INTERNATIONAL JOURNAL FOR INNOVATIVE RESEARCH IN MULTIDISCIPLINARY FIELD ISSN: 2455-0620 Volume - 7, Issue - 4, Apr – 2021
Monthly, Peer-Reviewed, Refereed, Indexed Journal with IC Value: 86.87 Impact Factor: 6.719
Received Date: 15/04/2021 Acceptance Date: 28/04/2021 Publication Date: 30/04/2021

Environmental effects of laterite excavation on household livelihoods in Nyamache Sub-County, Kisii County, Kenya

[1] **Mr. Chweya Bernard Samson,** Geography and Social Development, Jaramogi Oginga Odinga University of Science and Technology (JOOUST), Bondo, Kenya.

[2] **Prof. Ang'awa Francis Okere,** Geography and Social Development, Jaramogi Oginga Odinga University of Science and Technology (JOOUST), Bondo, Kenya.

[3] **Dr. Warkach Kipkoris Tonui,** Geography and Social Development, Jaramogi Oginga Odinga University of Science and Technology (JOOUST), Bondo, Kenya.
Email – [1]samsbc6@yahoo.com, [2]angawafrancis@gmail.com, [3]kwtonui@yahoo.com

Abstract: *Laterite is a highly ferruginous deposit has been used for road repair and maintenance. Researches on laterite excavation in Kenya are focused on its utilization and effects on the environment and socio-economic status. Consequently, studies on laterite excavation and effects are on the increase. Despite the existence of these studies, there is inadequate scholarly attention on the environmental effects of laterite excavation on household livelihoods at local levels. This paper examined the environmental effects of laterite excavation on household livelihoods in Nyamache sub-county, Kisii County, Kenya. The study employed descriptive survey design. A sample of 96 household heads (purposely selected) was used. Primary data was collected using interview schedules, structured questionnaires, observation checklists and photography. Secondary data was collected from published works which comprised of journals, articles, theses and credible internet resources. Qualitative data was subjected to content analysis, coding, generation of patterns and themes. Quantitative data was analyzed using descriptive statistics. Quantitative and qualitative data were integrated and presented by use of statistical tables, graphs, pie charts, percentages, plates and themes. The study findings established that laterite excavation was rampant in the study area due to its economic benefits to households' livelihoods. The findings further established that laterite excavation led to land pollution, degradation and damage to the biodiversity. Additionally, the unclaimed open pits provided breeding grounds to disease vectors. The study emphasized on reclamation measures to be put in place to mitigate on the negative environmental effects on households' livelihoods.*

Key Words: *Environment, Laterite, Excavation, Household, Livelihoods.*

1. INTRODUCTION:

Laterite is a soil type rich in iron and aluminium formed in hot and wet tropical areas (Tardy, 1997). Raychaudhuri, (1980) postulates that laterite was first discovered as a highly ferruginous deposit in Malabar, India and named after *later,* which is a Latin name for brick and has well been known in Asian countries as a building material for more than 1000 years. Existing studies concur that laterite is an ideal material for sustainable building. It has become a popular building material in tropical regions of the world due to its availability and economic benefits, compared to other natural earth materials (Stephen, 1961; Ndububa, *et al*., 2016; Oyelami and Van Rooy, 2016). Additionally, laterite is cost effective and possess better energy efficiency when compared to conventional modern building materials in tropical countries (Kasthurba, Krishna, and Venkat, 2014; Ndububa, 2017). Plain Earth Bricks (PEB) has been used for centuries in the building of mud houses (Bahar, Benazzoug, and Kenai, 2004). A study by Ajibuah (2012) reveals that the Fai community of Kaduna-State Nigeria use laterite in making local bricks which serve as a source of cheap raw material for building residential houses.

Adekoya (2003) observed that in all areas of laterite exploitation, the predominant form of mining used is the open cast method; where all the vegetation and top soils are removed, thus destroying wildlife habitats and preventing economic activities such as farming and hunting. Aigbedion (2005) asserts that laterite is an exhaustible and non-renewable resource of the earth crust. Due to the uncontrolled manner the illegal miners operate, a lot of damage is done to the environment by haphazard pitting and trenching of the ground in many areas.

Ocansey (2013) indicated that the extensive land clearance and open-pit had resulted in the destruction of vegetation, biodiversity of natural water such as streams, rivers, ponds etc. Consequently, farming activities are restricted to very small holdings. The people are likely to be engulfed by poverty since the farms which are the major source of livelihood for the indigenous people in the area have been relegated to the background. This is another avenue to help break the chain of poverty of the farmers in such communities.

A study carried out by Devalsam *et al.* (2014) on laterite excavation in Calabar Metropolis, Nigeria, show that machineries used to extract laterite disturbs the vegetation cover and exposes the area to erosion and degradation. Aigbedion (2005) observed that large scale exploitation of laterite results in a high degree of degradation of arable land, vegetation, landscape, loss of endangered species as well as other environmental problems. Severe land degradation caused by mining affects a significant portion of the earth's arable lands, decreasing the wealth and economic development of Nations (Devalsam *et al.*, 2014). As the land resource base becomes less productive, food security is compromised and competition for dwindling resources increases. Hence households are not able to meet their livelihoods (*ibid*).

Rejoice (2013) in a study examining land degradation in Gunda, Borno state, Nigeria observed that the detrimental effects of mining in the environment at local, regional and global levels will continue to be a topic of public concern. He showed that mining was a primary activity that had competed with farming in the area. This resulted in degradation of the landscape in the area. This impacted negatively on household livelihoods in the study area as most of the inhabitants depended on farming to source for their livelihoods.

Kitula (2006) in a study on gold mining in Geita district, Tanzania, affirms that mineral exploitation involves the appropriation of lands from indigenous people and massive displacement of settlements. In rural communities, locals depend on the land as a source of livelihood. The displacements threaten people's livelihoods and may result in confrontation between local people and staff at mines. Laurence (2001) postulated that for many years, mining companies focused on raw material production and generally neglected the effects on the environment of the mining operations. In many cases, mines have been abandoned in a highly disturbed condition, with limited or no rehabilitation treatment (EAPC, 2009). This can have destructive environmental impacts, and are an unwelcome legacy for governments and communities to deal with (Whitlow, 1991; Nichols and Gardner, 1998; Moffat, 2001).

Nissen-Petersen (2006) indicated that in Kenya borrow pits are excavated during road construction. Adeyemi and Wahab (2008) observed that the laterite soil, found at the bottom of such pits is usually impermeable and in demand for paving dirt roads. A report by USAID (2009): Support for Rural Roads, is generally confined to the development or rehabilitation of non-asphalt roads, with one- or two-lane unpaved surfaces. These may be constructed to provide farmers with access to markets or to increase community access to services such as health care or schools. Road improvements may bring substantial economic and social benefits to both rural communities and economy. But they may also lead to significant environmental damage (Devalsam *et al.*, 2014).

Laterite excavation is mainly for sourcing large supplies of raw materials for the construction industry in Kenya (EAPC 2009). The traditional open cast mining practices have caused destruction of land resources. The destructive effects include: denudation of vegetation cover, creation of uneven topography, loss of soil fertility, surface crusting and soil erosion (Kurmar, 1986; Sharma and Roy, 1997). When laterite excavated sites are inappropriately managed, they are likely to remain unutilized for centuries (Gathuru, 2011). These studies majorly focused on laterite excavation and its effects on the environment, vegetation cover and biodiversity, socio-economic benefits amongst others; there was still a gap on the effects of laterite excavation on household livelihoods. Therefore, this study was designed to examine the environmental effects of laterite excavation on the households in Nyamache sub-county, Kisii County, Kenya.

2. MATERIALS AND METHODS:

Materials and methods constitute the study area, target population, sampling procedure and sample size, data collection methods and tools, data analysis and presentation.

2.1 Area of Study

This study was carried out in Nyamache sub-county in Kisii County. Nyamache sub-county is one of the 11 sub-counties of Kisii County. It is located in Bobasi constituency and neighbour to sub-counties such as Sameta to the North, Kenyenya to the West, Gucha to the West, Kisii Central to the East and Trans Mara to the South as illustrated in

Figures 1. It is located between latitudes 0º47′00″ south and between longitudes 34º50′00″ east.

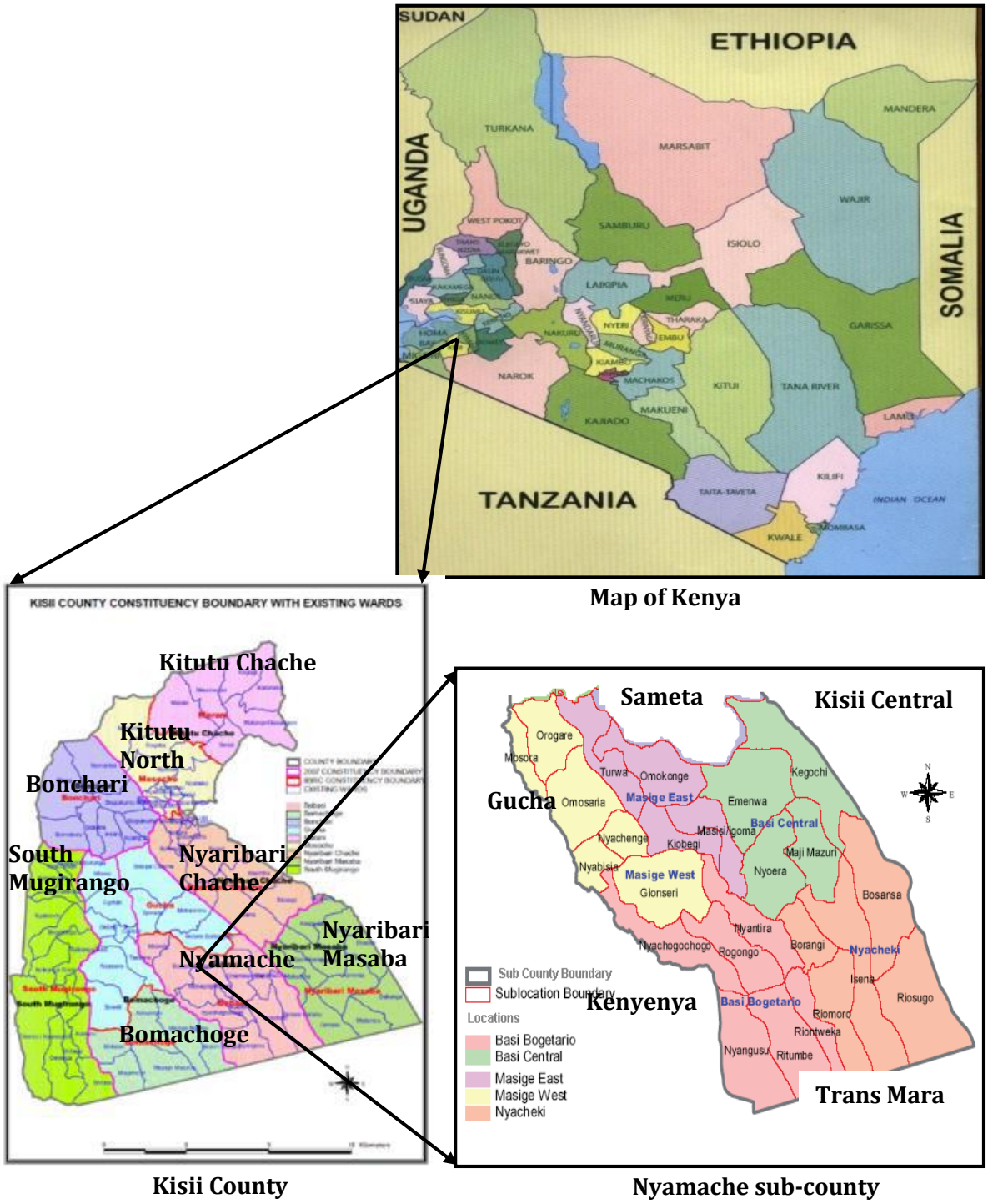


Figure 1: Map showing the relative position of Nyamache Sub-County
Source: IEBC (2012)

According to 2019 population census Nyamache sub-county covers an area of 162.7 km^2 and a population of 130,898 people with a population density of 805 persons/km^2 and 30,712 households with an average household size of 4.3 (KNBS, 2019). It is characterized by a hilly topography with several ridges and valleys, covering the areas lying between 1500-1800 metres above sea level (ASL), located in Gucha River basin (NEMA, 2009). It enjoys a highland equatorial climate resulting into a bimodal rainfall of 1500mm with the long rains between March and June while the short rains are received from September to November. The months of January and July are relatively dry. Temperatures ranges are between 15^{0}c and 30^{0}c (NDDP, 2008). The high and reliable rainfall coupled with moderate temperatures is suitable for growing crops like tea, coffee, pyrethrum, maize, beans and bananas as well as dairy farming. It generally

receives rain all year round due to its position in the Lake Victoria basin and the heavy foliaged Kisii highlands (NEMA, 2009).

NDDP (2008) categorized the main land uses in the area into three: agriculture, trading and quarrying. Agricultural activities involve both subsistence and cash crop farming. The cash crops grown include tea, coffee, sugarcane and pyrethrum. People are also involved in trading on agricultural produces and non-agriculture produce. Thus, the economy is driven by commerce and agriculture. Laterite excavation is also a main activity whereby the excavation sites are placed under a lease tenure system, where the developers lease the land from the owners at an agreed fee until the quarry work is finished.

2.2 Target Population

The target population comprised 26,458 household heads according to KNBS (2009) in the mapped laterite excavated areas in Nyamache Sub-county. Also included were quarry owners, laterite miners and NEMA officers in all the five sampled locations of Nyamache Sub-county.

2.3 Sampling Procedure and Sample Size

Purposive sampling based on random stratified technique was used to determine sample size of household heads as respondents to questionnaires as illustrated in table 2.1. This follows (Hancock, 1998 and Lewis-Beck *et al.*, 2004) who affirmed that purposive sampling is advantageous in obtaining rich information cases that provide in-depth information about a particular phenomenon. Palys (2008) insists that when using purposive sampling it is important to seek sites that will provide an understanding of the situation of a wider group of affected people.

Firstly, 96 households out of 26,458 households according to KNBS of 2009 were purposively chosen using simple random stratified sampling procedure based on Alain Bouchard's formula and table. In the second stage the 96 households were apportioned to the five (5) locations according to the number of households out of the total number of 26,458 (KNBS, 2009) households in Nyamache sub-county and accordingly sample sizes of households in each location determined. Thereafter simple random stratified sampling was used to choose these households from the KNBS of 2009 list. The chosen household heads in the 96 households constituted the respondents to the questionnaires, interview schedules and observation checklists.

Table 2.1: Sample size tabulation (n = 96)

Division	Location	Households	Proportion	Sample Size
Nyamache	Bassi Central	4,923	0.19	18
	Bassi Masige East	4,100	0.15	14
	Bassi Masige West	3,755	0.14	14
Nyacheki	Bassi Bogetaorio	5,328	0.20	19
	Nyacheki	8,352	0.32	31
Total		26,458	1.00	96

Source: (KNBS, 2009)

2.4 Data Collection

Data was collected from both primary and secondary sources. Primary data was sourced from oral interviews, filled questionnaires and observations conducted at the various stages of the detailed study. Sample sizes were determined within the 5 locations of Nyamache sub-county from which studies were carried out. These were done in three stages. Stage one was the reconnaissance survey aimed at familiarizing the researcher with the study area. General observations of the area were made and sample sites identified. The identification of sample sites was based on the purposive sampling technique.

Stage two involved data collection thus detailed observation was made to identify the mode of laterite excavation, identify the kinds of degradation that has occurred and also to find out the use to which the heavily mined sites have been put to; and to assess the livelihood outcomes of the laterite excavation. Also it involved the administering of questionnaires and conducting of interviews on household heads within the 96 purposively sampled households. Efforts of the inhabitants toward reclamation of the mined sites were also considered. Photographs depicting utilization of laterites and environmental degradation of mined sites were also captured at different locations within the study area.

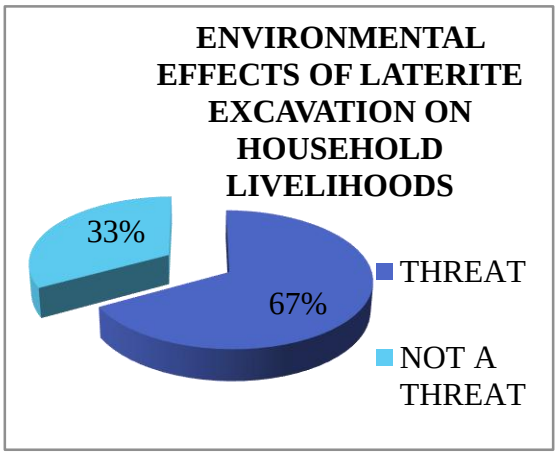
The third stage involved interviews with key informants namely NEMA officers (1), quarry owners (5) laterite miners (10) and village headmen (5) in all the 5 locations. All in all 21 people were interviewed who were both residents and non-residents of the area. This was based on random/proportionate stratified technique due to the situational issue found at the time of administering the interview. Secondary data included statistical data of households in Nyamache sub-county, review of literature and map of the study area. The sources were from published and non-published materials such as journals, with the aim of explaining the nature and importance of the study to the respondents.

2.5 Data Analysis and Presentation

Data analysis was based on the research objectives. Qualitative data was analysed by thematic and content analysis which used coding and organization of data into themes. The collected data was translated from the local language to English (where necessary). The data was edited to check for discrepancies. The data was organized and categories compared for similarities and differences. Themes were then generated from the categories in relation to research objectives. The responses on open-ended questions were reported by descriptive narrative. Data collected from secondary sources was subjected to content analysis and corroborated with primary data. Quantitative data on the other hand was analysed using descriptive statistics by using measures of central tendency such as mean, median and mode and measures of dispersion which included range, standard deviation and variance. Quantitative and qualitative data were integrated and presented by use of statistical tables, graphs, pie charts, percentages, plates and themes.

3. RESULTS AND DISCUSSIONS:

This section examines the environmental effects of laterite excavation activities on household livelihoods in Nyamache sub-county, Kisii County, Kenya. The type of data collected was on environmental effects of laterite excavation on household livelihoods, land degradation and the severity of environmental effects of laterite excavation on household livelihoods.



Findings from the area of study reveal that the environmental effects of laterite excavation on household livelihoods were felt. Sixty seven percent (67%) of the respondents indicated that environmental effects were a threat to the household livelihoods in the area of study. Thirty three percent (33%) of the respondents indicated that the environmental effects of laterite excavation were overshadowed by the benefits accruing from laterite excavation. However, they confirmed that there were threats to the land degradation which had little effect as far as household livelihoods were concerned as shown in Figure 4.7 and Plate 7.

Figure 4.7: Environmental effects of laterite excavation on household livelihoods
Source: Researcher, 2017

Plate 7: An exhausted excavation site indicating landscape degradation
Source: Researcher, 2017.

The results agree with Bukar (1977) on study in Nigeria, which observed that while the socio-economic benefits accruing from mining activities are positive and are of prime importance to the inhabitants, the environmental consequences of mining are blatantly disregarded. It also agrees with a study conducted by Gana (1999) in Nigeria, which noted that the immediate benefits of laterite excavation were more important and their survival is directly dependent on it, not minding the environmental cost.

On the severity of environmental effects of laterite excavation on household livelihoods, the respondents identified air pollution, water pollution, land degradation, dust, landslides and stagnant water as the major environmental effects that affected them as indicated in Table 4.5.

Table 4.5 Environmental Effects of Laterite Excavation

ENVIRONMENTAL EFFECTS	SEVERITY %
Air pollution	31
Water pollution	20
Land degradation	26
Dust	13
Landslides	4
Stagnant water	6

To the severity of the environmental effects; thirty one percent (31%) of the respondents singled out air pollution as having much felt severity as shown in Table 4.5. Air pollution was caused by tipper trucks using the laterite roads nearby while transporting lateritic material from quarries and spreading it on the road undergoing construction or repair see Table 4.6. This was due to the manner in which quarry activities were being conducted and the low financial capacity of the people in the area which could increase the degree to which people were affected by quarry activities in the area. Thus people living in quarry activity areas were prone to various environmental and health risks, coupled with lack of good health facilities and services in the rural areas. People were therefore vulnerable to adverse health hazards of quarry operations.

Table 4.6: Distribution of Respondents' Homes on Distance from the Laterite Roads Used by Tipper Trucks

Distance In Metres	Percentage %
0 – 500	31
501 – 1000	22
1001 – 1500	19
1501 – 2000	16
Above 2000	12
Total	100

The result is consistent with a study conducted by Oyegbile *et al*. (2017) in Oyo State, Nigeria who indicated that the trucks generated heavy dust particles that affected people, plants and animals in the area. Exposure of the people, plants and animals to the persistent dust particulates had serious implications on their vulnerability.

Severity of land degradation was at twenty six percent (26%), water pollution, twenty percent (20%), dust particles, thirteen percent (13%), stagnant water, six percent (6%) and landslides, four percent (4%). The results were consistent with the outcome of studies conducted by Devalsam *et al.* (2014) and Rejoice (2013) in Nigeria, which revealed that changes in the landscape that occur due to the mining are prominent: these include presence of overburden, gullies and effects on drainage and abandoned mined pits with grasses and shrubs growing around them which represent landscape degradation. These were treats to the households as they could lead to accidents, health problems and interferences to livelihood patterns.

4. CONCLUSION AND RECOMMENDATION:

On the environmental effects of laterite excavation on household livelihoods, the research findings revealed that laterite excavation has damaged the landscape as it has led to land degradation, pollution, loss of biodiversity thus endangering the household livelihoods. The research recommends that the national and county governments should regulate the extraction of laterite by forming a forum where all stakeholders should be involved in discussing the problem of excessive laterite excavation and come up with immediate solutions which will curb environmental damage. Also, the ministries of road and transport with the help of police officers should restrict tipper trucks transporting laterite

from using laterite roads passing through the villages. Constructing temporary roads out of the villages to reduce air pollution and noise pollution is necessary.

REFERENCES:

1. Tardy, Y. (1997). Petrology of Laterites and Tropical Soils. ISBN 90-5410-678-6
2. Adekoya, J.A. (1995). *Negative Environmental Impact of Mineral Exploitation in Nigeria.* London: Academic Press.
3. Raychaudhuri, S. (1980). *The Occurrence, Distribution, Classification and Management of Laterite and Lateritic Soils.* Journee Georges Aubert, 18(3-4): 249-252.
4. Stephen, C. G. (1961). Laterite and type locality, Angadipuram, Kerala, India,
5. Ndububa, E.E., and Mukkadas, A.M. (2016). Mud House Failures and Mitigation Options in Bauchi, North East Nigeria. *Journal of Engineering Technology*.
6. Kasthurba, A.K., Reddy, K.R., and Reddy, D.V. (2015). Use of Laterite as a Sustainable Building Material in Developing Countries. *International Journal of Earth Sciences and Engineering*, Vol. 7, No.4, pp. 1251-1258.
7. Ndububa, E.E. (2017). Stabilized Lateritic Bricks as Alternative to Mud Housing in Bauchi, North East Nigeria. IOSR *Journal of Mechanical and Civil Engineering* (IOSR-JMCE), Vol. 14. Issue 5 Ver. III, Pp. 67-73. Abuja, Nigeria.
8. Bahar, R., Benazzong,M.,Kenai, S. (2004) *Performance of Cement Stabilized Soil, Cement and Concrete Composites*. 26(7): 811-820.
9. Ajibuah, B. J. (2012). Socio-Economic Issues and Land Degradation in Fai Environs of Jaba Local Government Area of Kaduna State-Nigeria. *IOSR Journal of Engineering (IOSRJEN) Volume 2, Issue 11*, PP 06-17.
10. Adekoya, J.A. (2003). Environmental Effect of Solid Minerals Mining. *International Journal of Physical Sciences, Kenya, pp. 625-640.*
11. Aigbedion, I. (2005). Environmental Pollution in the Niger-Delta, Nigeria. *Inter-Disciplinary J. Enugu-Nigeria: 3(4)*, 205 – 210.
12. Ocansey, I.T. (2013). *Mining Influences on Agricultural Lands and Food Security: A Case study of towns in and around Kyebi in the Eastern Region of Ghana.*Turku University of Applied Sciences.
13. Devalsam, I. E., Joy, E. A., and Anim, O. A. (2014). Laterite Exploitation and its Impact on Vegetation Cover in Calabar Metropolis, Nigeria. Department of Geography and Environmental Science, University of Calabar, Calabar, Nigeria. *Journal of Environmental and Earth Science.*, ISSN 2224-3216. Vol. 4 no. 6.
14. Rejoice, M. P. (2013). Land Degradation due to Mining: The Gunda Scenario. Department of Geography, Kashim Ibrahim College of Education Maiduguri. Borno State, Nigeria. *International Journal of Geography and Geology,2(12)*, 144-158.
15. Kitula, A.G.N. (2006). The Environmental and Socio-Economic Impacts of Mining on Local Livelihoods in Tanzania: A Case Study of Geita District. Journal of Cleaner Production, Vol. 14, pp. 403-414.
16. Laurence, D. (2001). Mine closure and the community. . *Mining Environmental Management, 9(4):*, 10-12.
17. EAPC. (2009). *East African Portland Cement.* Retrieved july 17, 2015, from http://www.Eastafricanportland.com
18. Whitlow, R. (1991). *Environmental Impact Assessment and the Mining Industry: in 3rd UNESCO Regional Training Programme in Mining Geology*. Harare,Zimbabwe.
19. Nichols, O.G. and Gardner, J.H. (1998). *Long Term Monitoring of Fauna in Bauxite Mined Areas of the Darling Range. In Proceedings of the Australian Centre for Minesite Rehabilitation Research Workshop on Fauna Habitat Reconstruction.* Adelaide, Australia.
20. Moffat, A. (2001). Increasing Woodland in Urban Areas in the UK: *Meeting Ecological and Environmental Standards. In Forests in a Changing Landscape. Proceedings of the 16th Commonwealth Forestry Conference, Fremantle, Australia, 18-25 April 2001.*
21. Nissen-Petersen, E. (2006). *Water from Roads. ASAL Consultants Ltd. for Danida in Kenia.* Retrieved JULY 17, 2015, from HTTP://www.waterforaridland.com
22. Adeyemi, G. O. (2008). Variability in the Geotechnical Properties of a Lateritic Soil from South Western Nigeria:. *Bulletin of Engineering and the Environment, 67(4)*, 579-584.
23. USAID. (2009). *Support for Rural Roads.*
24. Kurmar, A. (1986). Paleolatitudes and Age of Indian Laterites Paleogeography. *Paleoclimatology. Amsterdam 53*, P.231 – 237.
25. Sharma, S. and Roy, D. (1997). *Environmental Protection.* Volume (10). 724
26. Gathuru, G. (2011). *The Performance of Selected Tree Species in the Rehabilitation of a Limestone Quarry at East African Portland Cement Company Land, Athi River, Kenya.* Kenyatta University.

27. KNBS (2019). 2*019 Kenya Population and Housing Census.* Vol. 1: Population by County and Sub-County. Nairobi: *http://.knbs.or.ke*
28. Bukar, Y. (1997). *The Effect of Mining on the Environment: A Study of Gypsum Mining in Southern Fune Local Government Area, Yobe State. Unpublished M.Sc Dissertation, Geography Department.* University of Maiduguri.
29. Gana,R. (1999) *The Effect of Mining on Socio-Economic Activities in Gunda, Biu L.G.A Borno State.* Unpublished B.sc. Final Year Project. Department of Geography: University of Maiduguri.
30. NDDP, (2008). *Kisii District Development Plans (2008-2012).* Nairobi: Government Printers.
31. NEMA, (2009). *Kisii District Environmental Action Plans (2009-2013).* Nairobi.: Government printers.
32. Hancock, B., Windridge, K., & Ockleford, E. (1998). *An Introduction to Qualitative Research.* The NIHR RDS EM / YH.
33. Palys, T. (2008). *Purposive Sampling*. In L. M. Given (ed.) The Stage Encyclopedia of Qualitative Research Methods. Sage: Los Angeles, vol. 2, pp. 697-698.
34. Lewis-Beck, Bryman A.E., Liao T.F. (2004). *The Sage Encyclopedia of Social Research Methods. Volume 3.* Sage Publishers Inc.
35. Oyebbile, S.A., Olawaye, J.E., Oladeji, J.O., and Oyesola, O.B., (2017). Vulnerability of *Rural Households to Risks Associated with Quarry Activities in Oyo State*, Nigeria. University of Ibadan, Ibadan.