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PERCEPTIONS AND REALITIES OF FLOOD HAZARDS, FLOOD MITIGATION AND CONTROL IN NIGERIA

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ABSTRACT

Flood is a catastrophic event that has a long history and occurs both in developed and developing countries. Flood is recurrent, its severity varies over a wide range, and it is largely unpredictable in terms of magnitude and occurrence. Vulnerability to flood has been linked to poverty and cultural affiliations in developing countries. Poverty affects people's capacity to protect themselves and their assets, as well as their ability to live in areas having less exposure to risk factors such as low income, poor housing and public services. Lack of flood insurance coverage and cultural attachment to the flood zone can force the poor to behave in ways that expose them to greater risk. Often, after floodwaters have subsided, the emphasis has been placed on rebuilding structures and trying to restore flood victims' lives back to normal as quickly as possible without addressing the causes. Unfortunately, in the rush, these flood victims have often rebuilt their structures to their previous "at risk" conditions. The economic cost or human losses from flood are enormous. There is growing societal impatience with continually bailing out those who live at risk. The realization that flood can never be controlled since they are part of a dynamic process caused by natural phenomena is very important. This review reflects on present and future challenges and priorities. The tasks ahead are immense as these solutions must be implemented in the face of a multitude of problems, such as conflicts, lack of leadership, economic corruption, discrimination, unstable governments, dictatorships, pandemics, lack of infrastructure, low education and public health, poverty, and over one billion humans without the basic needs of life being met.

KEY WORDS: Flood, Rainfall, Runoff, Sea level, Vulnerability

INTRODUCTION

Floods are recurrent phenomena in the world, resulting from a number of basic causes of which the most common is rainfall (Gobo, 1988). The term flood generally describes a partial or complete inundation of normally dry land area as a result of an unusual and rapid accumulation of runoff of surface waters from any source, or an overflow of inland or tidal waters. According to WMO (1973), it is the theoretically greatest depth of precipitation for a given duration that is physically possible. Floods occur periodically, and they become a problem when areas susceptible to flooding are employed and/or if human activities induce and enhance flood occurrence.

Serious flooding has occurred much more frequently in the last twenty-five years in Nigeria, Europe, United States and Australia (Gobo and Abam, 1991; UN, 2002; Fox, 2003; FMEnv, 2005) and there is no reason to believe that it will not continue to be a problem. There is need to be prepared to react to the dangers of floods as they are happening and to protect the public health and safety during these emergencies. Also, there is need to be proactive in managing our river systems now, to reduce the potential for flooding in the future and to design our recovery efforts following flood events to both accommodate the needs of the people affected by the flood, and to reduce the potential for the recurrence of similar damage in the future.

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The focus of this subject review therefore, is to present a general overview of flooding; causes types, hazards/vulnerability and approaches to mitigate flooding in Nigeria. How well we fare in the next flood will depend a lot on how we prepare for it now.

Factors that Influence Flooding in Nigeria
Climatic Condition

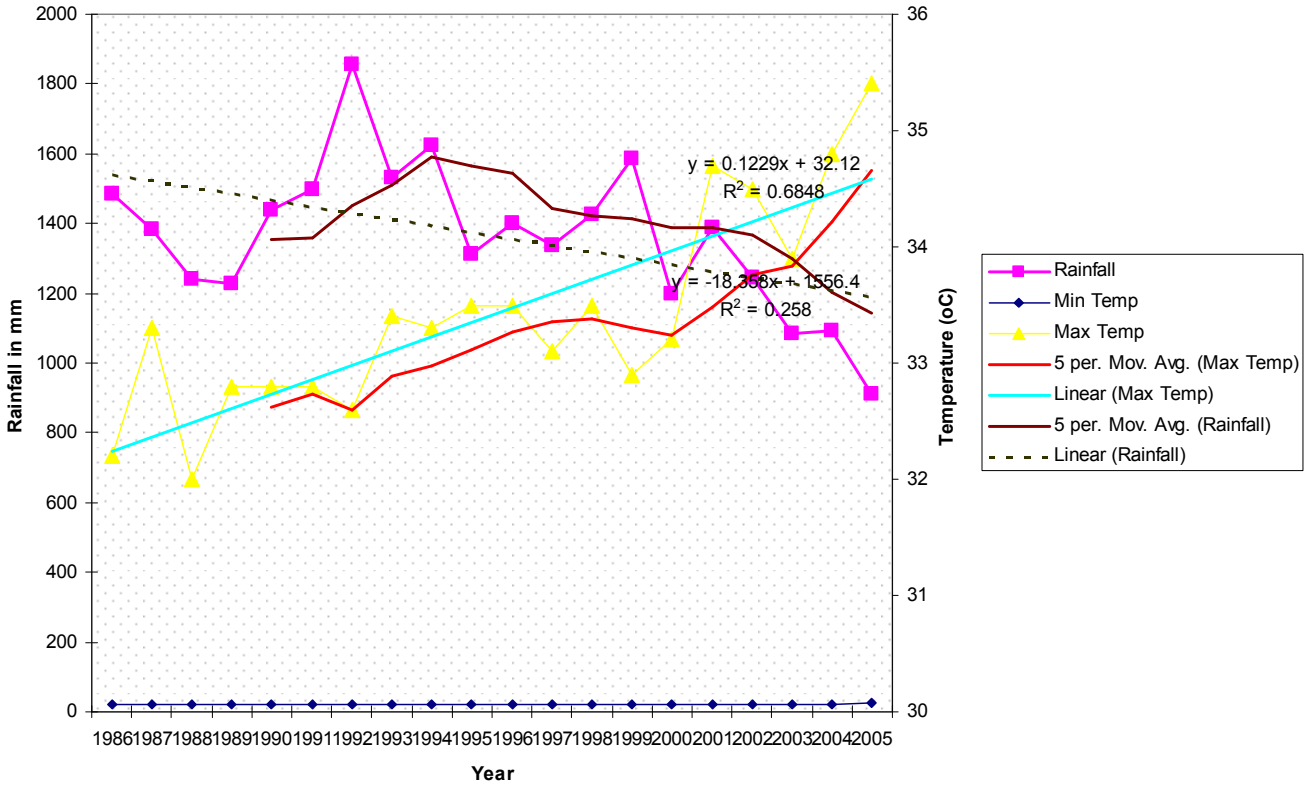
The major factor that influences flood is the climatic condition of a particular geographic location, and this manifests in the form of amount, duration and intensity of precipitation (rainfall). The combination of precipitation and high temperature affects the soil moisture content (percentage saturation), liquid limit, infiltration rates etc.

Table 1 Average Annual Temperature(oC) and Average Annual Rainfall (mm) of Abuja 1986 to 2005

Year	Max, Temp	Min Temp	Annual Avg	5 Yr MVA	Rainfall	5 Yr MVA
1986	32.2	20.4	26.3		1486.6	
1987	33.3	21.1	27.2		1383.6	
1988	32	21.1	26.55		1240.7	
1989	32.4	21	26.7		1227.2	
1990	32.8	20.8	26.8	26.71	1438.1	1355.24
1991	32.8	20.8	26.8	26.81	1499.6	1357.84
1992	32.6	20.1	26.35	26.64	1854.9	1452.1
1993	33.4	21	27.2	26.77	1523.2	1508.6
1994	33.3	21.1	27.2	26.87	1625.4	1588.24
1995	33.5	21	27.25	26.96	1310.9	1562.8
1996	33.5	20.8	27.15	27.03	1401.6	1543.2
1997	33.1	21.2	27.15	27.19	1336.3	1439.48
1998	33.5	21.5	27.5	27.25	1432.7	1421.38
1999	32.9	21.7	27.3	27.27	1587.7	1413.84
2000	33.2	21.5	27.35	27.29	1197.4	1391.14
2001	34.7	22.9	28.8	27.62	1389.5	1388.72
2002	34.5	23.2	28.85	27.96	1242.9	1370.04
2003	33.9	22.5	28.2	28.1	1084.7	1300.44
2004	34.8	22.7	28.75	28.39	1093.4	1201.58
2005	35.4	23.3	29.35	28.79	911.7	1144.44

Source: National Emergency Management Agency, Abuja 6th April 2010

Fig. 1 Rainfall and Temperature Pattern of Abuja 1986 - 2005



Generally, high temperatures and sparse rainfall (and sometimes, short, heavy and intense localized rainfall) characterize the climatic conditions in the Northern part of Nigeria (Table 1, Figure 1). The Southern part of Nigeria experiences between six and eight months of consistent rainfall especially in the coastal belts. Lagos State, Nigeria for example, experiences 0.80% yearly increase in temperature since 1971 (Tables 2 and 3, Figures 2 and 3). Worldwide, all the future scenarios consistently predict that global temperature would increase substantially (Guerrieri, 2002).

Table 2 Summary of the yearly Average Temperature For Lagos and Port Harcourt from 1971-2007

	Lagos		Port Harcourt	
Year	Mean Temp Value	5-yr MA	Mean Temp Value	5-yr MA
1971	26.77		26.62	
1972	27.21		26.83	
1973	26.9		27.09	
1974	26.95		26.7	
1975	26.69	26.904	26.49	26.746
1976	26.61	26.872	26.34	26.69
1977	26.07	26.644	26.84	26.692
1978	26.84	26.632	26.8	26.634
1979	27.09	26.66	26.85	26.664
1980	27.51	26.824	26.84	26.734
1981	27.63	27.028	26.49	26.764
1982	27.3	27.274	26.65	26.726
1983	27.62	27.43	26.85	26.736
1984	27.71	27.554	26.54	26.674
1985	27.4	27.532	26.73	26.652
1986	27.31	27.468	26.66	26.686
1987	27.85	27.578	27.4	26.836
1988	27.59	27.572	27.16	26.898
1989	27.07	27.444	26.72	26.934
1990	27.56	27.476	27.16	27.02
1991	27.36	27.486	26.85	27.058
1992	27.23	27.362	26.71	26.92
1993	27.61	27.366	26.74	26.836
1994	27.3	27.412	26.95	26.882
1995	27.79	27.458	27.18	26.886
1996	27.78	27.542	27.07	26.93
1997	27.56	27.608	27.03	26.994
1998	27.88	27.662	27.54	27.154
1999	27.61	27.724	26.94	27.152
2000	27.75	27.716	27.12	27.14
2001	27.76	27.712	26.96	27.118
2002	27.83	27.766	26.06	26.924
2003	28.02	27.794	26.84	26.784
2004	27.53	27.778	27.17	26.83
2005	27.76	27.78	27.36	26.878
2006	26.22	27.472	27.47	26.98
2007	26.11	27.128	27.36	27.24
	1010.78	903.658	995.11	886.792
mean temp	28.07722222	25.10161111	27.64194444	24.6331111
average annual increment in temp	0.77992284			

Fig 2. Yearly Average of Temp for Lagos 1971 - 2007

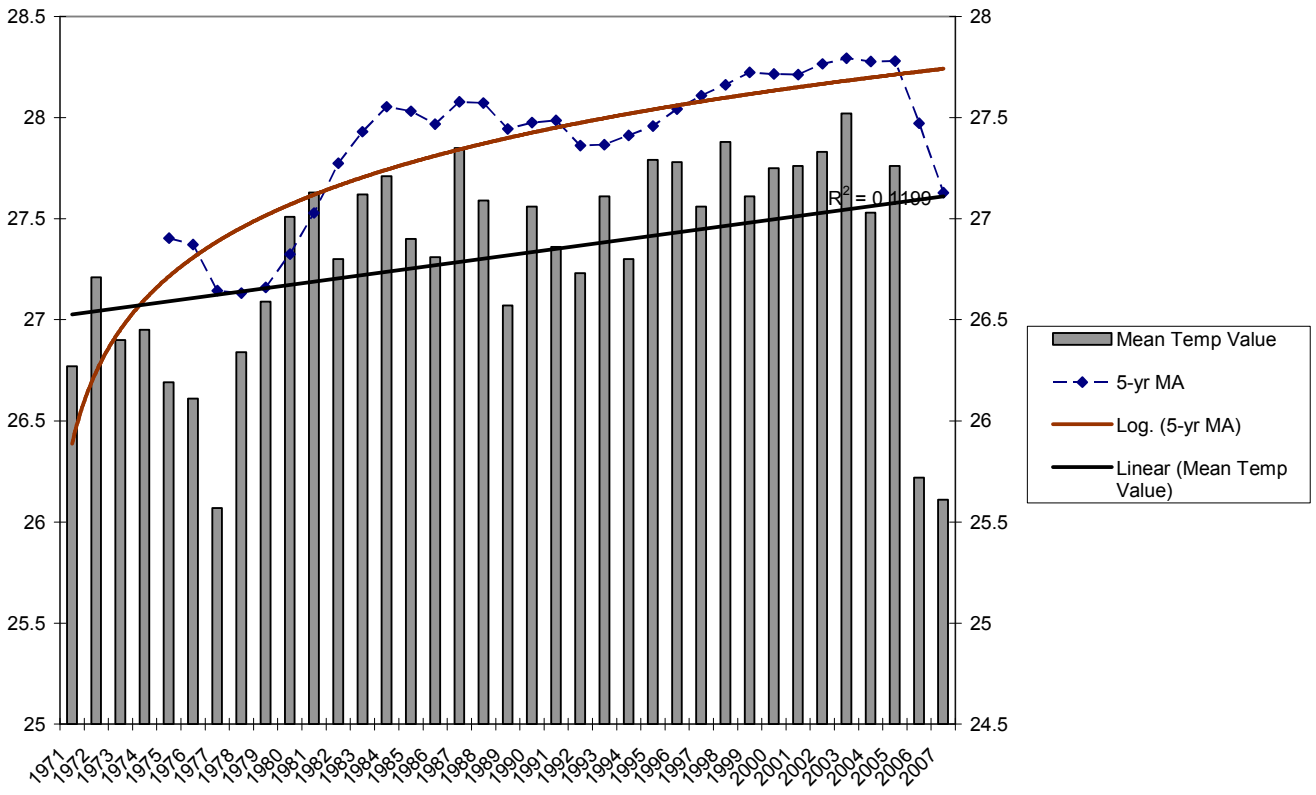
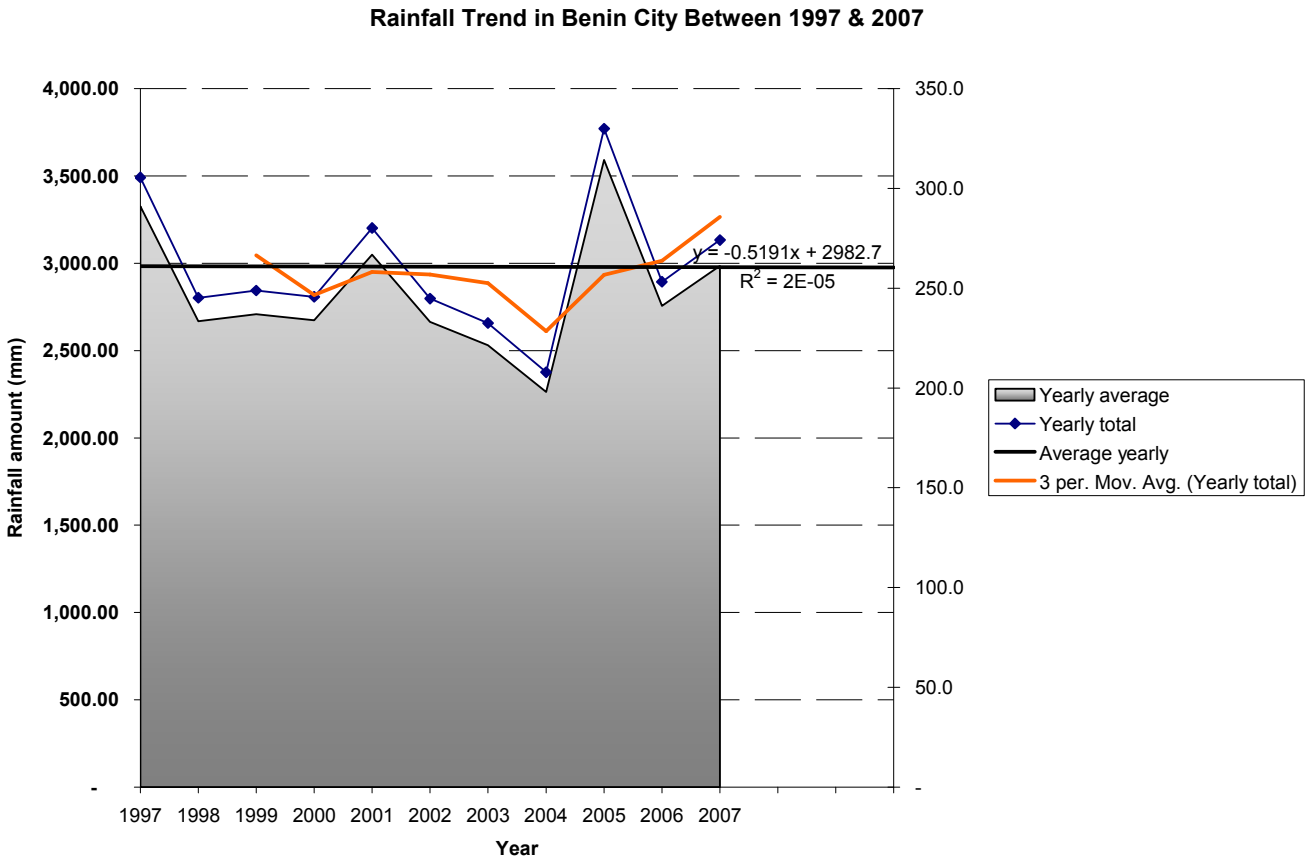


Table3: Mean Monthly/Annual Rainfall of Benin City Region (1997 - 2007) in Millimeters

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Annual Average	SD
1997	61.0	-	139.4	228.1	328.2	633.1	796.6	492.6	211.2	319.1	214.3	68.2	3,491.80	291.0	241.6
1998	25.4	6.0	174.0	149.1	211.6	504.5	255.2	352.7	365.0	439.1	286.3	33.6	2,802.50	233.5	164.2
1999	86.0	149.8	223.0	311.4	180.0	270.3	349.9	233.8	368.3	463.7	207.2	0.3	2,843.70	237.0	127.5
2000	66.0	-	95.9	166.4	217.0	250.6	597.9	392.0	577.6	232.9	153.6	57.5	2,807.40	234.0	195.5
2001	-	11.6	151.7	371.8	491.4	390.5	268.5	457.0	455.7	381.0	217.1	5.7	3,202.00	266.8	186.3
2002	-	13.5	154.6	383.2	301.3	344.6	274.1	623.5	284.3	285.8	126.1	6.8	2,797.76	233.1	183.5
2003	26.7	103.2	226.6	283.0	315.3	202.2	327.4	398.6	399.2	224.1	148.5	2.9	2,657.70	221.5	132.2
2004	9.9	19.9	73.5	278.4	270.2	308.0	303.5	391.9	355.5	196.4	168.3	0.6	2,376.10	198.0	141.3
2005	33.8	35.3	295.7	299.9	263.9	615.6	828.2	634.4	230.4	279.8	182.3	71.5	3,770.80	314.2	252.5
2006	84.7	57.1	323.0	166.1	430.8	227.7	484.9	273.4	536.0	175.3	134.4	0.1	2,893.50	241.1	172.7
2007	-	51.1	181.0	265.9	384.2	583.5	492.7	414.7	561.7	197.9	-	-	3,132.70	261.1	222.7
11yrs monthly total	393.50	447.50	2,038.40	2,903.30	3,393.90	4,330.60	4,978.90	4,664.60	4,344.90	3,195.10	1,838.06	247.20	32,775.96	2,731.3	1,725.9
Min	-	-	73.5	149.1	180.0	202.2	255.2	233.8	211.2	175.3	-	-			
Max	86.0	149.8	323.0	383.2	491.4	633.1	828.2	634.4	577.6	463.7	286.3	71.5	3,770.8		
11yrs Monthly Avg	35.8	40.7	185.3	263.9	308.5	393.7	452.6	424.1	395.0	290.5	167.1	22.5	2,979.6	248.3	

Source: Nig Met Agency Benin City.



There is no doubt on the effects of climate change in altering the precipitation patterns in terms of distribution, intensity and duration of extreme rainfall events and a higher frequency of strong precipitation. Due to higher temperatures and drought, lands have become more susceptible to runoff, exacerbating floods intensity. Changes in rainfall intensity and distribution influence river morphology (erosion of banks, fast sedimentation in riverbeds) introducing more dynamic changes in flood patterns (Guerrieri, 2002; Amangabara and Gobo, 2007).

Vegetation structure may change due to increase in atmospheric temperature and this is connected with the soil retention capacity and runoff. Increase in global temperature as a result of global warming has been linked to sea level rise. Increase in sea levels influence the occurrence and the effects of flooding in coastal communities. According to CEDA (1997), the length of Nigeria's coastline is 853km and much of Nigeria's population and economic activities are located along this coast with over 20% of the population inhabiting coastal areas. Of the thirty-six States in the country, nine States (Lagos, Ogun, Ondo, Edo, Delta, Bayelsa, Rivers, Akwa Ibom and Cross River) are located in the coastal zone. The Nigerian coastal zone and its resources have vast implications for the economy.

Urbanization

Rapid urbanization without due planning is also a major cause of flooding in our urban areas (Amangabara and Gobo, 2007; Amangabara *et al.,* 2008). There has been increase in the number of people who move from the rural areas to urban areas all over the world. There were about 352 million people in all the countries bordering the Mediterranean Sea in 1985 and it was projected that by 2025 it would be 545 million people (Guerrieri, 2002). Seventy –five percent (75%) of this projected population is

expected to live in urban areas. Alkali (2005) reported that 48.2% of Nigeria's population lives in urban centres and that this percentage is expected to increase to 60% of those that will live in urban centres by 2025.

In terms of flood risk, urbanization is increasing the percentage of total impervious covers (TIC) of the urban centre and some of these urban centres especially in the developing countries have poorly and defectively designed drainage systems that cannot effectively convey the surface runoff generated from storm precipitations (Akobo, 2005; Teme and Gobo, 2005; Amangabara *et al.,* 2008). The Ntamogba Stream catchment in the Port Harcourt City for example, experienced a quantum leap in the total impervious cover. Between 1990 and 2006 the TIC of the area rose from about 40% to 90% (Amangabara and Gobo, 2007) causing a tremendous change in the rainfall-runoff relations.

Types of Flood and Flood Hazards:

By virtue of Nigeria's spatial extent and its location in the tropical latitudes, the country encompasses various climatic regimes and physiographical units**,** which have severely exposed the country to the destructive influences of climatically induced hazards including flooding, drought and desertification (FMEnv, 2005).

Research data available on floods in Nigeria identified five major types of floods, which include,

Urban Floods: this type of flood describes a situation where urban centres are inundated as a result of intense rainfall, high total impervious cover (resulting in less infiltration and more surface runoff), flat topography, inadequate drainage networks, obstruction of drainage channels with solid objects, etc. Aba, Uyo, Port Harcourt, Warri, Benin, Lagos, etc., are examples of cities that experience this type of flood in different magnitudes. Hazards associated with this type of flooding are destruction of household properties, public infrastructures such as rail lines, electricity/utility facilities, obstruction of traffic flow, loss of man hours, health problems (e.g., outbreak of typhoid, fever, cholera) (Teme and Gobo, 2005; Ogbonna *et al.,* 2008)

Flash Floods: These are associated with intense, localised thunderstorm activity occurring in small basins. The extremely rapidity of this phenomena limits the efficiency of warning procedures and emergency actions. Thus, flash floods are the most significant flood hazards regarding the number of fatalities. Flash floods are distinguished from a regular flood by a timescale less than six hours. Lagos, Port Harcourt, Warri and Benin City are Cities that experience this type of flooding. Many people tend to underestimate the dangers of flash floods. What makes flash floods most dangerous is their sudden nature.

Channel Floods: Are other types of flood. These occur when the natural or artificial banks of any reach of a stream or river, are over-topped and spread beyond over normally dry land areas. In the upper reaches of streams and rivers, the cause of this type of flood could be associated with dam failures upstream, channel silting and long duration rainfall. In the middle and lower reaches (especially near coastal estuaries) the cause is associated with the combination of any or all of the above mentioned factors with high spring tide. The annual floods associated with the discharge pattern of the Niger-Benue Rivers System also fall into this type of classification. States in Nigeria that suffer this type of flood problem include Sokoto, Kaduna, Benue, Taraba, Gombe, Oyo (Ibadan) Bayelsa, Delta, Akwa Ibom and Rivers State. Hazards associated with this type of flood are channel bank failure during flood recession phase. Where these occur houses and villages are swept away besides destruction of farmland and out-break of diseases leading to serious epidemics and drowning (Gobo and Abam, 1991).

Back- swamps Flooding: Back swamps are located some distance away from the stream channel on the floodplain. When water spills over onto the floodplain, the heaviest material drops out first and finest material is carried a greater distance. The fine grained alluvium holds much water and drains rather slowly creating wetland areas. Back swamps are important "sponges" that retain water that might cause severe flooding downstream. This type of flood is the most prevalent in the entire Delta State. The flood peaks could be unusually high not only because of the high rainfall during the year and the preceding years but also because of the excessive release of water from dams.

Coastal Inundation is another type of flood. This is the regular diurnal flooding associated with the tidal invasion of creeks and ocean surges on coastlands e.g. Bar beach Lagos, Twon-Brass, Bonny Coastlines, Forcados,

Okrika Island, Ogu, Opobo Island etc. This type of flood is usually aggravated by storm episodes.

On a global scale, there is an alarming trend in the number of people affected by floods with an average of 147 million affected per year (1981 – 1990) rising to 211 million per year (1991 – 2000) [UN, 2004]. Within the last decade, there has been catastrophic flooding in Bangladesh, China, India, Germany, Poland, Morocco, Tunisia, Algeria, Mozambique, and The United States. In 2008, there were several reports of severe flooding in the Northern part of Nigeria with over five hundred houses, three bridges and seven hundred farmlands washed away. The majority of those affected were within the most vulnerable members of the society consisting of the elderly, women, children and the poor.

The Social and Economic Cost of Flooding

According to UN (2004), flooding, is the single most destructive type of natural disaster that strikes human and their livelihood around the world. The economic cost or human loss is not restricted to the least developed nations but also in the most developed and industrialized countries. It is however, the citizens of the least developed nations that suffer the highest toll from the occurrence of flooding.

For example, the devastating effect of Hurricane Mitch, which caused severe flooding in Honduras in 1998, was estimated by The United Nations Development Programme (UNDP) to have cost an economic loss of about US$3.64 billion, which is about 69% of their annual gross domestic product (GDP). In comparison, in 2002, the United States was hit by Hurricane Andrew resulting in estimated damage of US$30 billion. This damage is just 0.5% of the annual gross domestic product of the USA (www.aoml.noaa.gov/hrd/landsea/Usdmg).

Poverty has been linked to the impact experienced from flooding in developing countries; poverty affects people's capacity to protect themselves and their assets, as well as their ability to live in areas that are less exposed to risk (Rayhan, 2009). Vulnerability and poverty are mutually reinforcing (Amin *et al.,* 1999). Factors such as low income, poor housing and public services, lack of flood insurance coverage can force the poor to behave in ways that expose them to greater risk. As the impacts of flooding tend to fall disproportionately on the poor, specific policies are required to tackle the link between poverty and flooding vulnerability. It is very important to link flood management to poverty reduction.

The Cultural Dimension of Flooding

For many thousands of years people the world over, have chosen to live in areas subjected to flooding, they have accepted the risk of living with floods and have tried to adapt their way of living to cope with the floods while deriving economic and social gain (Fox, 2003; FMEnv, 2005). In such communities, for example, in the Niger Delta, Nigeria and in Bangladesh, Asia, houses are built to allow for flooding during the wet season; people use boats to travel when roads are impassable, and the whole cycle of planting and cropping is linked to the rise and fall of the floodwaters.

Back-swamp flood in the Niger Delta

Canoes used as means of transport during flood

Houses are built on trees and poles to avoid the floods, while canoes are used because the roads have become impassable

Channel Floods: the overflow of tributaries of River Niger at Bayelsa State

-Flood Management and Mitigation

Flood management is a broad concept that focuses on reducing flood hazards through a combination of policy, institutional, regulatory and physical measures, while recognizing that floods can never be fully controlled (GWP, 2001). According to Guerrieri (2002), it is any human activity to prevent loss of lives, property and production due to floods. The whole concept of flood management can therefore be grouped into

structural measures (altering the physical characteristics of the flood) and non-structural measures (procedures altering the exposure of lives and properties to flood such as forecasting and warning, education and public information).

To curtail the excessive negative impacts as a result of flood events, an effective framework must be put in place to manage flooding. This paper advocates a combination of structural and non-structural measures because often, after flood waters have subsided, the emphasis has been placed on rebuilding infrastructures and trying to restore flood victims' lives back to normal as quickly as possible without addressing the causes. Unfortunately, in the rush, these flood victims have often rebuilt their lives to their previous "at risk" conditions.

Over views of strategies adopted in addressing flood risk hazards

In response to the devastation arising from flooding, series of workshops and symposia have been held across the world in the last ten years. These were in April, 1999 in Honduras, November 1999 in Brasilia, and August 2001 in Thailand all sponsored by the United States National Oceanic and Atmospheric Administration and the United Nations Department of Economic and Social Affairs, to come up with strategies in overcoming the menace of flood. In December 2002, an adaptation strategy for improved flood management symposium was held in Athens.

In that same year, a regional consultation workshop on the impacts of floods, drought and other water disasters was held in China with key speakers advocating the balanced use of structural and non-structural measures to tackle the problems of flood. Some regional and national programmes towards addressing flood hazard include the landuse planning in France, the Spanish Water Act of 1986, the River Basin Authority law of 1989 of Italy, the Algeria Flood Disaster Reduction plans of 2001. One objective of these events and policies was to create comprehensive guidelines that could be used by government, international organizations, non-governmental organization and individuals to help avert losses from flooding

For the City of Port Harcourt, Nigeria, urban floods and tidal surges are a constant feature in the raining seasons, thus the Rivers State Government documented Guidelines and Standards for Flood Control in 2002 (RSMENR, 2002). Shortly after, in 2005, the Federal Government of Nigeria formulated the National Policy on Erosion and Flood Control (FMEnv, 2005).

Some of the objectives of the National Policy on Erosion and Flood control include:

i. To put in place appropriate mechanism and structures for flood prevention, control and water conservation.
ii. To undertake flood hazard assessment including mapping and risk evaluation
iii. To undertake flood forecasting and warning on flood prone areas
iv. Promote community education on the appropriate and simple techniques for flood control and water conservation, etc.

Getting the National Policy on Erosion and Flood Control to work will require the adoption of both structural and non-structural measures of flood management; this is important because five years after, the strategies and targets set in the National Flood and Erosion Control Policy might not have been met.

Structural Measures are the tools altering the physical characteristics of the floods. Wisely applied, the impact of flooding can be greatly reduced. However, structural measures on their own alone cannot get rid of flooding, and they can be costly and disruptive to the environment (Guerrieri, 2002). The success of minor flood protection embankments has led many communities to attempt to control much larger floods. They are culturally attached to the economic gains of the flood such that many have become vulnerable to the negative effect of flooding.

It is suggested that the best approach to flood management in Nigeria is one that seeks a balance application of both structural and non-structural measures. Non-structural measures may include the raising of public awareness through better education and capacity building in the organizations responsible for managing river basins. The involvement of communities in planning flood control, i.e., any effort at controlling flood at the national or regional level must consider the people who are directly affected by the floods.

CONCLUSIONS

Flooding is a serious issue. Major constraints in the time past to successfully mitigate the effect of flooding are the fragmented institutional structures and lack of coordination

and cooperation that can exist among national institutions. Countries need to establish a clear national agency responsible for flood disaster management. To make the national Erosion and Flood Control Policy work, communities should not be passive recipients of information.

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