2.5% of the respondents indicated that gullies damage other means of livelihood apart from the ones listed in their localities. Most of the respondents admitted that farm lands and farm produce is the most affected sector or means of livelihood in the study area. The respondents also indicated the level of gullies severity on the various livelihood means. 20. 10.1% of the respondents reveals that the damages caused by gullies are mild, while 47 (23.9%) of the respondents believe that the damages caused by gullies are moderate and 130 (66%) of the respondents reveals that gullies action is severe on the diverse livelihood means of the inhabitants in the study area.

Table 1: Damages caused by gullies

Damages caused by gullies	Freq	%	Severity					
			Mild	(%)	Moderate	(%)	Severe	(%)
Washing of farmlands and produce	97	49.2	6	30	22	46.8	69	53.1
Sedimentation of water bodies	8	4.1	2	10	2	4.2	4	3.1
Difficulty in farming	24	12.2	3	15	8	16.7	13	10
Destruction of grazing fields	39	19.8	3	15	7	14.6	29	22.3
Uprooting of economic trees	24	12.2	5	25	7	14.6	12	9.2
Others	5	2.5	1	5	1	2.1	3	2.3
Total	197	100	20	100	47	100	130	100

Degree of Damages Coursed by Gully Erosion

The empirical evidence provided in Table 2 revealed the proportions of gullies damage on the existing physical infrastructural facilities as follows; the most damaged is built-up structures with 22.3%, 17.8% was for cutting of bridges abutments and destruction of culverts respectively, destruction of roads was 16.2%, danger pits was 13.7%, 9.1% was for difficulty in construction, and 2% was for breaking of water pipes. Others are 0.5% was for uprooting of power pole and others respectively. Others include destruction made by gullies apart from the ones listed. In terms of severity of gullies damage in the study area, 14 (7.1%) of the respondents claim that the damages caused by gullies are mild, another 48 (24.3%) of the respondents believe that the damage caused by gulling are moderate and 135 (68.5%) of the respondents which is the vast majority believe that gullies damages caused by gullies are severe on the existing physical infrastructural facilities in the study area.

Table 2: Degree of Damages Caused by Gullies

Damages caused by gullies	Freq	(%)	Severity					
			Mild	(%)	Moderate	(%)	Severe	(%)
Cutting of bridges	35	17.8	2	14.3	10	20.8	23	17
Destruction of culverts	35	17.8	2	14.3	8	16.7	25	18.5
Collapse of built-up structures	44	22.3	3	21.4	10	20.8	31	23
Danger pits	27	13.7	2	14.3	7	14.6	18	13.3
Difficulty in construction	18	9.1	1	7.1	4	8.3	13	9.6
Breaking of water pipes	4	2	1	7.1	1	2.1	2	1.5
Uprooting of power poles	1	0.5	0	0	1	2.1	0	0
Destruction of roads	32	16.2	3	21.4	7	14.6	22	16.3
Others	1	0.5	0	0	0	0	1	0.7
Total	197	99.9	14	100	48	100	135	100

Gully Control Measures

Result of the major gullies control measures taken by the various communities as indicated in Table 3; revealed that 29% of the respondents revealed that they adopted planting of trees and other shrubs to control the excesses of gullies, 23.9% of the respondents are involved in construction of drainages to avert gullies, and 20.8% of the respondents adopt the use of sandbag

embankment, Others are 14% of the respondents adopt the use of broken stones as embankment and 12.2% of the respondents reveals that they uses sanitary landfills to control gullies in mitigating or controlling gully erosion within their localities. Most of the respondents indicated that they recorded relative success as a result of adopting one or more of the various control or mitigation measures, as seen in Table 5. 72 (36.5%) of the respondents indicated they have recorded high success in the control of gullies, while 57 (28.9%) of the respondents indicates that the control measures are moderately effective and 68 (34.5%) of the respondents indicates that the control measures adopted is lowly effective and revealed that there is need for implementation of other options when it comes to gullies control in the study area.

Table 3: Gullies control measures

Gullies control measures	Freq	%	Effectiveness					
			Highly	(%)	Moderate	(%)	Lowly	(%)
Sandbag embankment	41	20.8	12	16.7	10	17.5	19	27.9
Broken stone embankment	27	13.7	5	6.9	8	14	14	20.6
Planting of trees and grasses	58	29.4	25	34.7	18	31.6	15	22
Landfills	24	12.2	7	9.7	7	12.3	10	14.7
Construction of drainages	47	23.9	23	31.9	14	24.6	10	14.7
Total	197	100	72	99.9	57	100	68	99.9

Discussion

In regards to the impact of gullies on the physical infrastructures, it was observed that, all the respondents admitted that gullies do exist in their localities ever since they were born and gullies affect virtually all the physical infrastructural facilities type that exist in their respective communities. The most affected physical facility is identified to be housing which indicates that human shelter is most threatened by gullies in the study area which agreed with the view of (Dlamini, 2011 and Mbaya, 2012). In addition, impact of gully erosion on socio-economic activities revealed that, farming is the most identified mean of livelihood affected by gully, which implies that, there is need for urgent control measures to check mate gullies in order to attain food security in the study area. This result agrees with the findings of (Dlamini, 2011).

It was also observed that gullies have high impact on physical structures such as cutting of bridges abutments, destruction of culverts and roads. In addition, farm lands and farm produce are the most affected sector or means of livelihood by gully erosion in the study area. Following the information collected, it is clear that entire study area experience severe negative impact of gullies on various physical structures and means of livelihood of the residence.

Gullies control measures based on interview and questionnaires revealed that, the residence cannot adopt expensive erosion control measures such as construction of drainage channels, bridges among others, as such they adopted measures such planting of trees and grasses, sandbag embankment, broken stone embankment, sanitary landfills, construction of drainages which is similar with the view of (Poesen *et al* 2003). In addition, the respondent revealed that, they recorded relative success as a result of adopting one or more of the various control or mitigation measures used in controlling cully erosion.

CONCLUSION

Based on the findings of this study, it was concluded that, gully erosion devastating effects to physical structures and socio-economic activities and the impact of gully erosion is visible on residential houses, bridges, road network and culverts. In addition, was also concluded that, gully erosion causes severe damages to farmland and farm produce. Planting of trees and grasses, sandbag embankments and landfills were the common measures used in controlling gully erosion because of it low cost and easy practice. Based on the findings of this study, the following recommendations were presented:

a) The erosion channels should be diverted from critical areas to areas with little or no risk as well as construction of concrete culverts to channel surface runoff.
b) There should be regular maintenance of roads to keep drains and culvert clean so as to prevent flooding and also installing diversion at drains and culverts where runoff velocity can cause erosion.
c) The community should be encouraged and advised to contribute their quota in addressing the problem through traditional means and other cultural practices such as agro-forestry system, planting of cover crops in their farms, planting trees along the streets as well as other local factors that can mitigate the gully erosion.
d) Finally, there is a need for government at Federal and State level to pass new legislation to establish a soil erosion control agency and extension programme and fund the work at a high level to obtain satisfactory results.

References

Agagu, K.O. (2009). Threats to the Nigerian Environment: A Call for Positive Action. Paper Presentated at the 7th Chief S.L Edu memorial Lecture, Organized by the Nigerian Conservation Foundation.

Aliyu, D. (2012). A comparative Study of Soil Fertility Status under Different Agricultural Practice in Gombe Local Government Area. An unpublished B.Sc. Dissertation, Geography Department B. U. K.

Amangabara, G.T., Njoku, J.D. & iwuji, M.C. (2017). People's Perception of Soil Erosion and its Impact in Imo state, Nigeria. International Journal of Research in Applied, Natural and Social Sciences (IMPACT: IJRANSS) ISSN (P): 2347-4580; ISSN (E): 2321-8851 Vol. 5.

Balzerek H., Werner F., Jürgen H., Klaus-martin M. and Markus R. (2003). Man Made Flood Disaster in the Savanna Town of Gombe/NE Nigeria. In Erdkunde 94-109

Brooks, A., Spencer J., Olley, J., Pietsch, T., Borombovits, D., Curwen, G., Shellberg, J., Howley, C., Gleeson, A., Simon, A., Bankhead, N., Klimetz, D., Eslami-Endargoli, L. and Bourgeault A. (2013). An empirically based sediment budget for the Norman by basin. Griffith University.

Danladi, A. and Ray, H.H. (2014). Socio economics effect of gully erosion on land use in Gombe metropolis, Gombe state, Nigeria journal of Geography and regional Planning Vol. 7 (5) pp. 97-105.

Dlamini, W. (2000). Shape development on Tahiti-nui. Journal of Sedimentary Petrology, 40, 1167-1203.

Mbaya, L.A. (2011). Factors and Rate of Gully Erosion in Gombe Town, Gombe State, Nigeria. Journal of Environmental Issues and Agriculture in Developing Countries, Vol. 3, No. 3; Dec. 2011

Mbaya, L.A. (2012). An Assessment of Gully Erosion in Gombe Town, Nigeria. Unpublished Ph.D Thesis, University of Maiduguri.

Mbaya, L.A. (2013). A Study of Inter-relations among Gully Variables in Gombe town, Gombe State, Nigeria. Wudpecker J Geogr. Regional Plan. 1(1):001-006.

National Population Commission (NPC) (2006) Nigeria National Census: Population Distribution by Sex, State, LGAs and Senatorial District: 2006 Census Priority Tables (Vol. 3). http://www.population.gov.ng/index.php/publication/140-popn-distri-by-sex-state-jgas-and-senatorial-distr-2006.

Offodile, M.E. (2002). Groundwater study and development in Nigeria. Mecon, Jos, Nigeria, 451 pp.

Ofomata, G.E.K. (1976). Soil erosion. Nigeria in maps, Eastern States, Ethiope Publishing House, Benin City Nigeria.

Ofomata, G.E.K. (2015). Erosion in Nigeria: The views of a Geomorphologist. University of Nigeria Nsuka. Inaugural lecture.

Poesen, J., Nachtergaele, J., Verstraten, G. and Valentin, C., (2003). Gully erosion and environmental change: importance and research needs. Catena 50: 91-133.

Poesen, J. (2003) "Gully erosion in dry land environment". In Bull, Louise J. & Kirby, M.J. Dryland Rivers: Hydrology and geomorphology of semi-Arid channels. John wiley & Sons. ISBN 978-0-47149123-1

Poesen, J. (2011). Challenges in gully erosion research. Journal of Landform Analysis 17(5-9)

Ronán M C (2016). The RCSI Sample size handbook: A rough guide. May 2016 version. Semanticscholar.org/paper/The-RCSI-Sample-size-handbook-conroy.