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FLOODING AND TRAFFIC MANAGEMENT IN AKURE (NIGERIA) METROPOLITAN ENVIRONMENT

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ABSTRACT: In order to extend areas usable in cities, migrants to cities, often reshape the natural landscapes in various forms. In some cases, they reduce hills, reclaim beach regions, fill valleys and wetlands, and sometimes encroach on river valleys not minding the consequences on the environment. These cultural ways of increasing usable lands have some negative impact on the urban physical environment. The major negative impact is change in the micro-climate of urban environment which manifest in various forms including flooding. Based on the above impact, the paper identified the consequences of flooding in Akure and determines ways by which its menace on traffic congestion could be reduced. Structured questionnaire was administered to residents of Akure living within 200 meter radius to areas where flash flood had been witnessed. Result shows positive correlation between flash flood and traffic congestions in the city. Similarly, accident rates were found to increase during heavy downpour in many of the flood hot spots as many vehicles struggle for right of way. Flash flood on traffic corridor was noted to influence numbers of stranded vehicles in the pool of water. The paper recommends regular clearance of drainages at the on-set of rainy seasons especially in areas prone to flooding. Property developers should ensure that gutters are provided in newly developed areas of cities. The paper also advocated the creation of environmental awareness through both formal and Informal forms of education on how to dispose solid as the hallmark of managing traffic in flooded environment in the study area.

KEYWORDS: landscape, traffic corridor, flash flood, drainage system, urban managers.

1 INTRODUCTION

Natural disasters are unexpected sudden events which impacts with such severity that it is usually disastrous and uncontrollable whenever they occur. They could cause widespread destruction of properties, lives, displacement of people, animals and aquatic life wherever they occur. A natural disaster might be caused by one or more of the following: earthquake, flooding, tsunamis, land submergence, tornadoes, typhoons/hurricanes/willy-willies, smog and the likes. However, in order to be classified as a disaster, it must have profound environmental effect and human lost.

A flood is an overflow of an expanse of water that submerges lands. In a simple language, flood means a temporary covering by water of land not normally covered by water. Flood occurs when excess water fails to flow in any definite channel but spreads over land that is normally dry. Flooding may also result from the volume of water within a body of water, such as a river or lake which overflows or break levees, with the result that some of the water escapes its usual boundaries (Ayoade, 1983).

When rain falls, there are three (3) ways by which the water is disposed off. The first one is through percolation; the second is through surface runoff while the third one is through evaporation/evapo-transpiration. When the intensity of rainfall is very high, there is little or no time for the rainfall to percolate. Thus, the surface run-off water becomes greater than the water that percolates. It is this, in most cases that lead to flooding in some urban environment. If the duration of rainfall is elongated than usual, the flood becomes devastating and hazardous to people who live very close to river course or channels.

Some of the most notable flood disasters include:

- The Great Flood of 1931 in Huang-He, China claimed over 800,000 people.
- The 1998 Yangtze River Floods in China left 14 million people homeless.
- The 2000 Mozambique Flood covered much of the country for three weeks, resulting in thousands of death and leaving the country devastated for years afterwards.
- The 2010 Pakistan Floods, damaged crops and infrastructures and claimed many lives.

In Nigeria, there has been several reported cases of flood problems in cities such as Lagos, Port Harcourt, Uyo, Warri, Benin, Aba and so on but the chronological view of flood events in Nigeria include the following, Asa flood at Ilorin in 1976, Lisaluwa and Arogo flood in Ondo in 1988 and 1995. The serious and repeated flood disasters of Ogunpa River in Ibadan in 1978, 1980, 1981, 1985 , 1987 and 1988; Osun River flood in Oshogbo in 1992, 1996 and 2002. The Yobe River flood in 2000; River Ala flood in Akure in 1996, 2000, 2002 and 2004; Lagos flood in 1984, 1988 and 1995, Kano and Dekina floods in 1988, Lafia , Patigi, Kpada and Gbogbondogi floods in Kwara State in 1997, Indiegore flood of 1981 and 2012 in Aba as well as Jos, Gombe, Kaduna and Bauchi floods in 2013.

Apart from Yobe's flood (2012) which was caused by breakdown of a dam, three other dam bursts have occurred in Nigeria, resulting in disastrous floods and these are;

(a) Ojirami Dam in Edo State (1981)
(b) Bagauda Lake Dam in Kano State (1988)
(c) Goronyo Dam in Sokoto State

The dam burst flooded the roads, settlements and farms, thus causing a lot of hardship to the immediate neigbours of such dam sites.

Traffic management is a technique designed and used to promote efficient vehicular and non-vehicular movement in any geographical space. Unfortunately, traffic management has been noted to constitute most daunting problems faced by highly urbanized cities of developed world, whereas some cities of developing world had to contend with urbanization problems in relation to traffic congestion (Ogunbodede and Aribigbola, 2003 and Ogunsanya, 1994). According to Ogunbodede and Aribigbola (2003), a number of factors have been responsible for the precarious traffic problems on roads. Such traffic problems range from inadequate transport facilities, gross inadequacies of public transport services, accidents, poor road infrastructure to environmental pollution and absence of integrated traffic management measures to combat congestion. Today, the rapid development of cities coupled with the fact that drainage facilities are not often developed almost immediately as new areas are developed has introduced another dimension into traffic problems in urban environment. Flash floods often take over the traffic corridors in the new areas of cities thereby unleashing hardship to motorists as well as dwellers in such environment.

In the analysis of vehicular concentrations on roads, Omiunu (1988) applied the index of percentage of vehicular concentration on some selected roads (25rods) in Benin –City (Nigeria) using the formula: IVC = TVM/TVY *100/1. Where IVC = Index of Vehicular concentration, TVM = Total Vehicle of Traffic per Month and TVY = Total Vehicle of Traffic per Year. Both TVM and TVY were based on peak hours from 7.30 – 8.0 a.m., 12.30 – 2.30 p.m., and 5.30 – 7.30 p.m. The formula according to Omiunu (1988) was adapted from Winifred Ashton's work on theory of traffic flow. This model has no serious application to travel demand modeling but was very relevant in determining vehicular concentration on roads of which floods played significant roles.

Dam failure can also lead to flooding especially in some agricultural regions or in regions that are very close to banks of river valley. This occurred in Nigeria when a dam was opened in Cameroun and the banks of River Benue were flooded up to Lokoja in year 2012. Vehicles going to Abuja from the southern part of the country had to be ferried on roads after about three days of inaccessibility through the major trunk connecting the southern part of the country to the northern part.

2 STATEMENT OF PROBLEMS

In contemporary time, flooding has become a common feature and part of life in Nigeria not only in the low-lying coastal areas but also in the wetland regions as well as the hinterland. The growing population and rapid urbanization processes, for example, has exerted pressure on available lands to the extent that a larger proportion of river basins have been encroached upon by people.

The poor drainage system and the attitude of people using such drainage as dump sites have led to blockage of drains. The consequences of this attitude are that the run-off water finds its ways on the major roads there by resulting in flooding.

These floods not only constitute an obstacle to free flow of traffic but many vehicles get stranded once such water enters into their engines.

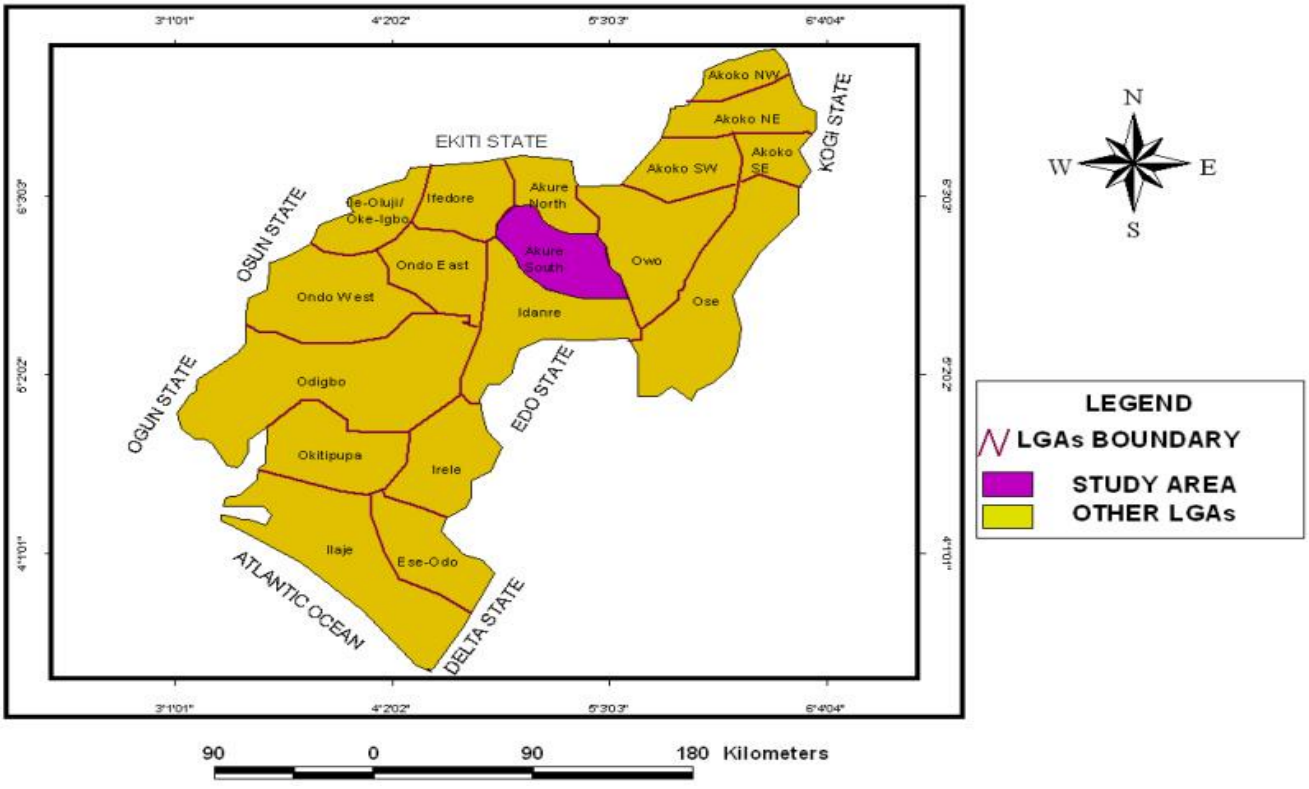
Flooded roads and broken down vehicles make journeys to be delayed. Commuters therefore get stranded and in most cases their journey time from home to place of work or other places in the urban environment are unnecessarily prolonged. Similarly, the aftermath of flooding is also felt in terms of loose soils and other debris that are deposited on the roads after flood. Apart from making affected roads to be dirty, they sometimes harbour sharp objects that may deflate tyres thereby causing untold hardship to motorists.

Most, if not all, environmental problems that we currently face can be directly or indirectly traced back to the legacy of lifestyles that we inherited and leading as human beings. Nowhere is this more correct than in the concentrations of human beings in urban environment. Cities and towns in most countries around the world have gained considerable attention due to the large number of migration to such cities and as a result, such high populations have always placed high pressure on their sites and their immediate hinterlands. In order to extend urban usable territories, urbanites often reshaped both natural and cultural landscapes involving the leveling of hilly areas, filling valleys, reclaiming beaches and putting wetlands into usable and profitable ventures, thus, creating huge areas of manmade land in urban areas. Structures of different magnitude occupy this new land irrespective of whether such lands have the capacity to sustain such structures or not. This is why Oriola (2000) and Sewel (1969) also confirmed that, though floods are purely environmental hazard of meteorological phenomena, very often they are induced by man's improper utilization of or abuse of the physical environment.

In view of the foregoing, this paper **aims** at identifying the consequences of flash floods on roads and traffic management in Akure Metropolis.

3 THE STUDY AREA (AKURE)

The study area is Akure, a rapidly developing metropolitan city. The city lies in the South-western part of Nigeria (Figure 1). Geographically, Akure lies approximately on 7^0 15^1 North of the Equator and Longitude 5^0 12^1 East of the Greenwich Meridian. Akure is currently the Capital city of Ondo State as well as Local Government Headquarter.



The city has had rapid population increase and space use over time because of its numerous roles in the sub-region. Such roles include being the central of economic activities, religion and cultures, commerce and industries, educational centres, Government seat, central of hospitality and headquarters of corporate organizations. With all these attributes, the city's morphology has changed over time to assume its present status with lots of transport problems.

River Ala and its tributaries are the major rivers that drain the city. The rivers have their annual floods which are very conspicuous in the wetland regions of the city. However, the flash flood which is a common phenomenon of the river has unleashed untold hardship on motorists and commuters during rainy seasons. In some cases, roads are made impassable while in other cases it elongates travelling hours.

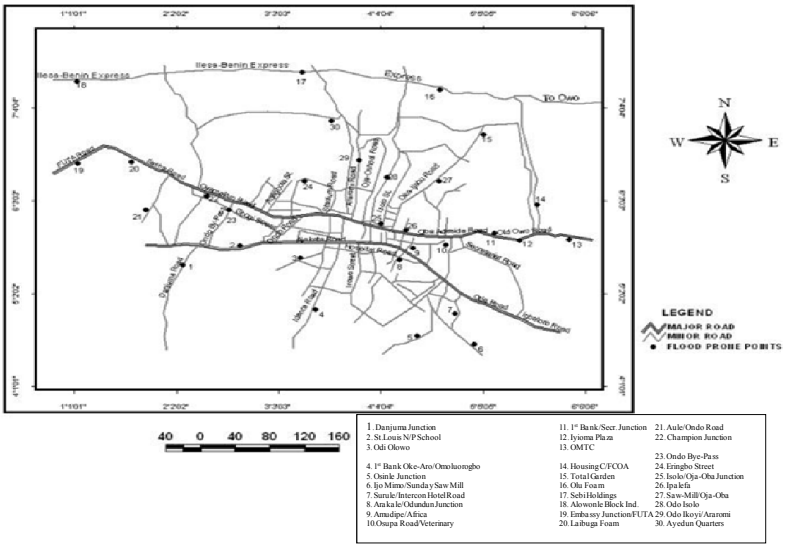
4 METHODOLOGY

The areas prone to flooding as well as wetland regions were identified through a reconnaissance survey in the city of Akure within a radius of about 10kms from the city centre. The streets were identified and mapped. About thirty (30) prominent flooded portions of these roads were identified and mapped (see Figure 2). Structured questionnaire to elicit information from respondents living within a 200metres radius to areas liable to flood were developed.

Data needed for the study and which were collected from the respondents include street names, nature of environment, nature of gutters, width of gutters, depth of gutters, nature of drainage during rainy seasons, waste disposal methods in the environment, causes of flood in the environment, consequences of flood in the environment with particular reference to road traffic and solutions to floods in the environment.

Data needed as specified above were collected using both primary and secondary methods of data collection. Purposive sampling method was used to sample ten hot spots where flash flood is said to be very prominent in Akure and these areas are Ipalefa, Odo Ijomu, Odo Isolo, Odo Ikoyi, Odo Araromi, Champion Junction, Oja Isikan, Ijala Kekere, Oja Adedeji and Ala close (figure 2). Fifteen copies of the designed questionnaire for this study were randomly administered in the ten (10) identified hot spots of the flooded zones in the environment. The target respondents are people living within 200metres radius within the vicinity of flood conflicts points. In all, a total of 150 copies of the questionnaire were administered in the study area.

Figure 2: Flood Prone Points along Major Roads in Akure



The second aspect of primary source was carried out by measuring areas occupied by flash floods as well as the depths and width of gutters in the flooded zone. Similarly, photographs of the affected areas were taken at different times and points. The topographical map of Akure was also used to identify the low and wetland areas.

Descriptive statistical method was used in summarizing responses on flooding and traffic congestion characteristics in Akure. Respondents perception on causes of flood, flood problems and surface run-off in the study area were identified.

Respondents were given options ranging from “Strongly Agree” ” (SA), “Agree” (A), “Disagree” (D) and “Strongly Disagree” (SD) from which to choose. The 4 point scale response was used to calculate the weight attached to SA, A, D and SD. The Mean Weight Value (MWV) were calculated from these order and compared with Group Arithmetic Mean (GAM) to determine acceptance or rejection of a problem items for taking decision (see Ogunbodede, 2009). Correlation analysis was then used to determine the relationship between width and depth of gutters and its implication on flood.

5 RESULTS AND DISCUSSIONS

DRAINAGE CHARACTERISTICS IN THE STUDY AREA

It was observed in the study area that about 36.57% of the built up areas have no gutters while the width of gutters between 31 and 90 cm carries a percentage of about 55.97% as shown in Table 1. A substantial part of the areas without gutters are found in the newly developed regions of the city. Thus, flash floods occur frequently in the city areas where there are no drainage system as well as areas with narrow gutter as soon as there is little downpour of rain in cities.

Table 1: Width of gutters in the study area

Width of gutters (cm)	Frequency	percentage
1 – 30	3	2.24
31 – 60	40	29.85
61 – 90	35	26.12
91 -120	01	0.75
121 – 150	06	4.48
No gutter	49	36.57
Total	134	100

Similarly the depth of the gutters in the study area shows that 36.57% of the areas had no gutter hence majority of the surface run-off has no channels to direct floods (see Figure 2). The implication is that all waters in the new areas are channeled on the traffic corridors thereby creating problems for road traffic management.

Table 2 : Depth of gutters in the study area

Depth of gutters (cm)	Frequency	Percentage
1 – 30	02	1.49
31 - 60	29	21.64
61 – 90	11	8.21
91 – 120	38	28.36
121 – 150	01	0.75
151 – 180	04	2.99
No gutters	49	36.57
Total	134	100

- **Causes of Flood in Akure**

Table 3 reveals that, the intensity of rainfall with a MWV of 3.769 ranked first among the cause of flood especially when it is high with little or no time for percolation, this is followed by dumping of refuse with a MWV of 3.291 into the gutters as perceived by respondents. However, the respondents did not accept anger of God with a MWV of 1.813, inadequate storm with a MWV of 2.694 and impervious urban surfaces with a MWV of 2.619 as important causes of flood in Akure. Although these factors were not significant as major factors causing floods but they have been very contributory as noted by respondents in the study area.

Blockage of drainage by sands is also noted to be one of the ways by which traffic corridor get flooded**.** The granitic rock which is the parent rock we have in this country is very loose and easily movable. With time, these loose soils accumulate in the drainage (gutters, culverts etc) and after sometimes too, start to block the drains. Blocked drainage system hampers smooth movement of water during rainy season. Since water must take its course, the surface run-off finds alternate routes thereby flooding the roads as well as houses (Odermerho, 1988).

Table 3 : Causes of flood as perceived by respondents

S/no	Statement items	Strongly agreed	agreed	disagreed	Strongly disagree	total	Mean Weight Value	Decision	Rank
1	Rainfall	456	42	02	05	505	3.769	accepted	1st
2	Anger of God	76	39	52	76	243	1.813	rejected	7th
3	Building along water flow path	144	153	20	37	354	2.642	rejected	4th
4	Impervious urban surfaces	116	177	24	34	351	2.619	rejected	5th
5	Inadequate storm drains	160	138	30	33	361	2.694	rejected	3rd
6	Dumping of refuse in drains and drainage paths	312	90	26	13	441	3.291	accepted	2nd
7	Concretization of urban surfaces (roads and buildings)	124	81	48	52	305	2.276	rejected	6th
	GMWV = 2.729								

Blockage of drainage by household wastes is one of the ways by which Nigerians have contributed to flood occurrence in our environment. Each time rain falls, you find children and adults emptying their household waste into the drainage. These wastes block the drainage and the surface run-off increases thereby flooding the roads and houses. It becomes difficult sometimes during this period to drive because sharp objects which sometimes accompany such wastes could deflate tyres. Houses that are constructed on low terrain are worst hit by flood because they easily get flooded. Table 3 reveals that dumping of refuse into gutters is an accepted cause of flood in the study area and ranked second as perceived by respondents with a MWV of 3.291.

Building close to river valley makes such structure highly susceptible to flooding. Thus**,** any street or buildings that are very close to river banks stand the risk of experiencing annual flood. This is because water must definitely take their normal course. In the same way a flooded valley allows water to encroach to its adjoining environment and any structure on its way becomes the first casualty. This factor ranked 4th among the causes of floods even though it was rejected by respondents as an important factor using GAMV.

PLATE 1: Flood has taken over this street and evidences of no vehicular movements are obvious

Another major factor influencing flood occurrence in cities is drainage failure. It is very common to find drainage system that are no longer functioning or had failed without attention being paid to it. In such circumstances, the flooded water makes use of the traffic corridor instead of the drainage and this affect free flow of traffic in urban environment as shown in Plate 2.

Another reason for flood occurrence is the absence of drainage system. As much as possible landlords must make provision for proper drainage system that will take care of not only the waste water in the house but also the surface run-off emanating from torrential rainfall.

PLATE 2: Pictures of Flooded road and traffic built-up

6 CONSEQUENCES OF FLOOD ON TRAFFIC MANAGEMENT

Table 4 shows the major consequences of flood in traffic management and the environment. Damage to landed property ranked 1st with MWV of 3.701 and this was followed by the following: clogging of drains (3.649), sediments build-up on the road (3.642), traffic congestion (3.612) and damage to household properties (3.604) which were all accepted with MWV greater than GMWV of 3.582. Others factors as far as this study is concerned fell below GMWV and so were rejected as not too important consequences of flood in the environment.

Table 4: Flood problems in various Land use zones in Akure as perceived by Respondents

S/no	Statement Items	Stongly agreed	Agreed	Disagree	Strongly disagree	Total	Mean Weight Value	Decision	Rank
1	Damage to landed property	404	84	06	02	496	3.701	accepted	1st
2	Damage to household property	344	132	06	01	483	3.604	accepted	5th
3	Business slow down	332	120	18	02	472	3.522	rejected	6th
4	Traffic congestion	364	102	18	0	484	3.612	accepted	4th
5	Clogging of drains	356	129	4	0	489	3.649	accepted	2nd
6	Accidents on the roads	296	117	28	07	448	3.343	rejected	7th
7	Sediments build up on the road	380	99	6	3	488	3.642	accepted	3rd
	GMWV = 3.582								

- **Surface water run-off and road traffic management**

It has been noted in another study that surface run-off on traffic corridor inhibits smooth traffic flow in cities (Ogunbodede, 2004 and Ogunsanya, 2002) and sometimes lead to road accident. Table 5 shows respondents' perception on the implications of surface run-off on traffic corridors. The most prominent of these factors was that, urban surface run-off in most streets was through open gutters and this accounted for a MWV of 3.276. Next to this, is that, road surfaces in the study area serve as disposal channel for floods in some streets with a MWV of 3.276. The implication of this is that such flash floods on traffic corridors impede smooth movement of vehicles on the road thereby leading to congestion. In some cases it may lead to accident especially when vehicles rush to escape flooded zones. Others factors in descending orders are as shown in table 5.

Table 5: Respondents' Perception of surface run-off in the study area (Akure)

S/no	Statement items	Strongly Agreed	agreed	disagree	Stongly disagree	total	Mean Weight value	decision	Rank
1	The road surface serves as a disposal channel for floods in my street.	300	63	76	0	439	3.276	accepted	2nd
2	Urban surface run-off disposal channel in my street is mainly open gutters	212	228	10	0	450	3.358	accepted	1st
3	Urban surface run-off disposal channel is barely open	192	213	24	3	432	224	accepted	3rd
4	Urban surface run-off disposal channel in my street is mainly through road surface	228	102	80	3	413	3.082	accepted	4th
5	Urban surface run-off disposal channel in my street is mainly covered gutters/drains	240	81	46	24	391	2.918	rejected	5th
6	Concretized surfaces increase surface run-off	112	102	28	58	300	2.239	rejected	6th
	Grand Mean weight value (GMWV) = 3.016								

Other factors which were not significant as important factor since they did not meet the cut-off point of the GMWV are items 6 and 7. This shows that urban surface run-off disposal channels are not covered in most areas covered by the study. The study also shows that respondents do not believe that concretized surface increase surface run-off. Even though this factor was rejected as important factor in flood formation, it was however noted to be a contributory factor.

A correlation analysis was carried out between width of gutter and depth of gutter to determine their influence on flood formation in the study area. It was discovered that correlation (r) between width of gutter and depth of gutter is 0.679 (see Table 6). This is a positive correlation which was significant at 0.01 level. The coefficient of variation (r^2) is 0.46, thus

percentage of variation is 46%. This therefore shows that the depth of gutter in all the zones has 46% influnce on the width of the gutter in the smooth flow of surface run-off in the study area.

Table 6: summary of Pearson correlation between width of gutter and depth of gutter

	Width of gutter	depth of gutter	length of street
width of gutter pearson correlation	1	0.679**	0.263*
significant (2 - tailed)		0	0.015
N	85	85	85
Depth of gutter pearson correlation	0.679**	1	.334**
significant (2 - tailed)	0		0.002
N	85	85	85
Length of street pearson correlation	0.263*	0.334**	1
significant (2 - tailed)	0.015	0.002	
N	85	85	121

**Correlation is sig. at the 0.01 level (2-tailed)
*correlation is sig at the 0.05 level (2-tailed)

7 MEASURES TO REDUCE FLOOD MENACE ON TRAFFIC CORRIDOR IN URBAN ENVIRONMENT

One thing we should note is that absolute control of floods is impossible rather partial control in form of protection is achievable Two feasible measures for combating flood menace in man's environment according to Oriola, (2000) *is flood prevention/abatement and flood protection.* Flood abatements/preventions are efforts geared towards the management of the water shed or river catchments zones, river bank stabilization and adherence to land use practices.

- **Flood Prevention:** Flood protection is carried out to control flood and minimize the damage it causes by regulating its flow or diverting it away from where it could damage properties. This measure, according to Oriola (2000) includes construction of flood walls, dykes, dams and reservoirs, channel improvement and dredging.
- **Discourage dumping of refuse into gutters:** This study shows that a very high proportion of people living in the study area still dispose off their refuse into the gutters especially when it is raining. This method aggravates flooding that often leads to flooding of streets. This attitude should be changed and the people educated on how to properly dispose their wastes.
- ***Channelization****:* Channelization is one of the major ways by which flood could be controlled in the study area. The river valley as well as gutters channeling water should be properly monitored during rainy seasons to ensure that they are not blocked in any way. Free movement of water in these channels will reduce flood occurrence during the peak of rainy season
- ***Town planning laws*****:** Set-back laws must be enforced for all structures close to the banks of river valley in urban areas as much as possible. A set back to streams for any structure is about 20 meters in low-density residential areas and not less than 30 meters in high-density areas.
- ***Reduction in concretization of urban surface:*** Majority of houses in urban environment have concretized surfaces leaving no room for greening environment. This situation reduces rainfall percolation irrespective of whether the rain is heavy or not. These types of water are added to surface run-off and invariably add to water that result in flood. A reduction in concretized surface of urban environment will definitely reduce flood in cities as more of the surface run off will percolate to join underground water.

8 RECOMMENDATIONS

- **Environmental education:** There is the need to create awareness through both formal and Informal forms of education on how to dispose solid waste in order to reduce its blockage on river channels. Most people are ignorant of the consequences of their uncontrolled use and abuse of the environment. To this extent, we need holistic approach through environmental Education that will capture both the young and the old. Environmental awareness can be created through: drama, radio jingles & TV, community meetings, bill-boards, posters, as well as through other indigenous means to inform people on how to manage their waste.

- **Minimum depth and width of gutters:** property developers should ensure that gutters are provided in newly developed areas of cities simultaneously as the structures are developed. This will reduce the rate at which such areas get flooded and create problems for smooth traffic movement.
- **Reduction in pot holes:** Attention should be paid to road maintenance in cities. Pot holes should be constantly attended to in urban environment and maintenance culture should be made part of the urban policy by urban managers.

9 CONCLUSION

Flood is a disaster that has become one of the environmental problems in Nigeria. This is because man's activities on daily basis continuously encourage flooding. The menace of flooding on traffic congestion has increased the problems confronting commuters as well as motorists in cities. Many people are becoming skeptical about travelling to urban environment as well as working there because of traffic congestion which has become daily menace.

It is therefore important for man to understand the limit of his activities within his environment (environmental determinism) otherwise there will always be conflict. Man should therefore understand that forces of nature can only be held at bay for a short time whenever there are conflicts. The consequences could be very disastrous, if necessary measures are not put in place to address such conflicts. Thus, there is need for man to understand his limit in his interaction with the environment. Man therefore needs to harmonize his actions as much as possibl e with the environment so as to reduce flood and its effects on traffic flow in cities.

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