

## **Mapping Vulnerability to Flash Flood in Ado Ekiti**

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**Abstract:** *Flooding In Ado-Ekiti Is Becoming One The Most Environmental Challenges Menacing the Metropolis In Recent Times. Many Parts Of The Metropolis Had Experience Flooding Especially Rains. There Had Been Various Researches On The Major Causes Of Such Floods In Ado-Ekiti, But Little Has Been Done To Map Vulnerability to Floods. The Work Presented Here Is A Vulnerability Mapping Methodology, Based On The Assessment Of Rainfall-Related Flood Hazard Scenarios Which Therefore Forms The Basis For This Research. The Study Started With A Review Of Relevant Literatures On How To Develop Indicators For Vulnerability Assessment, And How To Measure And Map Hazard To Flash Floods. Both Primary And Secondary Data Were Sourced To Analyzed Flood Hazard And Vulnerability Of Residents. Simple Statistics Were Employed In The Analysis To Develop Indicators Of Vulnerability. The Study Also Carried Out Questionnaires Survey Which Was Administered To A Sample Of 197 Households In The Study Area. A Vulnerability Map Was Produced Based On The Perception The Population Living In The Area, The Map Was Then Integrated With The Hazard Map, And Thus Producing A Vulnerability Map For The Study Area. Results Revealed That Apart From Houses That Submerged And Collapsed By The Floods, Market Places, Roads And Farmlands Are Submerged For Days And Some Of These Buildings And Critical Infrastructures Were Washed Away. The Methodology Has Proven To Be A Suitable Tool To Provide A First Overview Of Spatial Distribution Of Risk Which Is Considered By The Households*

**Keywords:** *Flash floods, Households, Hazard, Risk, Vulnerability*

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### **I. Introduction**

Recent decades have demonstrated an increased concern for the occurrence of natural disasters and their consequences, for leaders and organizations around the world. Experience has shown that considering the frequency of disasters affecting most community in the world today, its socio-economic context, and risk culture, the disaster management system tends to rely on a response approach. However, studies indicate that efforts are being made to engage more proactive approaches, involving mitigation and preparedness strategies (World Bank, 2005). In order to achieve this, it is thus important to investigate not only the nature of the threat but also the underlying characteristics of the environment and society that makes them susceptible to damage and losses – in other words, the role of vulnerability in determining natural hazard risk levels.

Floods are natural events that are considered hazards only when people and property are affected (Price et al, 2007). According to them, floods causes so many damage on an annual basis all over the world, its occurrence being in the news almost every day. Flood events usually results in physical damages, emotional damage and economic damages. Some floods develop slowly, while others such as flash floods can develop in just a few minutes and without visible signs of rain. Additionally, floods can be local, impacting a neighbourhood or community, or very large, affecting entire river basins. Flooding is an overflow of water that submerges land which is usually dry. The European Union (EU) floods directive defines a flood as a covering by water of land nor normally covered by water. In the sense of “flowing water”, the word may also be applied to the inflow of the tide. Flooding may occur as an overflow of water from water bodies, such as a river or lake, in which the water overtops or break levees, resulting in some of that water escaping its usual boundaries or it may occur due to an accumulation of rainwater on saturated ground in an area flood. While the size of a lake or other body of water will vary with seasonal changes in precipitation and snow melt, these changes in size are unlikely to be considered significant unless they flood property or drown domestic animals.

According to Price et al (2007), floods have resulted in more property damage than any other natural hazard. Physical damage from floods includes the following:

- Inundation of structures, causing water damage to structural elements and contents.
- Erosion or scouring of stream banks, roadway embankments, foundations, footings for bridge piers, and other features.
- Impact damage to structures, roads, bridges, culverts, and other features from high-velocity flow and from debris carried by floodwaters. Such debris may also accumulate on bridge piers and in culverts, increasing loads on these features or causing overtopping or backwater effects.
- Destruction of crops, erosion of topsoil, and deposition of debris and sediment on croplands.

- Release of sewage and hazardous or toxic materials as wastewater treatment plants are inundated, storage tanks are damaged, and pipelines severed.

According to UN-Water (2011) floods, including urban flood is seen to have caused about half of disasters worldwide, and 84% disaster deaths in the world was attributed to flooding. Commenting on the impacts of floods on national development, Action Aid (2006) reported that flood is a major natural disaster that prevents Africans growing population of city dwellers from escaping poverty and stand in the way of United Nations 2020 goals of achieving significant improvements in the lives of urban slum dwellers. The recent reported cases of flood disasters across the globe buttressed the point being made by the Action Aid International. For instance, within the month of September 2012 alone, Nigeria witnessed the most devastating flood disaster in the past decade, which killed over 148 people, displaced more than 64,000 people, and destroyed properties worth millions of Naira (Daily Sun, October 14, p.5) in Ugwu et al (2013).

Odufuwa et al, (2012) in Askew (1999) reiterated that floods cause about one third of all deaths, one third of all injuries and one third of all damage from natural disasters. It is displeasing to note that, Urban areas in Nigeria are particularly vulnerable to flooding due to inadequate drainage system; changes in ecosystem through the replacement of natural and absorptive soil cover with concrete; and deforestation of hillsides, which has the effect of increasing the quantity and rate of runoff, and through soil erosion and the silting up of drainage channels. According to Odufuwa et al (2012), flooding in most Nigerian cities is a major environmental challenge that deepens the horizon of poverty both directly and indirectly; and widens the inequality gaps between the have and have-not. In Ekiti state, cases of flood was experienced severally in areas like Olorunda, Ajobamidele, Igirigiri and Olorunsogo in Ado-Ekiti especially where the flood-plains have been abused due to haphazard physical developments, illegal erection of buildings and other structures as well as unhealthy habit of dumping refuse and solid wastes in open channel drainage systems are particularly prone to flood disasters. The resulting effect of these events lead to cause economic losses through closure of businesses and government facilities, disruption of communication networks, disruption of water supply and sewer service and general disruption of the normal function of a community. All these resulted in unexpected expenses both by the affected persons and the government by way of excessive expenditures for emergency response.

Colombo et al (2002) discussed various methods of determining vulnerability. They described vulnerability using scale; very low, low, medium, high and very high, and according to them vulnerability scale is defined via the consideration of the defined hazard scenarios and the information available regarding the damage to the population and environment. Their work on the Drau and Fersina rivers establishes five levels of vulnerability of the vulnerable area: viz very low, low, medium, high and very high.

In his analysis of the vulnerability of infrastructures involved in flood disaster in Kano state, Nabegu (2014) carried out the assessment of schools, hospitals, roads, bridges and markets in the affected area. He discussed the view of (Wisner et al., 2004) that adaptive capacity of a community can be defined as the vulnerability of a society before disaster strikes and its resilience and that the adaptive capacity is not "exogenous", but related to its level of development. He also stated from Davidson (1995) and Bollin (2003) that, unfavorable economic and social conditions such as poor urban infrastructures and services and weak regulatory practices including poor enforcement of building standards can render a society much more vulnerable and less resilient to any given shock. His measurement of vulnerability to flood was aimed at identifying the capacities of households and local communities to manage and overcome emergencies and disasters situations.

A study carried out by Hui Hsuang Yang and Hsin Chi Daigee (2008) utilizes data from the National Science and Technology Centre for Disaster Reduction (NCDR) gathered after typhoon Krosa in 2008. They hope to verify the appropriateness of variables adopted by Li et al. via statistical analysis. Li et al., (2008) divided the framework for measuring social Vulnerability into three concepts, including: degree of loss, susceptibility/resistance ability and recovery/resilience ability. This study verifies factors for the latter two concepts, in which susceptibility/resistance ability includes: gender, elders living alone, risk perception and impaired mobility; recovery/resilience ability includes: disposable income, low income households and social support. Study results have found that elders living alone are in fact more vulnerable to disasters, and their situation is aggravated when also affected by the Variables gender and impaired mobility. In addition, households that receive informal social support recover faster than those receiving formal social support and those receiving both. The researchers believes that households receiving formal social support recover relatively slower because more time is required to acquire benefits or compensation, compared with support (human resources or cash) from private networks that are free and immediate. In conclusion, elders living alone and social support are significant factors in the evaluation of social vulnerability, and should be carefully included into the framework of social vulnerability indicators.

Traditionally, vulnerability assessments focused on the physical or structural properties of a hazard, and on features of the natural and built landscape, such as proximity to water bodies, fault lines, floodplains,

wind fields, and the resilience of built surfaces and structures to hazard impacts. With regard to flood disasters, hydrologic or physical variables such as the amount of rainfall and flood duration, and built environment

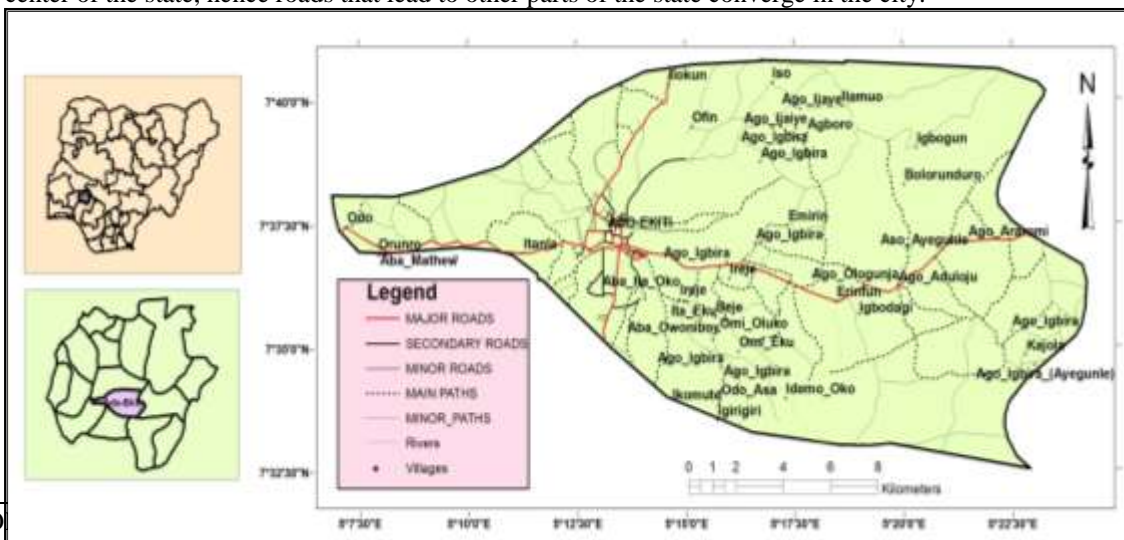


UNISDR (2004) defines Coping capacity as the ability of people, organizations and systems, using available skills and resources, to face and manage adverse conditions, emergencies or disasters. Capacity is the combination of all the strengths attributes and resources available within a community, society or organization that can be used to achieve agreed goals. Based on this framework, the researcher looks at the indicators of societies' coping capacities to flood and identifies the vulnerable groups or individuals based on these indicators.

This research work looks at the vulnerability issues in the study area and the factors that made these areas vulnerable to flood events. Actions taken by government and persons living in the areas are considered vis-à-vis combating this devastating and destructive environmental hazard. Objectives of the study include; creating a map of the flood areas; analyze the factors responsible for the flooding and predict areas vulnerable in future occurrence.

**1.1 Study Area**

Olorunda, Ajebamidele, Igirigiri and Olorunsogo parts of Ado-Ekiti were chosen for the study. Ado-Ekiti is a city in south-west Nigeria and it is the capital of Ekiti state. The city lies between Latitude 7° 34' and 7° 44' north of the equator and Longitude 5° 11' and 5° 18' east of Greenwich Meridian (See figure below). It has an approximate area of 150km<sup>2</sup> and a population of about 350,000 people (Census 2006). Ado-Ekiti has a number of satellite towns around it among which are Iworoko to the north, Are and Afao to the east, to the west are Iyin and Igede while to the south is Ikere. The city enjoys the privilege of being a model town and located at the center of the state, hence roads that lead to other parts of the state converge in the city.



Source: Google Earth Map & Authors fieldwork, 2015

**Figure 2:** Map showing the Study Area

## II. Material and Methods

The study at hand applied empirically acquired data from the flood area through the use of interviews, questionnaires and field observations. Information that had been elicited on the experience of the people who had been affected by flood events will be structured in such way that such information will provide an overview of the flood problem at hand in the study area. The result of the data collected by means of GIS-based survey of peoples' perception and experience about flood depth, duration and distribution or extent that had happened in the past will be spatially analysed and mapped, the resultant vulnerability map was classed or quantified based on peoples' perception. The traditional socio-economics and socio-demographic indicators were identified and analysed using simple statistical analysis in SPSS, this was employed in the order to develop indicators of vulnerability in order to analyse risk in the study area, depth and duration of flood helped to develop the hazard map. The outcome shows how the component of vulnerability hazards and coping interacts with each other in the study area.

## III. Results and Discussion

### 3.1 Vulnerability Assessment of the Study Area

Quantitative approach was used for vulnerability assessment for this study which aims at identifying households that are vulnerable to flash flood in the study area. This approach seeks, to better understand households' own perception of vulnerability. For the vulnerability analysis, an index-based approach was developed that considers several aspects of vulnerability as described in pertinent literature. The implementation of the concept into practice, however, is limited by data availability, a notorious problem for many. The indicators of a vulnerability analysis may vary considerably, since an important purpose of this study is to support risk reduction and management efforts, therefore, indicators were defined that assess from households' perception.

#### 3.1.1 Gender Structure

Gender is a factor to consider when assessing the impacts of flood event. It is assumed that women are more vulnerable than men not because of their biological differences, but their traditional role in the society of taking care of their family members tend to place some burden on them during disaster events. The gender structure of the whole questionnaire showed that there were more female respondents (63.7%) than male (36.3%) who took part in the survey (Table 1.1). It is assumed that the traditional household structure and the respective internal structure of division of labour in traditional African society where the male goes to work during the day and the women stay back to take care of the home and children, may be responsible for the higher percentage of female respondents than male.

**Table 1.1:** Gender Structure of households

| Gender       | Frequency  | Percentage (%) |
|--------------|------------|----------------|
| Male         | 73         | 36.3           |
| Female       | 124        | 63.7           |
| <b>Total</b> | <b>197</b> | <b>100</b>     |

Source: Authors fieldwork, 2015

#### 3.1.2 Age Structure

The respondents' age ranges from 18 to 75 years, with a mean age of 34 years and a standard deviation of 9.4. With age group 30 to 39 years having a higher percentage of 43%. Table 1.2 shows that 30-39 year age range and female were mainly interviewed.

**Table 1.2:** Age Structure of households

| Age          | Frequency  | Percentage (%) |
|--------------|------------|----------------|
| Less 20      | 2          | 1              |
| 20 - 29      | 48         | 24             |
| 30 - 39      | 65         | 33             |
| 40 - 49      | 39         | 30             |
| 50 - 59      | 5          | 3              |
| 60 and Above | 0          | 0              |
| <b>Total</b> | <b>197</b> | <b>100</b>     |

Source: Authors fieldwork, 2015

### 3.1.3 Household Type and Family Composition

When there are emergencies or when natural disasters happen, for example flooding, the assumption is the ability of household to react in an appropriate way, is very crucial, and this is dependent on the structure of the households. Households with dependent persons (with children and/or disabled or permanently ill persons) are often considered to be more vulnerable than households in which has less persons or in which every person can rely on herself/himself. In this survey household size was group in to One-person household representing 19%, Small family (with less than 5 persons) represent 36.6%, while large family (equal or more than 5 persons) is about 53.8% of the respondents (Table 1.3).

**Table 1.3:** Household type and Family Composition

| Household Type and Family Composition | Frequency  | Percent    |
|---------------------------------------|------------|------------|
| One-person household                  | 19         | 9.7        |
| Small Family                          | 71         | 36.0       |
| Large Family                          | 106        | 53.8       |
| <b>Total</b>                          | <b>197</b> | <b>100</b> |

Source: Author fieldwork, 2015

### 3.1.4 Educational structure of households

Economic, cultural and social capital is a systematic tool used to describe and interpret the social structures of modern societies (Jean-Baptiste *et al.*, 2011). All forms of income and assets that are translated to monetary value are considered economic capital, while formal and informal qualification, skills are considered cultural capital. Social capital relates interpersonal relationships, which allow an individual or households to get access to resources. One of the widely used indicators of cultural capital is usually operationalized through formal educational qualification. This is assumed to be a decisive factor or predictor of the position one can attain in professional ladder, as stated earlier in this work that vulnerability is about social inequality. For the sake of this study formal educational qualification was operationalized through highest level of education and was classified into None, Primary School, Secondary School and Higher Education. Table 1.4 shows that about 47% of the respondents have a higher education.

**Table 1.4:** Highest Educational Level

| Highest Educational Level of respondents | Frequency  | Percentage (%) |
|--|------------|----------------|
| None                                     | 12         | 6.1            |
| Primary School                           | 22         | 11.2           |
| Secondary School                         | 71         | 36.0           |
| Higher Education                         | 92         | 46.7           |
| <b>Total</b>                             | <b>197</b> | <b>100</b>     |

Source: Authors fieldwork, 2015

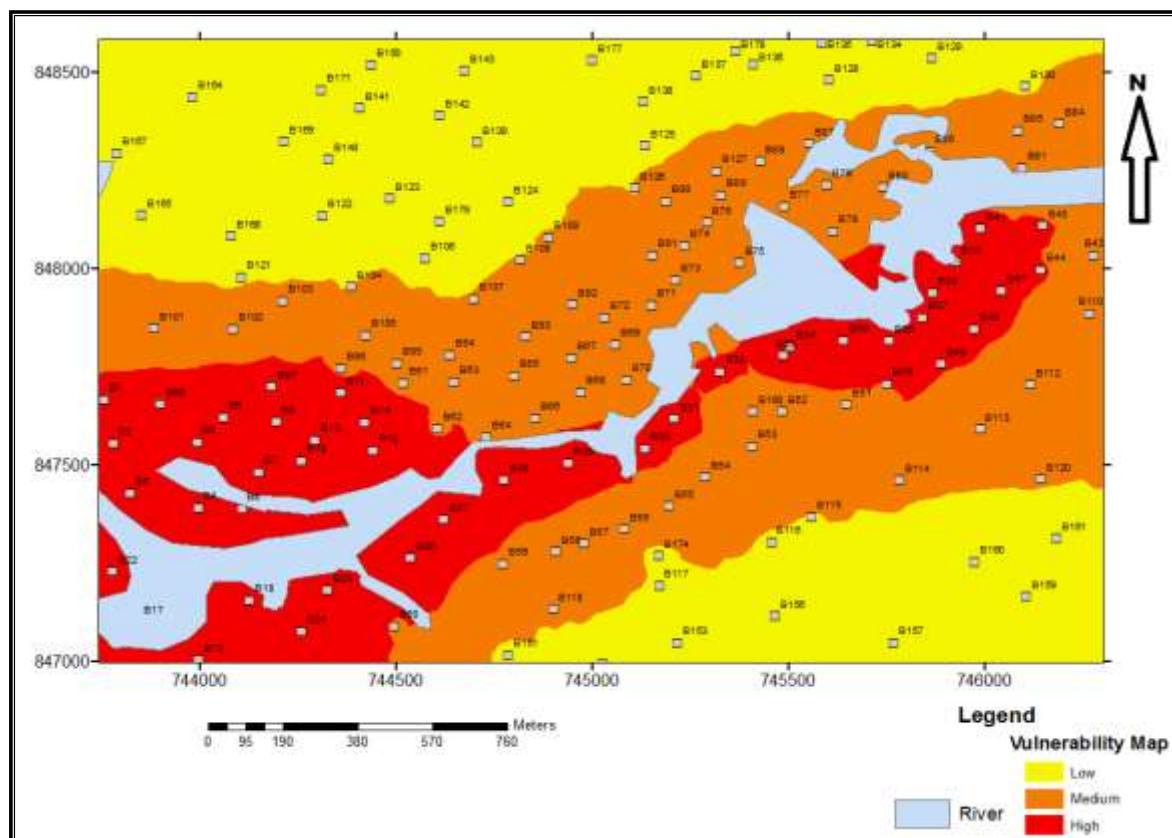
Table 1.5 shows that 83% of the household interviewed have a source of income. The implication of this analysis is that the households that fall in these categories people will be less vulnerable. Household incomes used to measure economic capital in this study exhibit a tendency of low range in the study area.

**Table 1.5:** Employment Status

| Employment Status of respondents | Frequency  | Percentage (%) |
|----------------------------------|------------|----------------|
| Employee                         | 83         | 42.5           |
| Employer                         | 10         | 5.1            |
| Self Employed                    | 80         | 40.7           |
| Unemployed                       | 23         | 11.7           |
| <b>Total</b>                     | <b>197</b> | <b>100</b>     |

Source: Authors fieldwork, 2015

Vulnerability map being a major component of a risk assessment is the assessment of the study area's vulnerability to hazards. This consists of the both socio-demographic and socio-economic data analyzed above (Gender and Age Structure, Household Type and Family Composition, Educational structure of households and Employment Status). As depicted in Figure 2, these components of vulnerability were aggregated to create an integrated vulnerability map. Instead of weighting all components equally, a weighting of the socio-economic and socio-demographic components used to produce the vulnerability map. However, this weighting was made as a normative decision and could easily be determined differently. Finally, vulnerability map was classified into three ordinal classes.



Source: Authors fieldwork, 2015

Fig. 3: Vulnerability map of the Study area

### 3.1.5 Impact of Flooding on households' in the study area

The impact of flood on households sampled revealed that 53% believed that flood occurrence in the study area have some of impacts on their life and expenditure, while 21% of respondents believe that it does not have much impact. This reason maybe, that the flood occurrence in the study area is not life threatening. In one session of face-to-face interviewed conducted with some residents, the outcome of the interviews coupled with household questionnaire and observations during the fieldwork confirmed that the flood affect residents from going to work, thus reducing their income, it also disrupt their children from going to school anytime it floods. Majority (69%) of the respondents have had damages to their buildings, while 60% stated that they had their home appliances and other properties was affected by flooding in the study area, at one time or the other. Many of the households stated that minor damages to building, wet clothes, furniture, mattress and pillows were some of the impact of floods on their household. Some of the impact of flooding in the study area is that of water borne diseases.

## IV. Conclusion

This study has descriptive survey design with 197 subject of the study area. Questionnaires was used by the researcher to collect relevant data that were analysed using descriptive statistics to develop indicators for the various the Hazard, Vulnerability and risk Mapping, which were carried out in a GIS environment. Floods are one of the most prevalent of natural disasters in Ado-Ekiti, hence making the affected areas at risk. The areas mostly affected include Olorunda/Olorunsogo, Adebayo Area, Omisanjana, Afao Roads and so on. This study carried out, further substantiates the premise that flooding results from excessive rainfall, blockage of natural drainage channels, overflow of river banks and building river banks that are flood-prone areas. Other finding shows that, the city of Ado-Ekiti has been characterized with flooding over the past years, besides the magnitude shows that it had contributed to loss of properties and human lives. The study evaluated the major component of risk, which are hazard and vulnerability of household through the uses of questionnaire. The method of integrating information from hazard and vulnerability into a risk analysis, as presented here, allows for an identification and categorization of risks from floods at reasonable cost. The maps can serve as a tool by responsible local authorities in risk reduction planning. Application of this methodology can be further applied to other areas or regions where no risk information at all exists. This study further reveals the advantages of

hazard map, vulnerability maps and risk map to land-use planning and management alternatives. Urban flood risk depends on a combination of components comprising hazard and vulnerability. It underlines the combination of natural and human factors that create flood risks. Flood management measures have to be planned across administrative and sector boundaries. It is therefore recommended that in order to achieve sustainable development which require the contribution of all stakeholders, effective countermeasures should therefore be put in place to combat the issue of flood in the study area, by carrying out risk assessment as a procedure to test and select appropriate mitigation strategies, also vulnerability indicators are important tools to understand the driving forces and different impacts of potential disaster. The vulnerability map will also help in time any emergency to know where people are more vulnerable than others. The risk map can be used for environmental impact assessment to know why people build on the flood plains. Community participation in flood risk assessment as well as in planning and implementation of risk management measures is a key for the success of flood risk management plans.

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