

# Analysis of Flood Risk Management in Nigerian Urban Environment

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## Abstract

Some of the major effects of global climate change are rise in sea level and increased frequency of extreme events. Urban settlements in Nigeria are likely to be seriously affected by flooding as a result of this change. Urbanization processes in Nigeria increase pressure on land use conversion augmenting for population increase. The study observed that climate change frequently take place in flood prone areas such as flood plains and seacoasts. Floods expose the urban population and infrastructure to risk due to the excessive runoff which must be directed to rivers, streams, canals and storm water drainage systems. While a reliable urban infrastructure is vital for human needs, current urbanization trends in Nigeria are defining negative regards to flood vulnerability. Of particular concern is the fact the most impoverished segment of the population who are most likely to settle in flood hazard prone areas are the least able to adopt measures for adaptation in the event of flood disaster. Addressing these problems require effective environmental management agenda. Major causes of flood in Nigeria were identified to include uncontrolled expansion of impermeable surfaces due to physical development and expansion, swamp reclamation for construction purposes, lack of adequate storm water drainage systems, lack of maintenance of existing drainage systems and weak institutional capacity of urban administration and environmental management in Nigeria.

**Keywords:** Climate change, environmental management, flood vulnerability, water runoff, urbanization process.

## 1. Introduction

Natural disasters are referred to as extreme events that are neither caused nor controlled by human beings. These events have the tendency to destroy or damage natural habitats, as well as life and property. Natural disasters are sometimes beyond human control though man can scientifically predict its occurrence.

Preventive and mitigative measures are therefore necessary to make the impacts less harmful. Our nation's policy makers at this juncture should be able to tackle the challenges of reduction or prevention of its impacts through effective management policies. The integration of scientific research into government policies and decision making is very essential. Urbanization activities in developed countries incorporate their storm sewage system in urban design which results in proper direction of surface runoff to nearby stream channels. In Nigeria and other developing countries, storm sewage system are not properly developed and managed in the urban centers. This makes discharging of excess street storm runoff into nearby streams which swells urban stream peak flow to low-lying areas causing flash floods and ponding. These types of floods have been reported in Nigerian urban centers by Nwafor, (2006). This study observed that in Nigeria and other developing nations within the southern hemisphere where remarkable economic transformation is taking place, unplanned urbanization and poverty are increasing vulnerability to flooding and other natural disasters (Galeemul et al, 2007). Disaster risk management has therefore a significant role to play in the event of flood disaster. The aim of this study is to discuss the importance of flood risk management in Nigeria's urban

## 2. Conceptual Framework:

Flood is a natural disaster which occurs as an extreme hydrological runoff event either in the form of exceptionally high rate discharge in water courses or as inundation of hitherto normal dry land. (Nwafor, 2006). Flood as a natural disaster occurs when soil infiltration capacity is higher than rainfall intensity; hence the rain water reaching the surface of earth percolates into the ground to form part of the shallow subsurface flow and saturation of over-land flow. In other words, flooding occurs when the infiltrating capacity of soil is exceeded. The immediate effect of flooding is inundation, while the long time effects include erosion and ponding. (Ekuade, 1995).

Urban flood is any overland flow over urban streets sufficient to cause significant property damages, traffic obstructions and displacement of people, nuisance and health hazards. (Rashi 1982) The removal of natural vegetation cover from a forested area due to construction activities lowers the infiltration capacity to an area where rainfall intensity becomes higher.

In urbanizing environment, the infiltration capacity becomes further reduced by the replacement of ground cover with impervious concrete and asphalted surfaces. This condition leads to surface overland flow to become dominant collector of excess rainwater.

Vulnerability according to Intergovernmental Panel on Climate Change (IPCC), in its second assessment report, (IPCC, 2000a) is “the extent to which climate change may damage or harm a system”.

Adaptation to climate change according to Sut et al, (2000) is the process through which people reduce the adverse effects of climate on their health and wellbeing, and take advantage of the opportunities that their climatic environment provides.

The international scientific community observed that effects of greenhouse gases are one of the major factors expected to lead to an increase in global mean sea level as well as to regional and global changes in temperature, precipitation and other climate variables contributing to flood events.

### 3. Causes of Flood

Floods are caused by many factors such as heavy precipitation, severe winds over water, unusual high tides, and failure of dams, levees, retention ponds or other structures that contained the water.

**Heavy Precipitation:** During rainfall, some of the water is retained in ponds, or soil, some absorbed by grass, and vegetation, some evaporates but the rest, which reach stream channels, are called surface runoffs. Floods occur when ponds, lakes, riverbeds, soil, and vegetation cannot absorb all the water. Water then runs off the land in large quantities, which cannot be carried within stream channels or retained in natural ponds, and man-made reservoirs. River flooding is often caused by heavy rain, or increased by melting snow. A flood that rises rapidly, with little or no advance warning, is typically called a flash flood. Flash floods usually result from intense rainfall over a relatively small area, or if the area was already saturated from previous precipitation.

**Severe Winds:** Shorelines of lakes, bays can be flooded by severe winds, such as during hurricanes that blow water into the shore areas exceeding the capacity of the shoreline to contain the water.

**Unusual High Tides:** This happens in coastal areas when unusual high tides induced by strong winds over ocean surfaces, during hurricane, or severe winds caused a high tide combined with the normal tide plus storm surge with higher waves on top.

**Tsunamis:** are high large waves typically caused by undersea earthquake or massive explosions such as eruption of an undersea volcano.

### EFFECTS OF FLOOD

- Endangers live of humans and animals
- Rapid water runoff causes soil erosion and sediment deposition problems downstream.
- Prolonged high flood can disrupt traffic in areas lacking elevated roadways.
- Interference with drainage and economic use of lands and farming. .
- Impairment of waterway navigation and hydroelectric power
- Economic loss due to damages to infrastructure, farmland, commercial goods and services.
- Impact on human health: unsanitary conditions associated with water pollution in urban areas leading to water-borne diseases
- Causes erosion menace especially in sloppy terrains.

### 4. Discussion

#### Urbanization and Flood Link in Nigeria:

Nigeria is undergoing rapid urbanization like other developing countries without adequate planning to guide against risks associated with locating new homes in hazard prone areas such as the coastal belts. On poverty and marginalization, the poor are usually forced to locate to cheaper lands and therefore are likely to be subjected to areas prone to more frequent flooding. The poor are also usually less capable of absorbing or recovering from any given hazardous occurrence making them more vulnerable to climate induced flood and other natural disasters. This is because, when people face the decision of settling in any place, poverty reduces their ability to make choices. They have no choice than to settle on lands more susceptible to climate variability such as floods. It is clear from the study that the poor frequently have higher levels of exposure and are more vulnerable to climate – induced flood. Nigeria and other poor nations lack the technical expertise and financial resources to adapt to climate change because they have too many competing necessities to address. Disparities in vulnerability were found in household level, where children, and the elderly are relatively less able to cope with climate – induced disturbances, from food scarcity, disease epidemic to flash-flooding. (Sheridan, Bartlett and Sari, Kovats 2007).

Poverty according to study is closely tied to marginality which carries a number of implications in terms of vulnerability because being marginal implies being removed from the security and resources collected and managed through a central administration network.

Access to economic and financial resources is essential to reduce vulnerability in the context of climate change and increased flood risk. The wealthier in a geographical entity, the more likely it is that:

Flood risk issues and built environment will be undertaken.

Exposure to risk will be reduced through infrastructure provision, relocation of critical facilities, best management practices and other strategic measures to reduce flood event affecting people and property. Coping with flood event will be easier because of better ability to absorb the impact and more economic and financial resources. The study is of the opinion that mitigation through reduction and prevention are necessary, therefore there is need to have a strengthened focus of adaptation, particularly for the poor, who are likely to suffer most consequences of extreme flood events (Satterwaite, 2007).

Flooding has great influence in artificial and natural catchments in many parts of Nigeria. The local features that promote flooding include:-

Average slope of land especially low-lying topography, type of land use, especially urban land, the nature of the drainage system and the volume of flood. The volume of flood is usually high during the wet seasons around the coastal belts and the extensive swampy alluvial plains of major rivers in Nigeria- Lagos, Port Harcourt, Warri, Calabar and other coastal towns.

The geographical distribution of an area liable to flooding and the magnitude of the flood events in Nigeria are determined by seasonal and regional scales of precipitation and the peculiar characteristics of the physical environment

( Nwafor 2006). Flooding within the artificial catchments during the rainy season can be very disastrous and problematic and pose serious socio-economic and health effects. This is because, urban centers in Nigeria experience substantial land cover by pavements, roofs over buildings and other kinds of construction and structures with impermeable surfaces which direct the rainwater directly into impervious drainage systems. The coastal areas of Nigeria sometimes have three consecutive days of rainfall. These may result in build-up of soil moisture content thus causing high residual surface flows prior to occurrence of another critical rain resulting to flooding. The urban areas experience greater flood with increasing urbanization resulting to greater volume of runoff of about 2-4 times before the development of the area. Significantly, urban cities in Nigeria experience greater flood events. Those located in the coastal plains of Atlantic Ocean notably –Lagos, Port Harcourt, Warri, Calabar, Bonny are exposed to highest levels of risk. These coastal cities and towns constitute artificial catchments within the already flood-prone natural catchments. They also experience higher intensity and longer duration of rainfall. They are also located within low level lands, with gentle slopes, saturated soils, intense coastal storms and tidal surges.

Other urban centers located further inland especially those located near major rivers or those with relatively flat land also experience serious flood events. The cities include Ibadan, Benin City, Onitsha, Aba, and Uyo. Flooding is also experienced in some rural areas of Niger Delta as well as within the hinterland.

## **5. Flooding and Urbanization in Nigeria.**

The study observed that expansion of urban areas without proper planning, improper maintenance of drainage facilities, increase in infrastructure provisions and population explosions results to increase of impervious surface and consequently increase in surface runoff causing urban floods. Urbanization and population increase are directly linked to cases of increasing demand for housing supply and infrastructure provision and as a consequence are drastically increasing vulnerability of human settlement to flooding events.

In Nigeria this is associated with growing levels of poverty with resultant proliferation of slums and squatter settlements. The study observed that poverty increases vulnerability in that, firstly, the poor are restricted by poverty to locate in unsafe areas because poverty implies lack of choices. Observed urban areas present some risk of flooding after rainfall occurrence. Buildings, roads, infrastructure and other paved areas prevent the rainwater from infiltrating into the soil and so produce runoff. Heavy rainfall or prolonged rainfall produces very large volumes of surface water in the city which can easily be removed by drainage systems. In well-planned cities this does not constitute problems because good provision for storm and surface water is easily built into the urban fabric with complementary measures to protect the city against flooding. Parks, open spaces are used to accommodate flood waters from small rains. In well planned cities, provisions are made for land use management and incremental adjustment to increase flood – water management.

Nigeria belongs to nations with poorly or unplanned cities where most areas have no adequate drainage system installed but rely on natural drainage channels which are often obstructed by buildings and other infrastructures. In most urban centers in Nigeria, a significant proportion of the population is not served by solid waste management. Garbage and plant growth clogging drains and canals are common features leading to localized flooding even with light rainfall. There are growing documentation on the inadequacies in drainage and flood protection for urban centers as the trend responsible for increased numbers of deaths and injuries, and displaced population. A good example is the coastal city of Port Harcourt (Abam et al, 2000) (Alam and Golam, 2007).

## **6. Flood Risk Management**

The aim of flood control mechanism is to give people in flood prone zones, new technologies and methods of

reducing the danger of flooding by means of integrated flood management and innovations in technical flood control. These include,

**Flood Control Plans:** Flood control plans serve the purpose of minimizing to the best possible degree and proportionately, the risks emanating from at least one flood statistically expected to occur once in a hundred years.

**Flood Control:** The principle of flood control is to avoid and limit damage through integrated planning. Thus practice-oriented instruments should be developed ranging from flood forecasts, technical innovations, to integrated flood management in catchments areas. Flood control measures include

- Planting of vegetation to retain excess water.
  - Terracing hillsides to slow flow of water downhill
  - Construction of flood ways i.e. man-made channels to divert floodwater.
  - Construction of levees, dykes, dams, reservoir, retention ponds, to hold extra water during times of flooding.
  - Defenses such as levees, bonding bands, reservoir and weirs are used to prevent rivers from bursting their banks. When these fail, emergency measures such as sand bags or portable inflated tubes are used.
- Others include-
- The use of seawalls and barrier islands.
  - Limiting development within the floodplains
  - Water diversion system for emergency preparedness
  - Use of engineered inter locking flexible tubes that are inflated with water.

## 7. Disaster Risk Management

Surface waters have to be managed in such a way that as far as possible, floods are held back, a non-harmful water run-off is ensured and flood damage is prevented. This is the principle applied in areas that may be inundated by a flood or where an inundation may help alleviate flood damages or risks.

The inter-relationship between climate change, urbanization and the urban poor has been analyzed to constitute vulnerability to human security. It is therefore necessary to integrate research and assessment into government decision-making policies in order to address the needs of the urban poor.

The institutional structures should take steps to adapt to global climate change in the context of urban poverty and rapid urbanization.

In general, aspects of activities of flood management in times of flood,

Include-.

- Flood forecasting
- Flood warning

### Flood Forecasting

-Flood Early Warning System. (FEWS)

Concerned parties might be organizations making weather forecasts, collecting and transmitting real-time hydro –metrological data, maintaining the river system, in charge of the development of the river basin, designing and effectuating flood control measures.

In operating Flood Early Warning Systems (FEWS), the following aspects are essential: -

-Weather forecasts:

Weather or precipitation for the coming few days are needed in order to make a forecast for future anticipated water levels in the major river network and other water courses.

-Real-time data collection network:

This involves updating flood forecasting model by assimilation of actual observed water levels and discharge in major rivers, water network systems and actual observed precipitation in the upstream catchments areas.

-Transmission of real-time collected data:

This involves the transmission of collected data to flood forecasting center, where forecasts for future water levels in the network system are made.

-Flood forecast time horizon:

It is essential that flood forecast are made for sufficient long time period in advance in order to enable the local authorities to warn and possible evacuate the local inhabitants of the flood prone areas.

-Flood forecasting model:

In the past flood forecasts (i.e. future water levels and discharges) were mainly based on real time monitored rainfall, water levels and discharges. Recent developments in flood forecasting is the use of

Flood Forecasting Model (FFM) consisting of a number of coupled rainfall-run-off models and hydrologic hydrodynamic models which describe the water movement in a particular river or water body network system.

-Flood forecasting Center (FFC):

Flood forecasting is made at the flood forecasting center, where real-time collected hydro-meteorological data and the weather forecasts are received. The flood forecasting model is operated and the actual hydrological status of the river network system is assessed. Also flood forecasting center issues flood warnings to concerned flood fighting agencies in case water levels are exceeded.

-Institutional Aspects:

For successful flood forecasting, it is of the utmost importance that all concerned parties show active involvement in the operation of the flood.

## 8. Flood Warning

Flood warning services are usually organized by institutional agents such as: Meteorological Stations and River Basin Authorities. They are responsible for dissemination of warning messages to inhabitants' settlements in flood plain areas and collect information to be communicated to the flood control agents so as to control the measures against flood and complementary information for the purposes of forecasting offices. Messages are passed through national or central, state, regional or local governments by means of electronic media- Radio, TV, Internet etc.

## Benefits of Extensive Flood Management

Growth of the agriculture industry, Removal of flood waters, Storage of excess water for use during dry periods, Prevention of saltwater intrusion by maintaining adequate groundwater level, Protection of developed urban areas, Construction of more urban and agricultural projects in traditional flood plains, Expansion of navigation activities and Transformation of muggy swamps and wetlands into hospitable paradise.

## 9. Recommendations and Conclusion

Floods are inevitable, unpredictable and largely preventable. Global warming is causing a wide variety of climate changes and all experts agree we are going to experience more floods, in more areas in the years to come. The time has come to take proactive measures to mitigate flood damage. By integrating and adopting emergency flood control measures into existing old flood control strategies, a significant amount of damages to life and property can be avoided

Water segments where more than minor flood damage has occurred or is expected to occur shall be determined by land law which shall make provisions to inform the general public to adjust the designation of such waters.

Those areas where statistically a flood event is expected to occur periodically (at minimum of every 100 years) shall be designated flood plains.

Flood plains with high potentials for damage in the wake of flood, particularly in settlement areas shall be made known to the general public by land law administrators.

The ministry of lands or other designated government statutory bodies shall adopt regulations designed to protect the public against the risk of flooding.

With the exception of land-use plans for harbors and ship yards, no new development sites must be designated by land-use plans in flood plains unless allowed by a competent authority.

The function of flood plains in retention areas shall be preserved, but where it conflicts with overriding public interest, the necessary compensatory measures must be taken in good time.

A very large population of the world faces increased threats to their security and there are no plans to provide them with adequate adaptation to climate change. There is therefore an urgent need to broaden the scope of the problem and search for solution particularly for the most vulnerable sectors of the population.

There is need for diversification of research and policy initiatives, embracing adaptation needs with a focus on the urban poor who are excluded from instances of governance.

To adequately mitigate and adapt to global climate in the context of poverty and rapid urbanization, the disaster risk management community can contribute in no small way by promoting the role of adaptation in climate change policies.

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