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Archives of Applied Science Research, 2011, 3 (1):17-24

(http://scholarsresearchlibrary.com/archive.html)

ISSN 0975-508X
CODEN (USA) AASRC9

Managing flood in Nigerian cities: Risk analysis and adaptation options – ilorin city as a case study

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INTRODUCTION

The potential consequences of climate change are profound, particularly on people in the less developed countries. The question is therefore not whether climate change is happening, but what to do about it. Over the last 20 years climate change has become an increasingly high profile issue both from a social and economic viewpoint. It's not only the scientists and environmentalists who are concerned about climate change. Governments, politicians and the general public are also taking an interest in climate change.

As a result of global warming, the type, frequency and intensity of extreme events, such as tropical cyclones (including hurricanes and typhoons), floods, droughts and heavy precipitation events, are expected to rise even with relatively small average temperature increases. Changes in some types of extreme events have already been observed, for example, increases in the frequency and intensity of heat waves and heavy precipitation events [1, 2].

Global climate change indicates a change in either the mean state of the climate or in its variability, persisting for several decades or longer. It is important to note that changes in individual weather events will potentially contribute substantially to changes in climate variability. Climate change could occur naturally as a result of a change in the sun's energy or Earth's orbital cycle (natural climate forcing), or it could occur as a result of persistent anthropogenic forcing, such as the addition of greenhouse gases, sulphate aerosols, or black carbon to the atmosphere, or through land-use change [2].

Climate change will have wide-ranging effects on the environment, and on socio-economic and related sectors, including water resources, agriculture and food security, human health, terrestrial ecosystems and biodiversity and coastal zones. Changes in rainfall pattern are likely to lead to severe water shortages and/or flooding.

Climate change will act as a multiplier of existing threats to food security: It will make natural disasters more frequent and intense, land and water more scarce and difficult to access, and

increases in productivity even harder to achieve. The implications for people who are poor and already food insecure and malnourished are immense [3].

As a result of global warming, the climate in Africa and Asia is predicted to become more variable, and extreme weather events are expected to be more frequent and severe, with increasing risk to health and life. This includes increasing risk of drought and flooding in new areas [4-6].

Many countries are already dealing with climate change impacts resulting from irregular, unpredictable rainfall patterns, increased incidence of storms and prolonged droughts [3]. Globally, the economic cost of extreme weather and flood catastrophes is severe, and if it rises owing to climate change, it will hit poorest nations the hardest. From 1971 to 1995, floods affected more than 1.5 billion people, or 100 million a year; of those, 318,000 people were killed and more than 81 million left homeless. Additionally, the number of major flood disasters has risen relentlessly over recent time [7].

Flooding affects more people on an annual basis than any other form of natural disaster. A variety of climatic and non-climatic processes influence flood processes, resulting in river floods, flash floods, urban floods, sewer floods, glacial lake outburst floods and coastal floods. These flood-producing processes include intense and /or long-lasting precipitation, snow melt, dam break, reduced conveyance due to jams or land-slides or by storm. Floods depend on precipitation intensity, volume, timing, phase (rain or snow), antecedent conditions of rivers and their drainage basins (e.g. presence of snow and ice, soil character and status (frozen or not, saturated or unsaturated), wetness, rate and timing of snow/ice melt, urbanisation, existence of dykes, dams and reservoirs).

Although a flood can often be assigned to a single event type, on many occasions a combination of flood types and other natural hazards such as hurricanes, hailstorms and earthquakes may have occurred. In these circumstances, problems with insurance cover can arise if some occurrences are covered, but others are not [7].

If global warming leads to rising sea levels and increased storm activity, it follows that it has the potential to increase both the frequency and severity of many of the types of flooding mentioned earlier. As a result, it is increasingly important to resolve the issues relating to flood risk assessment and its possible adaptation options.

Assessing the impacts of and vulnerability to climate change and subsequently working out adaptation needs requires good quality information. This information includes climate data, such as temperature, rainfall and the frequency of extreme events, and non-climatic data, such as the current situation on the ground for different sectors including water resources, agriculture and food security, human health, terrestrial ecosystems and biodiversity, and coastal zones.

If the capacity for assessing climate variability and change, and the tools used for assessing the impacts and vulnerability of countries to climate change is not there, countries are limited in their ability to plan adaptation measures and adapt effectively [6].
This paper focuses on the risk assessment and suggested mitigable/adaptation options to river flooding which is common in ILORIN- a major city in North- central Nigeria.

Situation Analysis

Changes in river flows, as well as lake and wet land levels due to climate change depend primarily on changes in the volumes and timing of precipitation and crucially, whether precipitation falls as snow or rain [8]. In Ilorin, during rainy seasons, precipitation often falls as rain leading to changes in Asa river flows. The river often overruns its bank and resulted into recurrent flooding of the roads in Wahab Folawiyo road popularly known as Unity and its environs. Movements of vehicles and humans becomes impeded, offices and business activities and residential houses are often affected by the flood.

Observed Changes

The largest negative trends since 1901 in annual precipitation are observed over western Africa and Sahel, although there were downward trends in many other parts of Africa, and in South Asia. Since 1979, precipitation has increased in the Sahel region and in other parts of tropical Africa, related in part to variations associated with teleconnection patterns [8]. Nigeria is no exception. Annually, Ilorin city in Kwara often experienced increased in precipitation with its attendant Asa river flood.

Projected Changes

Continued greenhouse gas emission at or above current rates would cause further warming and induce many changes on the global climate system during the 21st century, with these changes very likely to be larger than those observed during the 20th century. Warming is projected to be greatest over land and at most high northern latitudes (and least over the Southern ocean and parts of the North-Atlantic ocean). It is very likely that hot extremes and heat waves will continue to become more frequent. Ilorin city located in the North-Central Nigeria is often faced with such extremes of condition. The continual greenhouse gas emission, a practice in Nigerian cities could probably explain the incessant and constant high temperature of 40^{o}C and above in Ilorin often experienced in the dry seasons.

It is also very likely that heavy precipitation events will become more frequent in the subsequent rainy seasons in Ilorin. Intensity of precipitation events is projected to increase, particularly in tropical & high-latitude areas that experience increases in mean precipitation [8].

Case study-River flooding in Ilorin city, Nigeria

Ilorin is the capital city of Kwara state, Nigeria located in western Africa. Ilorin city lies between latitude 8^{o} 24'N and 8^{o}36'N and between longitude 4^{o}10' and 4^{o}36'E [9]. The city is drained mainly by consequent River Asa and its tributary streams such as Aluko, Alalubosa, Okun, Osere, Agba and Atileke. It has a humid tropical climate, which is characterized by wet and dry season. Rainy season in the city begins towards the end of March and ends in October with two peak periods in June and September [10]. Essentially, Ilorin is located in the transition zone between the deciduous forest (rainforest) of the southwest and the Savannah grasslands of the north [10]. Incidence of flood has been on the increase in Ilorin for sometime and this exemplifies the problem operating in most urban centres in Nigeria. Asa River is a major river that practically divides Ilorin city into two as it passes through [11]. It was dammed to serve as a major source of water to urban capital city of Ilorin and the dam, ASA DAM, is run by water works of Kwara state government with an average design capacity of about 50 million litres per day. The downstream runs through the industrial estate of the city as far as the commercial area of interest within the city. Studies on the rainfall, run-off regime and stream flow characteristics of Asa River catchment basins had shown that the incidence of flood has been on the increase and the results indicated that the basin size and land use have profound influence on the

explanation of discharge in the Asa River catchment basins [12]. Ilorin has been experiencing flood disaster/events on annual basis due to high river discharge of Asa River during extreme precipitation periods of wet season amongst other non -climate driven or anthropogenic reasons/factors [13]. Olaniran (1983) reported three (3) flooding events in Ilorin in just one decade , causing untold hardships and damages in the town [14]. Adekunle and Eniola (2008) also reported the impact of constant pollutions from effluent of detergent soap industries into Asa river [15]. The indiscriminate point pollutions of Asa river from industrial, domestic, agricultural, commercial activities in the environs have been associated with the river overflowing its bank in the rainy season (Unpublished data). Several other investigations on the discharges of wastewater and storm run-off into rivers in Ilorin during rainy season have been reported by Kolawole *et al*., 2008 [16]. The little attention being paid to run-off studies in Nigeria are daily manifesting in water and water-related problems being experienced in Nigeria [17,18].

From the work of Jimoh and Alao (2009), Asa river catchment was found to have a very high precipitation and sediment yields when analysed yearly for a period of seven years. Jimoh and Alao (2009) further reported that the high amount of sediment yield is directly related to the amount, duration and intensity of rainfall, as well as stream discharge, which often increases the river water level and finally causes flooding in the basin area in Ilorin [19]. This calls for preparative actions by water resource management operatives against such occurrence.

The Kwara state government has appealed to the Federal government to urgently come to its assistance in addressing the problem of flooding that has ravaged some parts of Ilorin, the state capital, in which many houses yearly have been submerged by floods and threaten lives of settlements at close proximity to the river side rendering hundreds of residents homeless with valuable properties destroyed. Usually affected settlement areas within the city include commercial buildings and residence along Unity road, Lower Taiwo, Obbo road and Amilegbe area of Ilorin city.

The state government claimed to have taken a lot of steps in the past to avert the disaster but also admittedly pointed out that the disaster was beyond what it could solely handle and thereby called for aid at the national level [20].

This situation demands appropriate flood risk analysis for effective choice of adaptation and mitigation options toward urban development planning of the city. The assessment issues addressed further in this paper may support long-term planning and decision-making for building adaptive capacity on flood disaster in many cities in Nigeria.

Risk Analysis Assessment

Risk is defined as the probability of a disaster, e.g a flood, related to the consequences (usually the multiplication of both variables).

The idea of acceptable risk for different regions/countries may be influenced by a single spectacular accident or incident like 1953 flood disaster in the Netherlands; tsunami disaster 2004 in Asia, Katrina in New Orleans, USA 2005; Damrey Typhoon in Vietnam 2005 and large flooding in Bangladesh 2007. These unwanted events could be starting/ turning points of any new safety policy establishment for the countries [21].

From literature, the acceptance of risk should be studied from three different points of view in relation to the estimation of the consequences of flooding [21]. The first point of view is the assessment by the individual. This is translated as the probability of losing one's life due to participating in daily activities. The second point of view concerns the risk assessment by society on a national level related to the number of causalities due to a certain activity. Acceptable level of risk can also be formulated by economical cost- benefit analysis.

However, this paper would focus on the qualitative assessment of the consequences of flooding in Ilorin based on two points of view i.e, individual risk and societal risk without employing the already established climate, statistical data and cost models normally used, though not disapproving them. The latter i.e societal risk would be sub-divided into three which are environmental/ecological risk, public- health risk and socio-economic risk.

(A) Individual Risk

This is the small- scale component of the social acceptance of risk. It is the personal cost benefit assessment by the individual. It is defined as the probability that an average unprotected person permanently present at a certain location is killed due to an accident resulting from a hazardous activity.

It has been observed that attempts to model this appraisal procedure quantitatively are not feasible [21]. Standards can not be set on individual basis because it is limiting.

(B) Societal Risk

Public Health Perspective (Impact Assessment)

The post-event impact of the river flooding in Ilorin city can be well assessed using the potential public-health issues or concerns associated with the occurrence.

The health impact assessment or vulnerability assessment of flooding can generate output that is policy relevant if analyses of the following range of sectors are done in Ilorin, Kwara state;

- Human Health
- Agriculture & Food Security
- Water resources

Human health is a sector that is sensitive and qualitative in analysing the societal risk during and after flooding. The following health issues may arise:

- Increased risk of deaths by drowning
- Infectious respiratory, water-borne and skin disease due to injuries.
- Pathogens and parasites may be conveyed in the flood water. E.g typhoid, dysentery, tetanus etc.
- Spatial and temporal transmission of disease vectors, including malaria, dengue fever, meningitis, cholera etc.

Agriculture is a sector that can be evaluated to assess the public-health impact through the following:

- Flash flooding /urban flooding destroys the produce e.g crop, rice paddy, fruit tree and vegetables thereby posing the risk of hunger to those engaged in subsistence farming and great loss to those engaged at a commercial scale.
- Hunger reduces labour output and also leads to psychological/emotional disorder in humans, thereby affecting mental health.
- Indiscriminate point pollutions into the river affects the survival of aquaculture (e.g Fish) thereby leading to reduction in the available food proteins for the populace.

Water resources:
- Water quality is compromised and thereby encourages the quick spread of water-borne diseases.
- Due to high level pollution of water body from the high surface-run off into it, the quality of the aquatic life e.g. shell fishes, fish, snails etc. may be degraded and may be deleterious to health on consumption.

Environmental /Ecological Risk Assessment (ERA)
Various harms would be done to the environment through ecosystem and bio-diversity losses after flooding. Issues to be evaluated include:
- Displacement of fauna and flora from the water body e.g. some environmentally friendly water plants and animals.
- Presence of physico-chemical and microbial indicators of faecal and effluent chemical pollution of the river from Global soap industry in Ilorin.
- Displacement of indigenous aquatic life species thereby leading to stress.
- Displacement of settlements at close proximity to the water body as well as import of unwanted material into the water body.
- Spreading and displacement of effluent hazardous, radioactive chemicals lodged in water body unto unrestricted areas of human reach thereby causing abnormalities in man and animals.

Socio-Economic Risk Assessment
Impact on the socio economics values of the society can be evaluated thus:
- Transportation problem: In most cases the flood rises over the bridges in Unity road, Taiwo, Amilegbe areas and Obbo road which distrupts transportation and at most times displaces means of transportation.
- Nuisance to the communities at large occurs due to flood transportation delays.
- Damage to infrastructures and settlements e.g NIIT complex, nearby mechanic workshops and houses in the vicinity.
- High cost of immediate remedial measures.
- People's exposure to natural hazards due to the lack of social infrastructure caused by the disaster.
- Administrative distraction to government budgets thereby lowering the economic status of the state.
- Disruption of governmental land-use plans.

Possible Mitigable & Adaptation Options
There is high confidence that adaptation can reduce vulnerability, especially in the short term. However, adaptive capacity is intimately connected to social and economic development, but it is not evenly distributed across and within societies. There is always a distinction between the two types of adaptation measures namely: autonomous adaptation and planned adaptations.

Autonomous adaptation action are defined as responses that will be implemented by individual farmers, rural communities and/or farmers' organization which not constitute a conscious response to climate stimuli, but only depend on perceived or real climate change in the coming decades without any intervention or coordination by regional and national governments and international agreements. Options for autonomous adaptation are largely extensions or intensifications of existing risk management & production enhancement activities, and are therefore already available to farmers and communities.

Planned adaptations are the result of deliberate policy decisions and specifically take climate change and variability into account, and have so far been implemented infrequently. Planned adaptations, therefore, including changes in policies, institutions and dedicated infrastructure will be needed to facilitate and maximize long-term benefits of adaptation response to climate change [8].

With the situation at hand of river flooding in Ilorin city, planned adaptation solutions and policy co-ordination across multiple institutions may be necessary to facilitate adaptation to flood damage. Autonomous adaptation measure would not be effective to achieve adaptation of projected flood impacts in coming decades, since it has been ascerted that there would be continual increase in global temperature consequent to extremes in precipitation [8].

The following planned adaptation options would be effective for such a disaster in Ilorin, a city among the developing nations.
Improved governance:
(i)Environment policy reforms, changes in urban and housing design, removal of laws that can inadvertently increase flood vulnerability
(ii) Appropriate infrastructure investments: build-up of unblocked drainage patterns, flood defences, increasing investment; improved health care through flood shelters and assistance shelters as part of community emergency preparedness programmes.
(iii) Changes in water and land-use management policies: Devising land-tenure markets, appropriate town planning, and encouraging use of water ways for higher values such as transportation.
(iv) Developing state backed flood insurance schemes.
Expansion and provision of alternative water passages
(v) Development of flood controls and monitoring: capacity building for research and training to enable adaptation.
(vi) Capacity building to integrate climate change and its impacts into urban development planning involving local communities, raising public awareness and education on climate change and enabling representation at international meetings.

However, any of these responses will entail cost, not only in monetary terms but also in term of societal impacts including the need to manage potential conflicts between different interest groups. The lack of funding available in various forms as well as difficulties in accessing the funds which are available represents a major barrier for adaptation, particularly for local community action.

CONCLUSION

Developing countries are already suffering from the impacts of climate change and are the most vulnerable to further change. Flooding is the common and most costly natural disaster, though its impacts are also exacerbated by anthropogenic sources. Quality assessment of the risk impacts of flood will facilitate countries to plan adaptation measures and adapt effectively.

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