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Assessment of the Effect of Inadequate Drainage Network on the Environment and Infrastructures

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Abstract:

The rapid increase in urbanization without corresponding infrastructures in the city of Keffi, combined with incipient and prolong weather conditions, has led to increased incidences of flood as the available drainage channels cannot contend with the volume of storm water. In this light, this study assessed the effects of inadequate drainage networks on the environment and infrastructures in Keffi, Nigeria. Employing a survey research design, 400 copies of questionnaire were administered to 400 households in five randomly sampled wards. In addition, 10 staff of Keffi Local Government who are directly involved in handling developmental projects in the area were interviewed for clarifications on reasons for inadequate drainage networks in Keffi. Descriptive statistics tools of frequencies and percentages were used to analyse the data obtained on variables of interest with respect to objectives of the study. The results revealed that about 47.25% of the respondents said devastating incidence of storm water occur every year in their zone and 41.75% said it occurred most parts of the year. The frequency of storm water destructions is compounded with its intensity as over 59% of the sampled population agreed that the intensity of damages due to inappropriately channelled storm water is very high in Keffi. On the perceived causes of inadequate drainage channel, the result indicated that abuse of land use plans (28.75%) was a major factor followed by poor monitoring and evaluation of project (20.25%). Also, it was revealed that the drainages in Keffi were very narrow and shallow. The inappropriately channelled storm water due to inadequate drainages often leads to erosion on streets (96%), silting of streets and compounds (86%), destruction of electric poles (75.5%), blocking of channels with wastes (75%) and inundating of streets, roads and compounds (71.5%). Based on these findings, the study recommended that since Keffi is located in a tropical zone characterized by heavy rainfall, the government should take proactive measure to mitigate storm water. The present drainage systems should be cleared with shovel by the people on a regular basis to allow for a free flow of storm water. Every existing drainage in Keffi should be inspected for possible upgrade with respect to their water volume capacity and house owners are encouraged to always make provision for drainage as an indispensable part of their building.

Keywords: Effects, drainage, inadequate, environment, infrastructure

1. Introduction

Cities the world over are the dominating forces in the organization of human population. As the world most crowded places, cities continue to show increase in urban population. This increase leads to a growing urbanization trend. Duru and Nnaji (2008) defined urbanization as the increase in the population of cities in proportion to the region's rural population. Urbanization is the outcome of social, economic and political developments that lead to concentration and growth of large cities, changes in land use and transformation from rural to metropolitan pattern of organization and governance. Rapid growth of towns and cities has been common feature of the developing world (Aderamo, 2008). Although urbanization is the driving force for modernization, economic growth and development, there is increasing concern about the effects of expanding cities, principally on human health, livelihoods and the environment. The implications of rapid urbanization and demographic trends for employment, food security, water supply, shelter and sanitation, especially the disposal of wastes (solid and liquid) that the cities produce are staggering (United Nations Conference on Environment and Development, 1992). The process of urbanization is believed to be connected with levels of development and some assert that, for a country to develop there is the need for an increased level of industrialization

as it is generally accepted that there cannot be urbanization without rapid economic growth (Tettey, 2005). The pattern of urbanization in developing countries, particularly Africa, however, is creating some concern that it may be generating a lot of development problems in the process of its growth.

One of the daunting challenges facing African countries in the wake of unprecedented urbanization during the last few decades is the planning and management of physical infrastructure and the urban environment. As urbanization gathered pace in most developing countries, the problem of inadequacy of infrastructure services and deteriorating urban environment became enormous (Sule, 2009). These problems range from poor housing conditions, inadequate infrastructure (including artificial drainages), to squatter settlements (Arimah, 2002).

Spurred by the oil boom prosperity of the 1970s and the massive improvements in roads and the availability of vehicles, Nigeria since independence has become an increasingly urbanized and urban-oriented society. During the 1970s, Nigeria had possibly the fastest urbanization growth rate in the world (Sule, 2009). Because of the great influx of people into urban areas, the growth rate of urban population in Nigeria in 1986 was estimated to be close to 6 percent per year, more than twice that of the rural population. Specifically, while only 7% of Nigerians lived in urban centers in the 1930s, and 10% in 1950, by 1970, 1980 and 1990, 20%, 27% and 35% respectively lived in the cities (Okupe, 2002). Over 40% of Nigerians now live in urban centers of varying sizes (Ndoma 2015). Like other developing countries, the rapid growth in urban areas in Nigeria is a "sword of two edges" (Sule, 2009). While increasing human capital increased the economic status of the country, the growths of large centers had outpaced government capacity to meet the increasing demand for the provision of basic infrastructural facilities and services. These are manifested in poor investment in roads, housing, water supply, electricity, waste disposal mechanisms, adequate drainage systems etc. (Sule, 2007; Aderamo, 2008; Jimoh, 2008). These problems have continued to persist and made worst due to non-compliance to planning ordinances (Sule, 2010). Appropriate management of drainage systems requires knowledge relating to the system boundary, system resources, interactions between adjacent systems and allowable limits, or thresholds, for each resource. Each of these elements will be unique to the particular system under consideration, and each system must be assessed on its own merits.

2. Materials and Methods

2.1. The Study Area

2.1.1. Location and Extent

Keffi Local Government area of Nasarawa state is located in the North Central Part of Nigeria between Latitudes $8^{\circ}18''N$ and $8^{\circ}51''N$ and Longitudes $7^{\circ}18''E$ and $7^{\circ}40''E$. It has an area of 138km^2 and bounded by Karu Local Government in the North, South and West and by Kokona Local Government to West, (Ministry of land and survey, 2014).

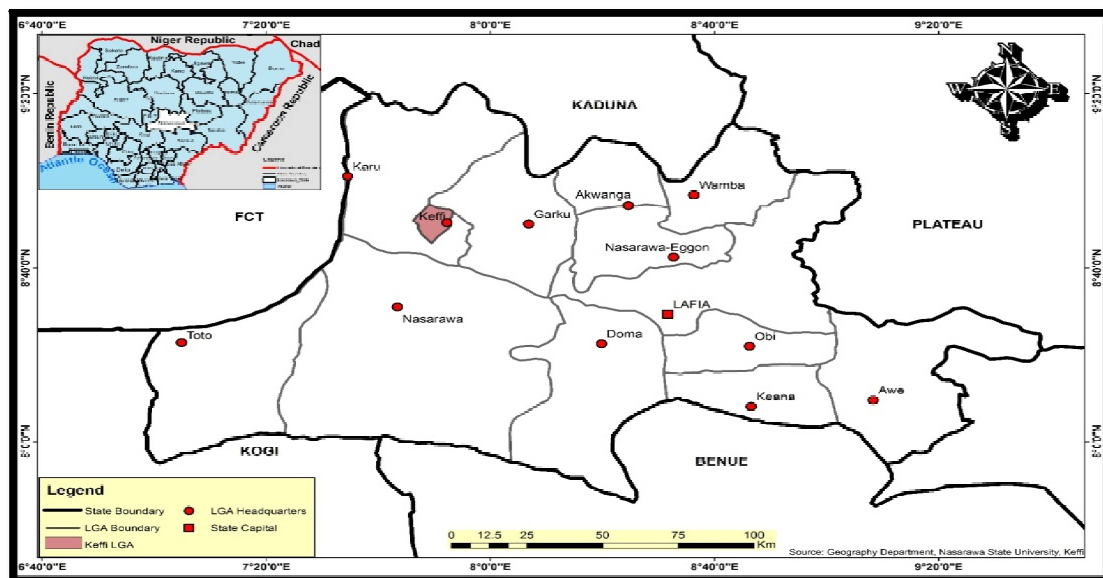


Figure 1: Nasarawa State Showing Keffi LGA

Keffi has two distinct seasons, namely the rainy season that begins around March and runs through October and the dry season which begins from October and ends in March. The temperature value ranges between (23°C - 33°C) while the humidity value ranges between (64%-96%) However, within these seasons is a brief harmattan season that is occasioned by the north east trade wind and the attendant dust haze, increased cold and dryness (NIMET, 2011).

2.2. Methodology

Two data sources, primary and secondary were relied upon to generate data for this study. The primary sources of data involved data obtained through questionnaire administration, interviews and direct observation to extract the

necessary information in the field. While secondary sources basically included, data from existing literature on the research topic from journal articles, textbook, magazines and gazettes.

The data collected by the questionnaires forms were converted into numerical codes representing measurement of variables using the statistical package for social sciences (SPSS) for windows version vista and Microsoft excel. The data were then analyzed using descriptive statistics of mean, Frequency and percentages.

Frequency tables and charts were used to present a summary of the data by describing the type of data collected and its frequency and occurrence. Figure s were also used to clearly show some of the information captured through photography. Descriptive statistics was used because it enables meaningful description of scores or measurements using few statistics.

3. Results and Discussion

3.1. Frequency of Storm Water Destruction in Keffi

Frequency of Storm Water Destruction	Number in Sample	Percentage Distribution
Every year	189	47.25
Every month of the season	0	0
Most parts of the year	167	41.75
Once in two years	25	6.25
None at all	7	1.75
Others	12	3
Total	400	100

Table 1: Frequency of Storm Water Destruction in Keffi
Source: Field Data Analysis 2018

Table 1 presents the frequency of storm water destruction in Keffi. It was shown by the table that 47.25% (189) of the respondents in the sampled wards claimed that they experience destructions due to inappropriately channelled storm water, yearly. The table also revealed that more than 41.75% of the sampled population in the study were of the view that storm water destruction do occur in most parts of the year, during rainy seasons. On further probing it was discovered that the months that usually record flood disasters over the last ten years are between July and early October. The table also indicates that 6.25% of the respondents were of the opinion that such events occur minimum of once in every two years, while 1.75% said they have never experience storm water destruction in their area. These are mostly people who live in the satellite axis such as zone A around the Emir Palace, as this zone has planned layout with most of the needed drainage facilities.

Damages due to inadequately channelled storm water has become a recurrent phenomenon in the city of Keffi. It has assumed a devastating dimension as it has become an annual event which leads to the destruction of roads, traffic obstruction, and poses a serious health hazard to the inhabitants of the city. The findings of this study were earlier corroborated elsewhere by Abaje and Giwa (2007). In their study, it was reported that the increasing frequency of flood goes beyond heavy rainfall as urbanization rate and poor land use planning are the main precursors to flood episodes in most Nigerian cities.

3.2. Intensity of Storm Water Destruction in Keffi

Intensity Level	Frequency	Percentage
Very high	238	59.5
Fairly high	160	40
Low	2	0.5
Total	400	100

Table 2: Intensity of Storm Water Destruction in Keffi
Source: Field Data Analysis 2018

On flood intensity 50.9% of the respondents said that the incident of storm water destruction is often very high in Keffi while 40% of the sampled population were of the opinion that the incident use to be fairly high and 0.5% expressed a contrary view by claiming that the incident is usually of low intensity. Table 3 presents the information on the intensity of storm water destruction in Keffi. These respective views point to the high incidence of flash flood in Keffi which could be traced largely to nonconformity to land use (Sule, 2010).

3.3. Adequacy of Drainage Networks in Keffi

Quality of drainage	GRA		Keffi East Central		Keffi North Central		TudunKofa		Yara	
	N	%	N	%	N	%	N	%	N	%
Very narrow	33	41.25	28	35.00	26	32.50	40	50.00	51	63.75
Not well plastered	6	7.50	4	5.00	2	2.50	0	0.00	1	1.25
Not well designed	13	16.25	16	20.00	15	18.75	14	17.50	16	20.00
Highly fractured	10	12.50	22	27.5	18	22.50	18	22.50	10	12.50
Not present at all	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Covered up by waste/sand	18	22.50	10	12.5	19	23.75	8	10.00	2	2.50
Total	80	100	80	100	80	100	80	100	80	100

Table 3: Quality and Quantity of Drainage Network
Source: Field Data Analysis 2018

Table 3 presents information on the quality of drainage networks in Keffi town. From the table, it can be observed that there was an overwhelming agreement across the sampled areas that the dimensions of the drainages are well below the volume of storm water that is often experienced in the area. Specifically, in Yara GRA, 41.25% of the respondents opined that the gutters in the area are very narrow just like 35% were of similar view in Keffi East Central. In Keffi North Central, TudunKofa and Yara, 32.5% (26), 50% (40), and 63.75% (51) of the respondents respectively, accepted that the drainage channels in their area were very narrow.

This finding corroborates the statement of David (2014) that; urban flooding which is the inundation of land or property in a built environment, particularly in more crowded areas are caused by rainfall overwhelming the capacity of drainage systems. According to Offiong et al., (2009), urban environments in Nigeria are faced with myriad of issues regarding poor drainage systems. This is in addition to the problem of water tight structures which are the major causes of storm water destruction (Belete, 2011).



Figure 2: A Typical Keffi drainage around FMC, Keffi East Central
Source: Field Survey 2018

Furthermore, table 4.4 revealed that some of the respondents were of the view that the drainages were not well plastered. These views were shared by quite a few number of the respondents and unevenly distributed across the sampled zones. For instance, in GRA, 7.5% of the respondents said the gutters were not plastered properly, while in Keffi East Central, 5% of the sampled population held similar views. In the same vein, 2.5% of those sampled in Keffi North Central said the drainages were not well plastered. While in Yara, 1.25% of those respondents agreed that drainages around their neighbourhood were not properly plastered and none of those from TudunKofa held similar view. Relating it now to the present dimension of the drainage, it was observed that the channels are without concrete at the base and walls. Over time, the force of the torrential rain will cut off the road as is the case along Diamond bank road last two years back.



*Figure 3: Poorly Plastered Drainage at Dadin Kowa, Yara Ward
Source: Field Survey 2018*

Other issues pointed out by the respondents in the various wards regarding the quality of drainages were the fracturing (that is the non-continuity or connectivity) of drainages and the covering of drainages by waste/sand. Surprisingly, GRA which is purported to be a high brow area have very high responses in favour of the drainages within this as table 4.4 shows that 12.5% and 22.5% of the respondents in GRA were of the opinion that drainages in the area are highly fractured and often covered with wastes/sand respectively. In Keffi East Central, the opinion was upheld by 27.5% and 12.5% of the respondents respectively, followed by 22.5% and 23.75% in Keffi North Central. It was 22.5% and 10% in TudunKofa, while the claim was less supported in Yara ward. This could be due to the presence Emir Palace in the zone which made it to have been given more developmental attention.



*Figure 4: A Discontinued Drainage Close To CRDP –
Nasarawa Road, Iya Ward
Source: Field Survey 2018*



*Figure 5: Waste/Sand Filled Drainage Immediately After
Antaubridge, Keffi North Central
Source: Field Survey 2018*

3.4. Perceived Causes of Inadequate Drainage Network in Keffi

Causes	Number of Response	Percentages (%)
Inadequate funding	38	9.50
Negligence from the Government and Individuals	69	17.25
Poor maintenance culture	49	12.25
Poor monitoring and evaluation of projects	81	20.25
Non-conformity to land use planning	115	28.75
All of the above	48	12.00
Total	400	100

*Table 4: Reasons for Inadequacy of Drainage Network in Keffi
Source: Field Data Analysis 2018*

Table 4 presents the perceived causes of inadequate drainage network in the city of Keffi. It can be observed that non-conformity to land use planning was identified as a major factor responsible for inadequate storm water channels in the study area. Majority of the respondents comprising 28.75% linked poor drainages to non-conformity to land use zonation. Closely following this factor was poor monitoring and evaluation of project, as high as 20.25% of those sampled accepted that poor monitoring and evaluation is a serious problem that affects the standardization of drainages in the city. Table 4 also revealed that government don't often prioritize the provisions of drainage channels as about 17.25% of the respondents claimed government neglects this segment of urban infrastructure development and house owners also follow the same footsteps as they often fail to plan for drainage space when building. With respect to urban infrastructural development, even when provisions are made for drainage channels in road construction contracts, the contractors often construct the roads without recourse to drainage provisions (Offionget.al 2008). This has persisted because governments pay little or no attention to contract specification. This is compounded by the weak institutions in the city. Furthermore, 12.25% of the respondents opined that poor maintenance culture on both the part of the concerned government institution (s) and the residents of the town is another contributing factor to inadequate storm water channels in Keffi. This factor is closely tied to monitoring and evaluation as it would not take place if the drainage infrastructures in the city are not being closely monitored and evaluated for such needs as repairs, clearing and expansion due to increasing pace of development. Figure 2 – 4.4 are all good evidence of poor drainage maintenance culture in Keffi. In addition, 9.5% of the sampled population attributed inadequate funding as a factor that hampered the provision of adequate drainages in the city. This was supported by interview respondents from the Local Government Secretariat who claimed that money meant for such projects as drainage development are often diverted by top politicians for their personal needs.

Another 12% of the respondents claimed government negligence, inadequate funding, nonconformity to land use planning, poor maintenance culture and poor monitoring and evaluation are all responsible for inadequate drainage channels in the city. This finding is corroborated by Amaize, (2011) who found that the estimated required drainage channel for the entire country is short by about 61.78%; and the existing ones are only about 30% maintained. This finding reflects the reality in Keffi as the drainages are either too narrow or too shallow to contend the volume of storm water during rainy seasons.

3.5. Effect of Poor Drainage Network on the Environment/Infrastructure

The various effects of poor drainage networks in Keffi as identified by multiple response of her residents are shown in Figure 6. Quite a large number representing 96% of the respondents identified landslides and erosion as the major environmental effect of poor drainage network in the city. Figure 4.5 shows a typical case of erosion along the road leading to civil defence office, in GRA ward. Silting of streets and compounds with 86% response was revealed to be the second most challenging effect. This was closely followed by destruction of electric poles by inappropriately channelled storm water and blocking of poorly developed channels by wastes with 75.5% and 75% response, respectively. Also, 71.5% of the respondents claimed that flooding of streets, houses and roads are common effects of poor drainage networks in Keffi, while 64.75% were of the opinion that poor drainage network in Keffi has been responsible for structural failure of tarred roads given that it causes early pavement distress. This was clearly observed on several tarred roads in the study area. Figure7 shows a typical case along old Nasarawa road (Iya 1 ward).



*Figure 6: A Typical Case of Erosion Due to Poor Drainage Network in GRA
Source: Field Survey 2018*



*Figure 7: A Typical Case of Structural Failure of Road along Old Nasarawa Road
Source: Field Survey 2018*

Furthermore, 58.75% of the respondents said that poor drainage networks results in outbreak of malaria and other diseases due to increased volume of stagnating water in the neighbourhoods. Also, 47.25% of the respondents claimed that inadequate drainage causes flooding of markets/shops. In this instance, people are endangered as they step into their flooded shops to take care of what could still be recovered. Pollution water sources, particularly hand dug wells due to flooding, and collapsing of walls/buildings were also identified by 39% and 10% of the respondents respectively, as some of the environmental effects of poor drainage network in Keffi.

According to Etuonovbe (2011), floods are the most devastating natural disasters, claiming more lives and causing damage to properties than any other natural phenomena. In Nigeria, though not leading in terms of claiming lives, flood affects and displaces more people than any other disaster. It also causes more damage to properties and at least 20% of the population of Nigeria is at risk of one form of flooding or the other (Ochere and Okeke, 2012). According to Eze (2008), poor drainage network are often associated with street flooding and this has become critical environmental problem in most Nigerian cities, including Keffi. However, it is not water from streams or rivers that usually flood these cities but the heavy rains, and the poor drainage network (Aderamo, 2008).

The finding of this study is line with the studies of Offionget.al, (2008), Offiong and Imoke (2008), Eze (2008), Jimoh (2008), Adedejiet.al, (2012), Aderogba (2012a, 2012b), Olajuyigbeet.al (2012), Ochere and Okeke (2012), Bariweniet.al (2012). These studies listed the effects of flood in most northern and southern parts of Nigerian to include but not limited to death of people especially children and the aged, damage to properties, displacement of people and obstruction of movements, collapsing of buildings and pollution of sources of water. Flooding also affects public infrastructures such as roads been submerged, electric and telephone poles pulled down, markets, schools and churches flooded and drainage channels blocked with wastes.

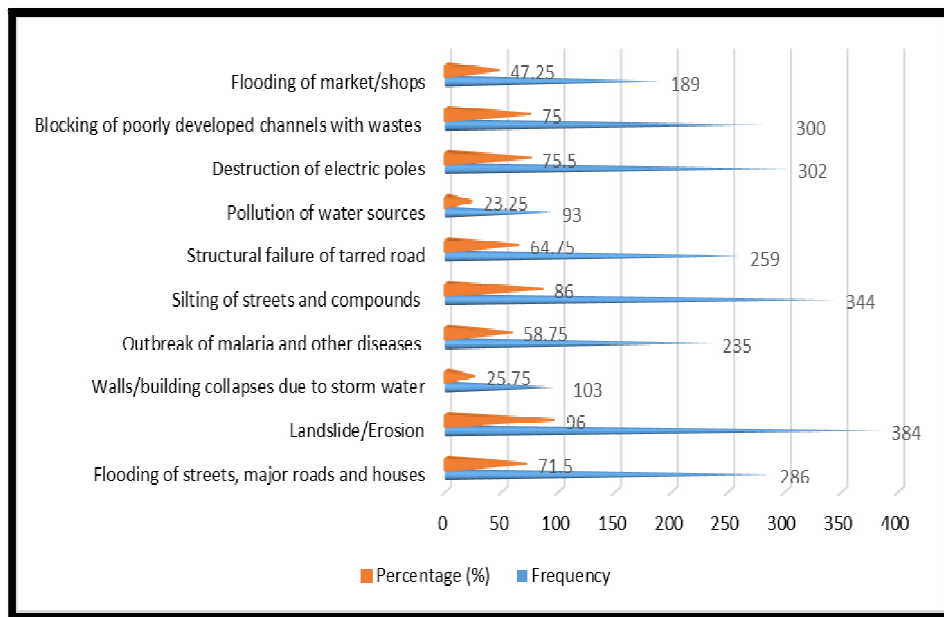


Figure 8: Effects of Poor Drainage Network
Source: Field Data Analysis 2018

4. Conclusion

These menace of inappropriately drained storm water in Keffi is increasingly becoming worrisome in recent time. Poor planning and inordinate development of properties in the area often exacerbate the problems. Recurrent destruction due to storm water events in Keffi have been traced to inadequate water channels. Many properties have been destroyed and this has subjected the people to unquantifiable trauma. More so, the menaces of storm water have been on the increase as a result of incipient and prolong weather conditions and uncontrolled urbanization.

From the findings of the study, it can be concluded that the event of damages due to storm water occurs in Keffi every year and in most parts of the rainy season while the intensity ranges from very high to fairly high. The existing water channels in Keffi are no longer adequate to contain the present day volume of storm water and the major reasons for this inadequacy are: non-conformity to land use planning, poor monitoring and evaluation as well as Government and residents' negligence. The inadequacy of water channels in Keffi has also created series of environmental problem among which are: erosion on roads, silting of streets and compounds during rainy seasons, destruction infrastructures, flooding of streets and roads as well as pollution of water sources. This is why this study makes the following recommendations.

5. References

- i. Abase, I.B and Giwa, P.N (2008). Urban Flooding in Environmental Safety: Urbanization, Resources Exploitation and Environmental Stability, Association of Nigerian Geographer book of proceedings of the 4th annual conference held in the department of Geography, University of Abuja, 15th-19th October, 2007. Kaduna, Joyce publishers.
- ii. Abu-Ghazalah, S. (2008). The Sustainable City Development Plan for Aqaba, Jordan. Journal of Developing Societies, 24, 381-398.
- iii. Action Aid (2006). Climate Change, Urban Flooding and the Rights of the Urban Poor in Africa. Report by Action Aid International Urbanization 19, 17- 37.
- iv. Adedeji, B. H., Bashir, O., Bongwa, A., and Olusegun, H. A. (2012). Building Capabilities for Flood Disaster and Hazard Preparedness and Risk Reduction in Nigeria: Need for Spatial Planning and Land Management. Journal of Sustainable Development in Africa 14(1), 45-58.
- v. Adedeji, S., Adeola B., Adeyemi C., and Kuyoro, P. (2011). Panorama: The Day the Heaven Opened up in Lagos. The Tell: Nigerian Independent Weekly. Lagos: Tell Communications Limited. 30, 11-13.
- vi. Aderamo, A. J. (2008). Urbanization and Transportation in Nigeria: Urbanization, Resources Exploitation and Environmental Stability, Association of Nigerian Geographer book of proceedings of the 4th annual conference held in the department of Geography, University of Abuja, 15th-19th October, 2007. Kaduna, Joyce publishers.
- vii. Aderogba, K. A. (2012). Qualitative Studies of Recent Floods and Sustainable Growth and Development of Cities and Towns in Nigeria. International Journal of Academic Research in Economics and Management Sciences 1(3) 90-97.
- viii. Agbonkhese, Onoyan-usin, Yisa Godwin Lazhi, & Daudu Paul Itomi-ushi. (2013). Bad Drainage and Its Effects on Road Pavement Conditions in Nigeria. Civil and Environmental Research, 3(1), 7-15.
- ix. Agboola, T. (2002). Urban Violence, Urban Insecurity and Challenges of Good Governance: The Evolving Disturbing Scenario from Abuja, Nigeria. Proceedings of the 33rd Annual conference of the NITP, held at Ilorin, October 30th-1st November.

- x. Ahern, M., Few, R., Matthies, F and Kovats, S. (1995). Floods, Health and Climate Change: A Strategic Review". Working Paper No. 63. Tyndall Centre for Climate Change Research.
- xi. Amaize, E. (2011). "Flood Displaces 50 Villagers in Delta State", in Vanguard: Towards a Better Life for the People. Lagos: Vanguard Media Limited. Monday, July, 4.p. 9.
- xii. Amit, K. D. (2016). Drainage system in highways. Term paper in transportation engineering. Lovely professional University. Puniab-India. <https://www.scribd.com/doc/42527504/Drainage-System-in-Highways>.
- xiii. Arimah, B. C. (2002) The Face of Urban Poverty. Explaining the Prevalence of Slums in Developing Countries, UNU-WIDER Working Paper No. 2010/30.
- xiv. Arimah, B. C. (2008). The Face of Urban Poverty. Explaining the Prevalence of Slums in Developing Countries, UNU-WIDER Working Paper No. 2010/30.