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Research article

Coastal flood disasters and environmental remediation: A perceptive analysis from Victoria Island, Lagos, Nigeria

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ABSTRACT

Flooding as a phenomenon occurs where predisposing geographical attributes and socio-cultural practices conspire to inundate low lying areas. Wherever it does, it often implicates city planning and environmental management. This study examines flood disaster on Victoria Island, Eti –Osa Local Government Area of Lagos State, Nigeria. This is with a view to proffering environmental remediation measures in managing the disaster, flood on this Island being a recurring event that brings with it untold losses.

The research was conducted using the social survey tool - questionnaire and the Geographic Information System (GIS) to collect required data for the purpose of fulfilling the objectives of the study. Relying on the multi-staged survey sampling methods, a reconnaissance survey was done. From this, the study area was zoned into four residential zones for effective questionnaire administration. Copies of the structured questionnaire were then purposively administered on selected residences, where flood hazardsare prominent on Victoria Island. Respondents were systematically selected at every 10thhouse interval on each street of the four zones after the first house was randomly selected. There are 3248 buildings in this study area which constitute the research population. Given the sample size of 10% adopted, 325 copies of questionnaire were administered and multiple regressions were run to test the relationship between flooding and the socio-economic activities of the respondents. The study adopted GIS to map out the study area and to capture the number of houses in the study area.

Research reveals the study area is highly urbanized, having high preponderance of concrete surfaces. The area has very narrow sewers which are often blocked. Coupled with the heavy rains in the area, flash floods quickly

build up to combine with rising seawater levels to inundate the low lying coastal fronts. Owing to the fact that it is highly urbanized, many lives and properties are at risk in the eventualities of floods.

The study prescribes remedial measures to the menace of coastal flooding in the study area. These include: construction of standard paved surfaces and drainages, interdisciplinary cooperation at all government levels for co-ordination of sectorial policies on environmental protection, flood zone mapping and re-planning where necessary, flood forecasting and generation of possible early warning systems for public awareness supported by meteorological information.

Key words: Early warning systems, flood, remedial, disaster, management, risk, inundations.

1.0 INTRODUCTION

Disasters by definition are destructive events that appear suddenly and with little warnings. They are usually short – lived but with extreme events bringing death, injury and destruction of properties. Disasters have also been presented as events that are accompanied with extreme irremediable ruin and misfortune, catastrophe, calamity or cataclysmic tragedy resulting in great losses (Adetunberu, 2009). A common example of this is the phenomenon of flood. This is recognized when an ordinarily dry land carries water of appreciable height beyond acceptable length of time, that is, a body of water flows over land that is not normally submerged. It is a natural process that is triggered by a variety of geographical and local attributes. Floods occur in most parts of the world and range from annual occurrences which in some cases replenish soil nutrients, to sudden events that cause loss of lives, homes, livelihoods as well as properties worth millions of dollars and other physical and social impacts. The world community has attached much importance to floods, not often for their usefulness but for the fact that floods are probably the most dangerous hydro-meteorological phenomenon causing considerable loss of lives and properties every year the world over. Since flood is one of the natural disasters which endanger both life and properties, it becomes vital to know its extent and evolution.

There have been several flooding disasters in Nigeria. Some recent occurrences includethe Sokoto floods of September, 2010; Ibadan floods of August, 2011; and the 'eloquent floods' across most parts of Nigeria in October, 2012; hinting of gross environmental lapses, climate change realities and many more. The 2012 flood have been described as a most devastating one in the last 50 years. It affected many states such as Adamawa, Kogi, Delta, Bayelsa, Benue and Rivers States; it displaced millions of Nigerians in the process. Owing to severities of floods, scholars have advocated and shown the values of integrating Remote Sensing and the Geographic Information Systems (GIS) to provide valuable spatial and dynamic information in the events of disasters and its management.

Floods in Nigeria have been studied and classified by different fluvial scholars. Awosika (1993) and Adetunberu (2009) recognized four major types namely -

i). Localized flooding which occurs many times a year in slum areas because there are few drains and most parts of the ground is highly compacted. The pathways between dwellings become streams after heavy rains due to blocked culverts and drains.

ii).Flooding occasioned when small streams in urban areas rise quickly beyond their usual levels after heavy rains to inundate ordinarily dry areas.

iii). Flooding caused by major rivers flowing through urban areas which have been affected by land use changes and engineering works upstream; and

iv). Coastal flooding resulting from storm surges, 'tsunami' and sea level rises.

However, Ologunorisa (2004) classified flooding into three broadcategoriesnamely: coastal flooding, river flooding and urban flooding. Later, Offiong*et al*, (2008) pointed out that flood disasterstypically occur in two distinct areas: the coastal areas and areas bisected by rivers (water-fronts). In the coastal areas, flooding may occur when the volume of water in a stream or river channel exceeds the capacity of the channel. Folorunso and Awosika (2001) emphasised that, the frequent flooding of Ikoyi and Victoria Islands in Lagos is predominantly caused by excessive rains (natural cause) which are very prevalent during the months of September to October. They also noted that the disaster worsens when rain storms coincide with high tides.Wherever it occurs, flood constitutes an environmental disaster that affects human beings and the environment either at the hinterlands or the coastal areas.

The typical urbanized coastal area in the developing countries is often an area that is characterized by dense populations, large industrial developments and infrastructure. This accounts for the consideration that

coastal floods attract as a hydro-meteorological phenomenon capable of causing huge losses of lives and properties.This is often the case, when such a coast is developed with little or no consideration for its proper conservation, planning and management.The invasion by man on the coastal areas has led to the effect of flood in such areas. Current research in Environmental Science has also linked flooding with global warming effects. Sea level rise makes coastal areas even more susceptible to hazards such as wave inundation, or erosion from storms, hurricanes, tsunamis and flooding (IPCC, 2007). Therefore, this study assesses the socio-economic impact of coastal flooding and suggests possible remuneration measures in Victoria Island, Nigeria.

The aim of this study is to assess the socio-economic impact of coastal flooding in Victoria Island Nigeria; and establish some remediation measures to combat it. The objectives of the study are to: (i) investigate the causes of coastal flooding in the study area; (ii) assess the effects of coastal flooding on the socio-economic characteristics of the residents in the study area and (iii) assess the mitigating strategies to combat coastal flooding in the study area.

2.0THE STUDY AREA

Lagos State lies on the intersect of Latitude 6°27′11″ N and Longitude 3°23′45″E. This is in South-Western Nigeria on the Atlantic coast of the Gulf of Guinea. Lagos State has a population of about 7,937,932 (NPC, 2006). The latitudinal location of Victoria Island Lagos subjects it to the characteristic West African monsoon climate marked by distinct seasonal shifts in wind patterns. Although, one or more months are not humid, there is no month that is dry. The climate is determined largely by the influence of the two air masses; the maritime South -West monsoon winds and the continental North-East dry winds from the continental interior. The former are due to the hot and humid tropical maritime air mass blowing from the Atlantic Ocean, while the latter are due to the warm and dry air mass from the Sahara Desert,in the North. These two air masses are separated by a zone of discontinuity called Inter Tropical Convergence Zone (ITCZ).The rainfall pattern in the study area can be explained in terms of the movement of the ITCZ. The apparent movement of the sun over the equator twice in a year is responsible for the occasional and localized rainfalls that are experienced over the area throughout the year. The temperature pattern of the study area is influenced largely by the movement of ITCZ, the wind direction, position relative to the equator and distance from the sea. The mean annual temperature is 32^0C, while the mean monthly minimum and maximum temperature are 24.2^0C and 30.0^0C respectively and the daily temperature range is 2.7^oC. The study area originally had dense mangrove forests and swamps which are now largely sand-filled. The geological history accounts for the terrain where most land areas are between 18 and 25 meters above the sea level. Victoria Island and the entire axis are surrounded by Atlantic Ocean. Expectedly, the areas drained by the various water bodies are low lying. The mass of water around the town is believed to have also influenced the pattern of growth on Victoria Island and the adjoining development water bodies.

3.0 CONCEPTUAL AND LITERATURE REVIEW

Floods have been described as a covering of water inany area of land not normally covered by water. These take place when rivers overflow their banks as a result of excessive rainfall, dam failure, or obstruction of river channel resulting from encroachment (Enaruvbe and Yesuf, 2012). It is of various types and magnitudes, occurs in most terrestrial portions of the globe, causing huge annual losses in terms of damage and disruption to economic livelihoods, business, infrastructure, services and public health. Generally, some of the mechanisms that trigger flood are dam or levee failure, more rain than what the landscape can dispose of, torrential rains or hurricanes, ***tsunamis,*** and ocean storm surges, rapid snow melts, ice flows blocking a river and burst water mains. Studies have shown that man's socio-cultural activities serve as triggers to the occurrence of flood. These activities include: farming and deforestation that expose the soil to erosion and increase runoff; urbanization by building recklessly in vulnerable areas without regards to Town Planning regulations, poor watershed management and failure to control flooding promptly. Fadamiro (1998) concluded that, human activities contribute to the occurrences of flood disasters; noting that the various socio-cultural activities of residents of flood prone areas like stream or river channel encroachment and abuse; increased paved surfaces and poor solid waste disposal techniques due to high level of illiteracy; a low degree of community awareness and poor environmental management are the major contributors to flooding.

Coastal flooding occurs when normally dry, low-lying land is flooded by sea water. It occurs in coastal areas when high tides or storms cause the water level to rise. Where the water level is higher than the level of the coastal lowland, flooding occurs. The extent of coastal flooding is a function of how far inland the flood

waters penetrate. This is controlled by the topography of the coastal land exposed to flooding. Coastal flooding can result from a variety of different causes including storm surges created by storms like hurricanes and tropical cyclones, rising sea-level due to climate change and tsunamis (Doorkamp, 1998). Storm surges are main cause of coastal flooding, the biggest floods occur when larger than normal tides ('king tides') and storm surges occur at the same time caused by forces generated from a severe windstorm, waves and low atmospheric pressure. Storm surges are extremely dangerous, because they are capable of flooding large coastal areas. Sea level rise is a relatively slow process, connected to Climate Change, which may increase the frequency and severity of storms, bringing unusually high tides, and changes in winds, waves and currents. Coastal flooding can also threaten lifeline services such as water, power, telecommunication and transportation networks. The consequence of this as Ayoade (1997) noted, is that a large proportion of the rainfall which should normally infiltrate into the soil, or be intercepted by the vegetation and thus delayed for sometimes before running off, is immediately available for surface run off into streams and rivers making them flood. This is more so the case as there is a lot of de-vegetation in the areas as well as concretization of large expanse of land by urban development. Heavy rainfall raises the water level, when the water level is higher than the river bank or the dams, the water comes out from the river, there will be flooding. According to the International Federation of Red Cross and Red Crescent Societies, in 10 years from 1993 to 2002 flood disasters affected more people across the globe (140 million per year on average) than all the other natural or technological disasters put together (IFRC, 2003). Floods can lead to several problems, especially with buildings along and around flood plains. Among many of these effects are: destruction of houses and structures, traffic congestion, obstruction of business activities, collapse of historical monuments and even loss of human lives.

All around us today, there is a clear evidence of environmental change due to buildup of earth warming gasses that induce climate change. Among the most important of these changes is the buildup of carbon dioxide and methane which is a result of human activities through combustion of fossil fuel and tropical deforestation (Geist and Lambin, 2001). Due to sea-level rise projected throughout the 21st century and beyond, coastal systems and low-lying areas will increasingly experience adverse impacts such as submergence, coastal flooding, and coastal erosion (IPCC, 2014). Coastal floods caused by the combination of high tides, storm surges and storm generated wind waves are a major natural hazard in many parts of the world. Low lying densely populated and poorly defended coastal areas are susceptible. Where defences against coastal flooding and erosion exist they are designed to withstand storm situations which on the average may occur once in a given number of years. Literature affirms that before the 1800s, the average temperature of the world was 15^0C or 29^0F but over the past 100 years, the average temperature has risen by, 0.7^0C or 1.3^0F. The atmospheric concentration of carbon dioxide has also risen from 280 parts per million in 1800, to 380 parts per million today. Due to an increase in the combustion of fossil fuels, scientists have projected that, by the year 2100, the average global temperature will increase by between 2.4^0C to 6.4^0C, or 4.3^0F to 11.5^0F (Akinbamijo, 2012; Ayo, 2009). Climate related changes in sea level; in particular high water levels are important because coastal defence structures which protect areas susceptible to flooding have lifetimes comparable with the timescale of significant changes in atmospheric CO_2. Indeed, sea-level rise is increasing as a result of warming ocean waters and melting ice caps. These are among the most certain consequences of climate change. Rising sea levels will thus inundate adjacent low lying areas, increase erosion of beaches and bluffs, and increase the incidence of flooding from storm surges. The effects of sea level rise in the coastal zone include displacement and loss of wetlands, inundation of low-lying properties, increased erosion of shorelines, change in the extent of flood zones, changing water circulation patterns, and more salt water intrusion into groundwater. It is also possible that due to climate change there could be changes in coastal storm patterns that alter the frequency and intensity of coastal flooding (Emmanuel, 2005).

4.0 RESEARCH METHODOLOGY

The research design employed in this study is survey design. The study population includes the residents of buildings in the study area. Essentially, the sources of data for this study were both primary and secondary data. Primary data were obtained through personal observation and administering of copies of multiple-choice questionnaire. Detailed multi-staged survey techniques were used – i.) to delineate study area into quadrats. ii.)to adapt a randomized sampling technique with replacement that was used to pick respondents using a sample interval of one in every tenth house across the study area. Geographic Information System(GIS) was used to capture and count the numbers of buildings in the study area. Numbers of houses in each zone was counted and 10% of the total buildings in each zone, given the interval above, were administered the copies of

questionnaire. In all, three hundred and twenty-five (325) respondents were taken from all the four zones of the study area as seen in table 1.

Table 1: Questionnaires administered in each zone of the study area

Zone	Area (Hectares)	Area (square/metres)	No of buildings	Questionnaires administered 10% of Building
A	55	550507.12	799	80
B	73	734400.04	813	81
C	65	653565.27	749	75
D	68	679382.51	887	89
Total	261	2617854.94	3248	325

Source: Authors' Fieldwork, 2015.

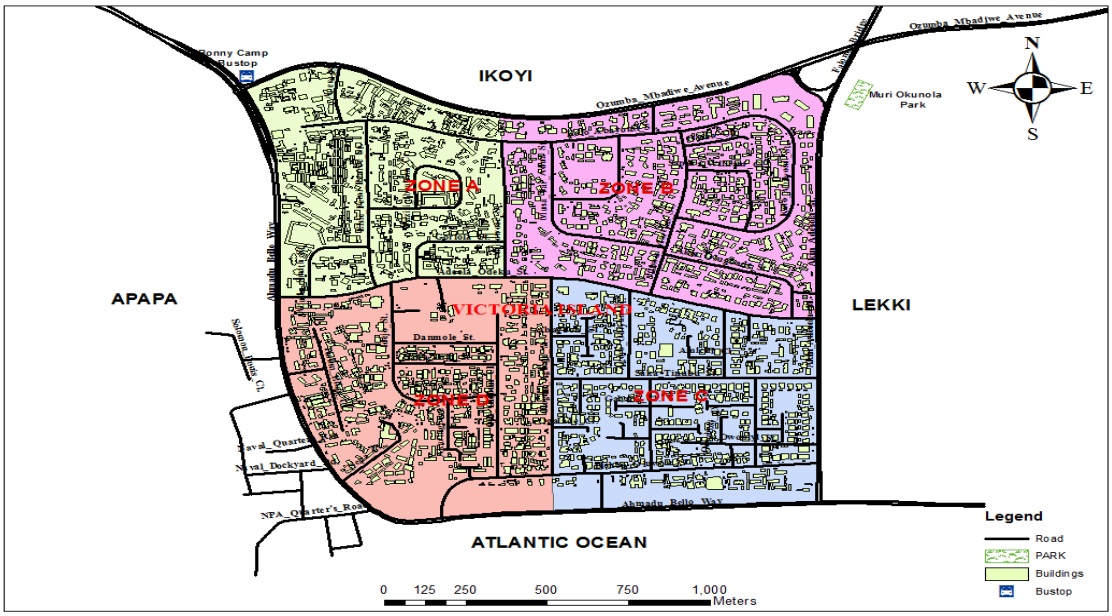

Figure 1: Map showing the buildings in the four zones of the study area
Source: http://www@googleearth.com (Digitized by the authors)

The secondary data used include published materials such as books, academic and professional journals, published information and other reports as well as the publications of government and relevant government agencies. Unpublished materials such as thesis and dissertations, technical reports/papers, papers presented at conferences, seminars and workshops were used where necessary. Useful information was obtained from internet and the Lagos State Ministry of Water-Front Management was consulted for relevant information on the contribution of the State to stem the phenomenon of flooding in the study area. These data, when combined with the primary data, gave a clear picture of the flooding situation in the study area. The descriptive and inferential statistics were used to analyse data collated. Tables and charts were employed to present the magnitude of occurrences of the variables that were obtained. Correlation statistics was employed to test the formulated hypothesis:

H_0: There is no significant relationship between flooding and the socio-economic activities of the residents.

H_1: There issignificant relationship between flooding and the socio-economic activities of the residents.

5.0 DISCUSSION OF FINDINGS

The study area was divided into four zones to facilitate effective questionnaire administration. Field data were subsequently collated and analysed. Inferences therefrom are presented and discussed in the ensuing subheads below. The major findings are discussed below.

5.1 Demographic and Socio-Economic attributes of the Respondents

Table 2 shows the disposition of the study respondents. More male respondents (56%) were encountered in the survey. This probably may be because of the fact that the study area comprises some industries which require male services than the female services. This is supported by the position of the Australian Human Rights Commission (AHRC, 2013) that male services are required in most industries than the female services. Figure 2 shows the occupation structure of the respondents in the study area. Critical observation of the occupational status of the respondents reveals that corporate/company workers(35%) and civil servants(37%) were more in the study area. This could be as a result of the fact that the study area is highly urbanized centre. It comprises of residential and office buildings used as government offices and head offices of some companies. Figure 3 shows that the age group 46 years and above (46.2%) dominate the age group of respondents in the study area. From Table 3, we have a feel of the income levels of the respondents. It was observed from the table that, majority of the respondents (51.3%) earn below N50,000monthly income. This indicates that majority of the respondent still live below one dollar per day as indicated by the United Nation and this may affect the people's standard of living, ability to demand for standard housing and requirements for other services (Olarenwaju, 1996;Agbola and Agunbiade, 2007).

Table 2: Sex of Respondents

Sex	Frequency	Percent
Male	183	56.0
Female	142	44.0
Total	325	100

Source: Author's Fieldwork, 2015.

Table 3: Level of Monthly Income

Monthly Income	Frequency	Percent
below N20,000	5	1.5
N20,000-N30,000	50	15.4
N40,000-N50,000	115	35.4
above N50,000	155	47.7
Total	325	100.0

Source: Authors' Fieldwork, 2015. $1 =N240.00k

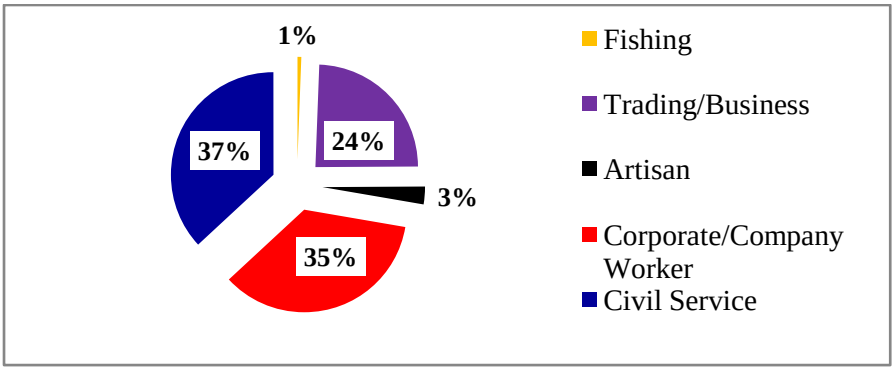

Figure 2: Occupation of Respondents

Source: Authors' Fieldwork, 2015.

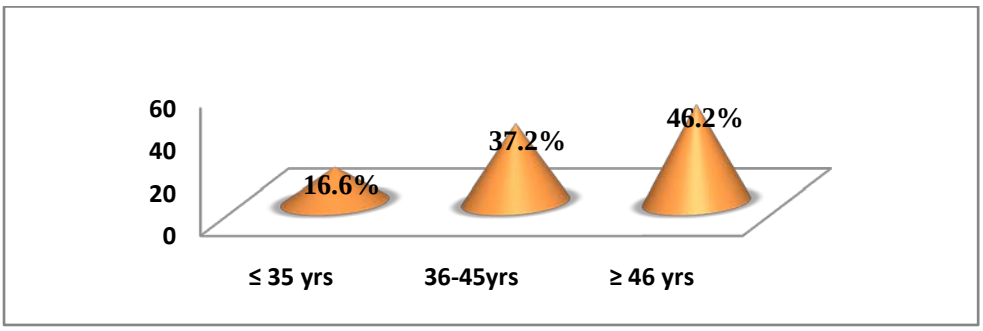

Figure 3: Age group of Respondents

Source: Authors' Fieldwork, 2015.

5.2 Perception of Flood Issues in the study area

Table 4 shows the respondents' perception of the condition of the sewers in the study area. It was revealed that majority (67.4%) of the respondents claimed that most of the sewerage system in the study area are perceived as poor, inadequate and narrow. This may be the reason for the incessant flood disaster in the study area, as poor and narrow drainages can lead to flooding resulting in property loss (Kolsky, 1998). Table 5 shows that the major causes of flooding in the study area are heavy rainfall and blocked/narrow sewers. Coupled with the narrow gauge are poor cultural practices of discharging solid wastes in drains by residents. These combine to hinder effective conveyance of urban waste water. Figure 4 shows the average monthly rainfall pattern of the study area. This reveals that rainfall is heavy between the months of May to October. The impact of South-West Trade wind which brings rainfall to Nigeria is very high in this area. This wind blows across the Atlantic Ocean towards the coast of Nigeria, Lagos in particular. The wind is warm and moist; hence it brings rainfall to Nigeria with the wettest part being along the coasts. Areas close to the Atlantic Ocean therefore experience more rainfall than the parts farther from the Atlantic Ocean as the effect of the South –West Trade wind decreases inward towards the Northern parts.

Table 4: Assessment of the drainage – perception analysis

Assessment of the sewerage system	Frequency	Percent
Wide enough sewers	2	0.6
Moderately sized	81	24.9
Narrow sewers	219	67.4
Absence of sewers	23	7.1
Total	325	100.0

Source: Authors' Fieldwork, 2015.

Table 5: Major causes of flooding in the study area

Major causes of Flooding	Frequency	Percentage
lack of drainage facilities	23	7.1
blocked/narrow sewers	111	34.2
buildings close to river flood plain	31	9.5
heavy rainfall	158	48.6
high paved surface	2	0.6
Total	325	100.0

Source: Authors' Fieldwork, 2015.

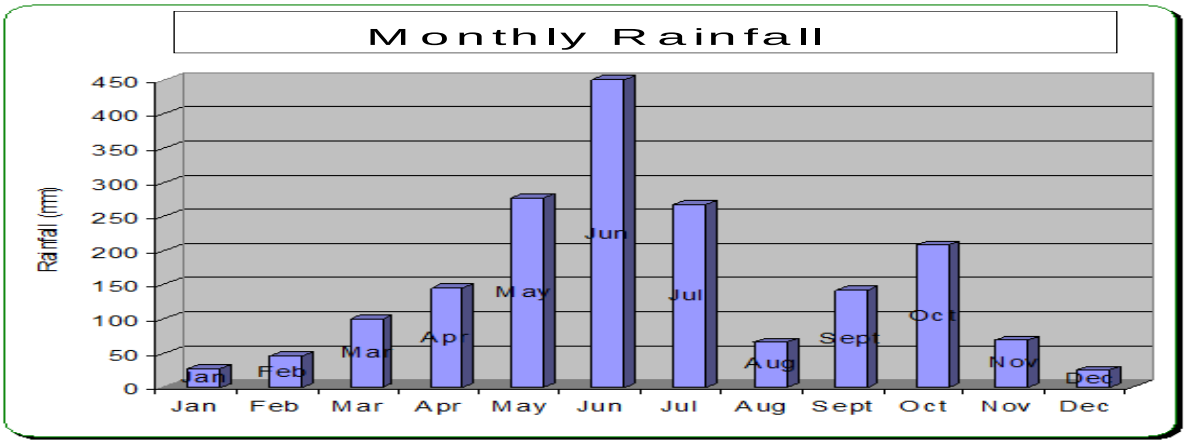

Figure 4: Average monthly rainfall pattern in the study area over 1990-2010

Source: Nigerian Meteorological Service, 2014

5.3 Impact of Flooding and Remediation Measuresin the Study Area

Table 6 reveals the major impacts of flooding in the study area as damage and deterioration of buildings, deterioration of environmental infrastructure, obstruction of movement and economic activities and prevalence of malaria disease. Other impacts are soaking and water making on the walls of buildings, homelessness, dirty environment and building collapse. The prevalence of malaria disease and soaking/ water marks on the wall of the building may be as a result of the fact that the area gets waterlogged. The prevalence of malaria pathogens may result in incessant suffering from malaria diseases by the residents. This is confirmed by Calvert Mosquito Control Program (2011), that any ground that can hold water for more than a few days can be a potential breeding ground for mosquitoes. Continuous soaking and wetting of the wall of a building gradually weakens the wall and leads to reduction of the life span of a building and its eventual collapse. Table 7 shows that majority of the respondents (64.9%) claimed that the government is currently making efforts in controlling flood menace in the study area, this may be as a result of the efforts of Lagos state government in constructing embankments especially between the sea and the popular Ahmadu Bello Way, this will prevent the entire sea sand submerging and water which usually covered the entire Ahmadu Bello Way. Also the Government of Lagos State is making frantic efforts in sand-filling parts of the sea closed to this major road in order to militate against the incessant flooding of this road and the entire environment.

Table 6: Impacts of flood on the Study area

Impacts of flooding	Frequency	Percentage
Damage and deterioration of buildings	56	17
Deterioration of environmental infrastructure	52	16
Building collapse due to inundation	7	2
Result to homelessness	37	11
Result to dirty environment	30	9
Soaking / water mark on the wall of the building	44	14
Prevalence of malaria disease	48	15
Obstruction of movement and economic activities	51	16
Total	**325**	**100**

Source: Authors' Fieldwork, 2015.

Table 7: Government's effort in controlling floods in this area

Government's Effort	Frequency	Percentage
Government has made frantic efforts	65	20.0
Government is currently making efforts	211	64.9
Government is not making any effort	33	10.2
Government is not aware of the flood situation in this area.	16	4.9
Total	325	100.0

Source: Authors' Fieldwork 2015

6.0 RECOMMENDATIONS AND REMEDIATION MEASURES

The following recommendations and remediation measures are put forward generally to mitigate flooding in the study area.

- The government should construction standard paved surface; this will allow smooth run-offs of water to the right channels.
- Standard drainages should be constructed in the study area, this will help to combat flood hazard especially in the built up areas. Lack of drainages or poor drainages along the streets accentuates the tendency to flooding (Oriola, 1989). Culverts should be placed technically where necessary so that debris can pass freely through them to avoid blockage which may consequently result to overspill of water to the environment.

- There isneed for interdisciplinary cooperation at all government and local levels for a co-ordination of sectorial policies regarding environmental protection.

- The possibility of climate change in decades to come further emphasizes the need for early warning and flood forecasting particularly in flood plain areas at immediate and high risk.

- Flood forecasting can be effectively combined with other measures for flood prevention such as retention, flood emergency and public awareness supported by meteorological information and the earliest possible warning of extreme weather conditions on when to have heavy rainfall will go a long way to reduce damage cause to lives and properties.

- There should be proper construction of embankments, seawalls, groin, and offshore breakwaters these can help to stop or reduce the rate of coastal flooding.

7.0 Conclusion

Flooding has significant impact on human activities and the environment; it can threaten people's lives, their property and environment. Assets at risk include: housing, transport, public service, and infrastructure, commercial, industrial and agricultural enterprises. The health, social, economic and environmental impact of flooding can be significant and have a wide community impact (OPW 2009). Urbanization aggravates flooding by restricting where flood waters can go, covering large parts of the ground with roofs, roads, and pavements, obstructing sections of natural channels and building drains that ensure that water move to rivers faster and freely than it did under natural conditions.

Climate change is now a much talked about phenomenon in Nigeria, particularly, given the unprecedented flooding experience in many parts of the country in previous years. This has eloquently registered the issue of environmental management as that which needs every attention if only to build defense strategies that will alert on early warning systems, probabilities and consequences of occurrence of such disasters in the country (Akinbamijo 2012). Sea level rise makes coastal areas even more susceptible to hazards such as flooding, wave inundation, or erosion from storms, hurricanes, and tsunamis. Consideration of sea level rise impacts is one of the many adaptation planning measures to protect life and property (IPCC, 2007). Animal bio-diversities such as shorebirds, sea turtles, white crabs and other important bio-diversities are more prominent on the western coastal area, therefore, there is a great need to protect the coastal environment from environmental hazards such as flooding (Oyedepo and Adeofun, 2012).Without any iota of doubt, proper management of coastal area of Victoria Island will help militate the effects of coastal flooding to lives and properties.

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