



# Relevance of Social Vulnerability Assessment to Flood Risk Reduction in the Lagos Metropolis of Nigeria

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## Authors' contributions

*This work was carried out in collaboration between all authors. Author NUC designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript and managed literature searches. Authors WM and BB reviewed the first draft and made academic contributions. All authors read and approved the final manuscript.*

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## ABSTRACT

Vulnerability which is a factor of concern within the context of disaster risk reduction is considered in this study. The widespread flooding which impacts massively on urban residents in the Lagos metropolis of Nigeria highlights the prevailing needs to explore the lack of social capacities of people exposed to the hazard. Social vulnerability, defined by place and social inequalities is a critical concept in this regard and its assessment underpins best practices in flood risk reduction. However, such a concept has been poorly investigated in the Lagos area most likely due to lack of knowledge about its relevance. The present study addresses this gap through critical discussions regarding social vulnerability and its assessment in relation to addressing the challenges of flooding in Lagos, Nigeria. The roles social vulnerability assessment can play in view of flood risk reduction within the context of the study area are considered along with relevant factors that influence social vulnerabilities in the area. The study concludes with some recommendations that key stake holders will find quite desirable towards flood risk reduction in the area.

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## 1. INTRODUCTION

Flood risk management within the context of living with floods highlights among other factors the importance of assessing the vulnerabilities of systems, subsystems or system components to flooding [1]. Since risk can be perceived as a function of hazard, exposure and vulnerability [2], assessment of vulnerability to flooding will generally assist in understanding the major drivers of flood risk and means of reducing them. For the Lagos metropolis of Nigeria where it is clear that flooding affects considerable number of people, destroys an array of urban infrastructure, disrupts economic activities and constrains sustainable development, such assessment will play significant roles towards addressing those factors which may be associated with the susceptibilities of social systems to the hazard and in the long run assist in building a community resilient to flooding and its threats. The vulnerabilities to flooding of human populations and places in the Lagos area are disturbing issues given the rapid population growth and urbanization that characterize the area. More critical is the obvious disproportion in the impacts of the hazard on people and places exposed, revealed in the way in which some individuals and places (for examples small enumeration units) are severely threatened by flooding repeatedly while the threats of flooding are only minimal experiences for other individuals and in other places. Although this situation prevails in the area, little attention has been given to the causes of vulnerability as a primary concern, the sources of its imbalance among people and places and their remedies. Besides the lack of a homogenous methodology generally known to constrain vulnerability assessment, the lack of accurate and quality data is also a limiting factor [3-5].

From the body of literature relating to flooding in Nigeria, it can be argued that assessment of social vulnerability to flooding in Lagos is inadequately carried out [3]. Whilst the lack of a sound means for measuring social characteristics prevails, social vulnerability indices, computed by evaluation of how social factors relate with one another to produce the overall vulnerability are lacking in the area. Following the groundwork for vulnerability assessment provided in more global literature [6-10], some key studies in the Lagos area exist that considered vulnerability [3,11,12]. Studies by

[3,11] were localized to small urban communities and individual local government areas (LGAs). Such works lack the element of "wider application" required for social and political links necessary to take advantage of resources that would accelerate recovery for populations socially vulnerable to flooding. The authors in [12] assessed social vulnerability to flooding in the study area, but focused attention on the feminine gender. An important question maintained throughout the study was: "is vulnerability gendered?" Whereas it can be recognized that gender is a key consideration in matters relating to social vulnerability, it is possible that dealing with it in isolation lacks the substance to reveal the pattern of vulnerability to flooding in the area.

The problem of data limitation was raised but not discussed. The means to obtain and utilize freely available data to compute vulnerability indices remain both a promising and a challenging issue. The data available must be good enough to give a measure of reliability in flood risks mitigation. Attempting to address this situation, the approach in [12] was to utilize demographic data in addition to primary survey to adapt proven methodologies to local situations. However, despite these progresses, the lingering susceptibilities and the lack of coping capacity to flood hazard in the area suggest the need to carry out more vulnerability research, especially towards social vulnerabilities.

Undoubtedly, for the Lagos metropolis of Nigeria this poor attention given to assessment of vulnerability to flooding and the limited scope and application of few studies not only create a yawning gap in knowledge in flood risk mitigation in the area, but also could result in the increased loss of lives and properties in the future. With regards to achieving a more substantial goal of mitigating the risk of flooding, constructing an index of vulnerability solely to support the government and various stake holders at all levels towards flood risk reduction may be necessary. At the same time it will assist towards defining the susceptibilities of different people and places to the hazard and building a society more resilient against all kinds of flood hazard and is able to cope with its severe impacts. However, this goal should emphasize and presuppose the knowledge of the concept of vulnerability and how it relates to flood risk.

Against this background, the aim of this study is to present a discussion that reveals the relevance of social vulnerability assessment to flood risk mitigation within the context of the Lagos metropolis of Nigeria. As a contribution to present efforts towards addressing the challenges of flooding in the area, as well as presenting possible means of assisting local communities, urban residents and the general public in the area towards living with floods, this aim is aligned with the ethos of recent global integrated approaches of flood risk mitigation which de-emphasize fighting flood but supports living with it [1,13]. The specific objectives are (1) to reveal the level of impact of flooding, (2) to discuss the concept of vulnerability generally and its assessment and (3) to discuss relevant factors which influence the vulnerabilities of human populations in the area. It is intended that the ideas expressed in this discussion will be utilized for future social vulnerability assessment and flood risk mapping of the area and could be useful for decision making towards prioritizing plans and strategies for flood risk reduction activities.

Section 2 of this paper presents materials and methods, the Lagos metropolis of Nigeria and the widespread flooding in the area, conceptual framework of vulnerability and its assessment within the body of literature, social vulnerability and the importance of its assessment towards flood risk reduction in the study area. Section 3 gives the results and discussions of relevant factors that influence social vulnerabilities in the study area. Section 4 concludes the study with a key recommendation.

## 2. MATERIALS AND METHODS

A deductive research method was strictly followed in the present study in which a search process was undertaken to identify the body of literature relating to vulnerability to flooding and its assessment in Lagos Nigeria. Besides looking up "vulnerability" as a concept, combination of terms such as "flooding and vulnerability in Lagos, Nigeria", "vulnerability indices in Lagos, Nigeria", "vulnerability assessment in Lagos", "social vulnerability in Lagos, Nigeria" and "vulnerability and climate change in Lagos, Nigeria" were applicable to the search. Ample studies were found which focused on aspects of vulnerability and how to measure them. To be consistent with academic standard and regulations, the scientific quality of these searched papers was assessed based on the

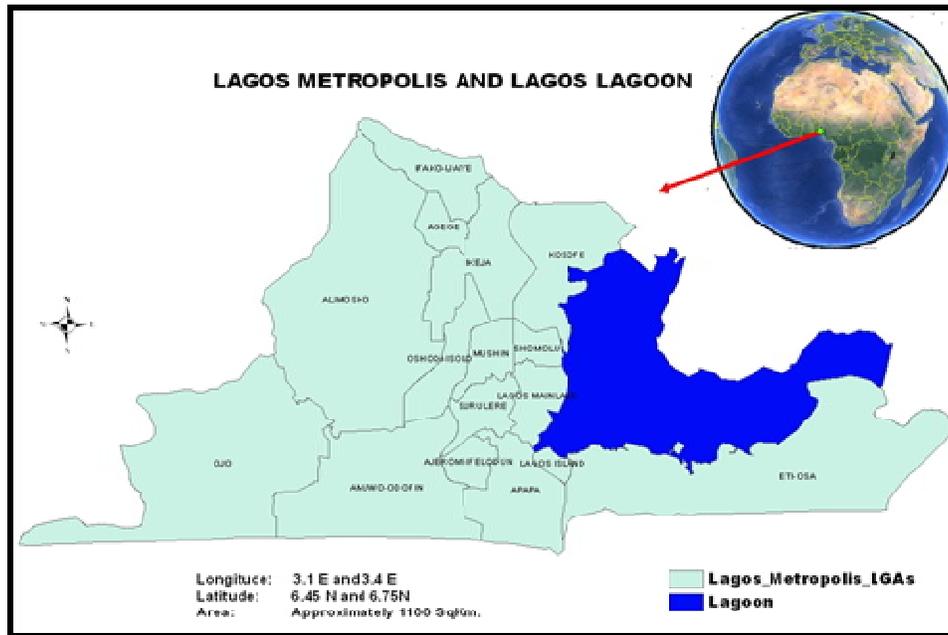
publishing journal. Although locally published articles provided most of the local information required to establish the case in the present study, however, the key concepts of vulnerability were addressed in journals published by Elsevier, Science Direct, Taylor and Francis, Wiley and sons, ASCE, Nature, Sage, Springer, Science domain, Copernicus publishers and papers presented in International conferences. The data that provided much of the evidence regarding the prevalence of flooding in Nigeria was sourced from EM-DAT database, Nigerian ministry of Environment and from previous studies. These evidences are fundamental to discussions presented in this paper.

### 2.1 The Lagos Metropolis of Nigeria and Widespread Flooding

The Lagos metropolis of Nigeria consists of sixteen LGAs lying within the geographical extents of 3.10 E to 3.40 E and 6.50 N to 6.80 N, south-western Nigeria in West Africa (Fig. 1). The city covers approximately 1100 km<sup>2</sup> of low-lying coastal land, bordered on the south by the Atlantic Ocean and surrounded by domestic water resources such as the Lagos lagoon. With a minimum ground elevation of less than 6 m above sea level, the Lagos metropolis is home to more than 20 million people, made up of local indigenes<sup>1</sup> and migrants from other states of Nigeria and overseas [14]. From previous census reports, this population has grown from a little above 25 thousand persons in 1866 to its present number, revealing significant rate of urban growth in the area [15]. Based on recent empirical predictions, the probability that this population will considerably increase in the future is high [16,17].

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<sup>1</sup> *Lagos typifies Nigeria in ethnicity and cultural diversity. With Fulani/Hausa, Yoruba and Igbo ethnic groups dominating, the area may be inhabited by at least 250 ethnic groups of varying languages and customs [18]. Historically, the major occupations and source of livelihood of the people had been fishing, hunting, farming, grazing, and trading [18,19]. Since the industrial revolution of the 1970s, proliferation of industries and government agencies is getting more and more people engaged in white-collar and blue-collar working opportunities. Such patterns of ethnicity and community livelihood seem to affect social vulnerability, as diversities in culture and ethnicity tend to determine the strength and weaknesses of people [20], judged by their natural occupations and by extension their responses to previous shocks and stressors. The background, 'unity in diversity', a telling evidence of many years of struggle by the founding fathers of Nigeria may play a part in hazard definition and mitigation. This assumption, if data with regards to ethnicity and cultural diversity exist for the study area, could form an interesting part of social vulnerability index construct.*



**Fig. 1. The Lagos metropolis of Nigeria**

*Source: Drafted by authors*

Meteorologically, Lagos has a tropical climate with an average annual temperature of 27°C and about 1693 mm of precipitation falling annually. June is the wettest month of the year with an average precipitation of 386 mm, producing quick runoffs and lingering surface retentions due to rapid urbanization which tends to modify the local hydrology of the area. In addition to quick urban growth, increasing number of population and the lack of space to accommodate them within the city give rise to a series of unplanned human settlements and slum developments which now characterize the Lagos metropolis and explain why the area along with other conurbations in Africa has been ranked highly from the point of view of vulnerability to flood hazard [21].

Quick urban growth in Lagos is a critical factor to flooding in the area. With more than 1.2 million houses that currently exist in the conurbation [22], it is easier to imagine a situation in which overcrowding would appear to have occasioned a serious lack of space for the myriad of human activities. As a result, much of the population has been pushed towards unsuitable locations (possibly prone to pluvial flooding) as mentioned in [23], and more and more built-up structures have tended to be unplanned and have rarely adhered to local building regulations and town planning guidelines. Encroachments, illegal structures and slum envelopments are everyday

issues in the area. Arguably, the condition of these buildings is not sufficiently taken into consideration in many flood hazard assessment discussions. Additionally, a good number of the houses either have long exceeded their life spans, or have been built with inferior materials or are built along natural drains and channels, thus, making them and their occupiers susceptible to flooding [14,16].

Flooding in Lagos Nigeria is generally attributed to poor urban planning and climate change especially in increased rainfall frequency and intensity [24,25]. Other possible triggers are: the influence of canals, lagoons and beaches, and the topography of the area. It is commonly known that Lagos state drains two-thirds of South-west Nigeria into the Atlantic Ocean, and having just one-off estuary, the possibility of frequent discharges into the lowlands during heavy storms is undisputable. Historically, flooding in this part of Nigeria dates back to the early 1960's and with the exception of 1973, the drought year, flooding in Lagos area has since occurred annually [26-28]. Whilst coastal and fluvial floods (due to rivers overtopping their natural and artificial defences and affecting nearby human settlements) often occurred in the historic years of flooding in the Lagos area, pluvial floods (due to severe storms which overwhelm drainage infrastructure and soil infiltration capacity) have

been more widespread in recent times [11]. These floods which trigger concerns for environmental management, humanitarian needs and services, primary health delivery, solid waste management, urban development and governance, and the vulnerability of urban residents, the general public and local communities within the area usually occur between July and October (rainy season) with severe consequences [12,29,30]. According to previous studies [26,27], the threats of flooding in Lagos appears to be more severe for Lagos Island, Apapa, Ikeja, Mushin, Surulere and parts of Ikorodu.

Flood water depth, inundation extent and duration as well as depth averaged velocity are factors that influence the level of flood impacts in the Lagos area. Based on the scales and magnitudes of these features, there have been the collapse of sewage systems and possible air and water pollution which jeopardize the ambience of the area along with health consequences which also pose possible significant economic challenges [31]. Some health impacts include mortality (mainly through drowning), physical injuries, fecal-oral and rodent-borne diseases, vector-borne diseases and psychological conditions mainly through depression, anxiety and post-traumatic stress [25]. For the social systems, the lack of capacity to cope with the hazard and the inability to quickly recovery from losses following the hazard has been clearly problematic in the area [3]. The magnitude of flooding experience in the Lagos area of Nigeria is highlighted in Fig. 2 below.

The incidence that easily comes to mind is the 2011 July flooding, caused by a severe storm that lasted 17 hours. The flood affected more than 10 thousand people with deaths exceeding 100 and a range of damage including public infrastructure like roads, bridges and schools. Houses were submerged by flood water while lots of properties including vehicles were destroyed due to the intensity of the flood. An estimated economic loss of about 50 billion Naira (\$US 320 million) was incurred [32]. Table 1 gives a summary of major flooding events and associated threats in the Lagos metropolis of Nigeria from 1968 to 2012.

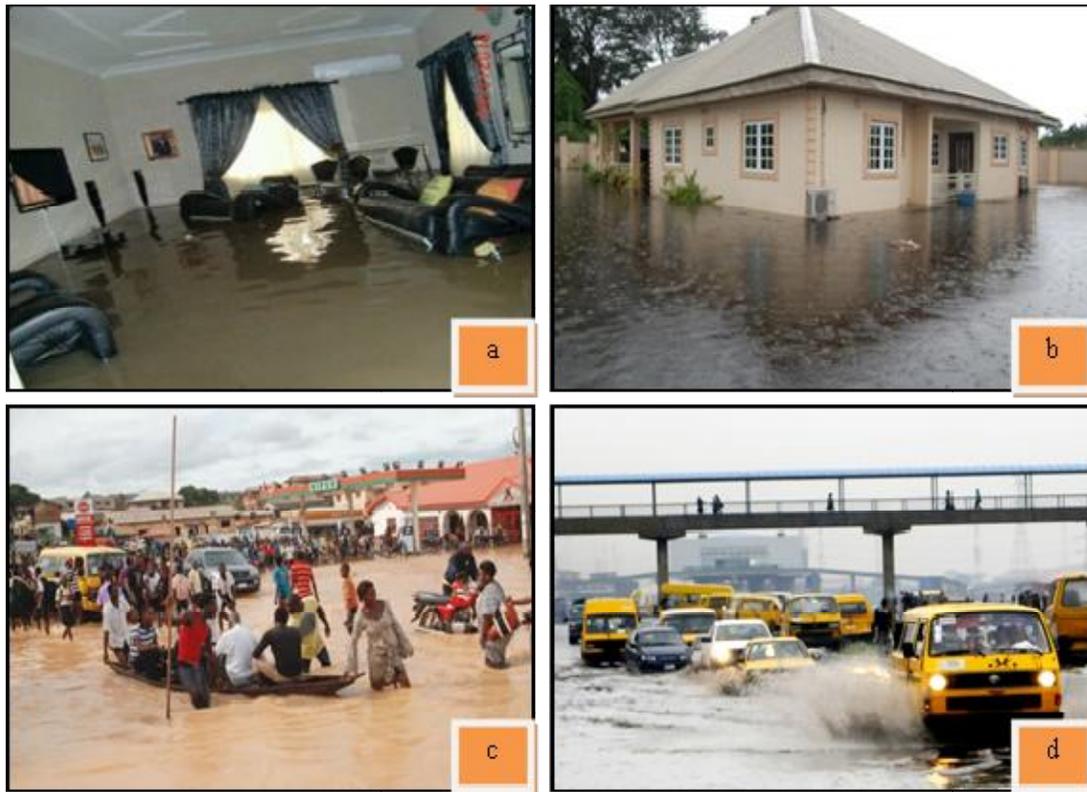
Indeed, these unfortunate realities have received the attention of government at various levels (particularly the Lagos state government) and major stake holders, but the success so far has been limited and identification of possible ways

of mitigating the risk of flooding remains speculative. However, the lack of a possible solution to the poor knowledge of vulnerability in the area continues to subject more human populations to the threat of the hazard and to deny a nuanced understanding of the dynamic interaction between flood processes and social, physical, economic and environmental factors of the study area.

## 2.2 Concept of Vulnerability and Its Assessment

Vulnerability is a concept widely known and discussed within global environmental change and hazards literature. While forming a major component of risk assessment, it is perceived as a dominant diagnostic tool for revealing the propensity or predisposition to be adversely affected, and for directing optimal actions towards hazard risk reduction [33]. Many views have been expressed with regards to vulnerability and some of them are: a potential for loss which varies with time and space [10]; lack of capacity and resources to effectively withstand a shock or stress [8]; an inherent quality that subjects a feature to losses [34]; and the degree of susceptibility of a feature which is determined by exposure and lack of coping capacity [35]. However, a more quintessential definition of vulnerability is given by the United Nations International Strategy on Disaster Reduction [1], in which vulnerability was defined as the condition determined by the physical, social, economic and environmental factors within a group, and by extension, within a physical structure, such as critical infrastructure, that reduce the chances of surviving or withstanding the impact of an adverse event.

Increasing environmental hazards, expansion of hazard prone locations and climate change concerns intensify debate towards understanding and interpreting vulnerabilities for its analysis [36,37]. Towards this debate, the hazard to which a feature is exposed, its sensitivity and the lack of coping capacity and resilience of the system experiencing the hazard are significant factors which highlight vulnerability [33,38]. Exposure is the extent to which a system experiences a perturbation. The sensitivity of the system is measured by the degree to which it has been altered by the perturbations, while its resilience is determined by its ability to return to its stable state after being altered by the perturbation. These concepts underlie the interactions between social systems, particularly humans,



**Fig. 2. Examples of flooding scenes in the Lagos metropolis of Nigeria: (a) living room submerged by flood water, (b) residential building submerged, (c) local community affected by flood waters, and (d) expressway overwhelmed by flood water**

and the ecosystem in which they reside and give impetus for the two important models adapted in the literature for exploring vulnerability which are: risk-hazard (RH) and pressure and release (PAR) models [39,40].

From these models an important concept emerges known as ‘entitlement’, which complements exposure, sensitivity, and coping capacity in exploring vulnerability. Basically, entitlement, which is used to explain food insecurity, civil strife and social disruption, refers to legitimate rights of an individual to have humanitarian needs such as food, shelter and other necessities of life at his disposal [40]. It is the definite or probable resources (wealth, real income, security, etc.,) available to an individual based on their own efforts and endowments, and highlights the social differentiation in causes and outcomes of vulnerabilities [33]. In essence the lack of entitlement is a fundamental factor to vulnerability among social systems implying that a population with sufficient entitlements can circumvent the possibilities of being affected by

perturbations. Additionally, this factor underlines the fact that vulnerability occurs when people lack the means to improve their livelihood or when there is a failure in the previously held capacities (real income, wealth), and underpins the need for social, economic, institutional and political structures within government and private sectors to be proactive towards building a society’s capacity to cope with perturbations [33,40].

The concept of vulnerability based on only entitlements is insufficient for a nuanced understanding and critical analysis of vulnerability. For this reason, a more classical interpretation and analysis of vulnerability should take cognizance of ecological and physical risks which while often being unpredictable in nature are also issues of global concern within the context of climate change [36,41]. Within this framework, vulnerability with reference to risk reduction has been based on two distinct streams of research which are clearly identifiable: Disaster Risk Reduction (DRR) and

Climate change adaptation (CCA). A significant merit for these research spheres is the fact that vulnerability is treated as a major input towards assessing the expected overall damage upon which risk is based, complying with the International Panel on Climate Change (IPCC) and UN/ISDR standards on risk assessment and reduction [42].

From various ideas in the literature, the strategy focused on coupling the merits of “lack of entitlements” and “sensitivity-exposure-lack of coping capacity” and “lack of resilience” models for an outcome that will be relevant to expedite action towards overcoming the vulnerability of a system located within an area deemed prone to widespread environmental hazards such as flooding is apparent [7,43,44]. In relation to flooding, such integrated strategies have also emphasized the idea of living with floods rather than fighting them which is the ethos behind recent methodologies to flood risk reduction [1,13]. Ultimately, whilst vulnerability within flood risk reduction cannot be ignored, a framework which recognizes all relevant concepts (see Fig. 3) including entitlements, sensitivity, hazard and lack of coping capacity as well as lack of resilience will be more desirable.

From the final document of the World Conference on Disaster Reduction: the Hyogo Framework for Action, 2005-2015, assessment of vulnerability through indicators or indicators systems is fundamental to investigating the impacts of disasters on social, economic and environmental conditions [45]. Conceptually, this assessment of vulnerability which has received significant attention in the literature generally means identifying and ranking susceptibilities or a lack of coping capacity across a sampled population [33,39,46-48]. As a growing research theme in both the physical and social sciences, assessing the vulnerabilities of people to hazards promotes a broader perspective of hazard and assists to capture the range of characteristics that interact directly with human beings to shape their susceptibilities and lack of coping capacities to hazardous events [43,49,50]. Additionally, such investigation is presently gaining acceptance as a prerequisite for development of emergency management competences [51]. Since vulnerability is perceived as an inherent quality that subjects a feature to losses [52], its assessment will avail the understanding of the fundamental drivers of loss. For flood hazards, the outcome of this exercise particularly on people will couple with flood modelling to derive

a realistic output which supports integrated flood risk mitigation approaches [53].

Many methodologies for assessing vulnerabilities have been proposed [6,8,41,43,54]. Many of these studies have been shown to relate significantly with the perceptions, representations and concepts of vulnerability [8]. Nevertheless, there is significant uncertainty in such methodologies caused mainly by the uniqueness of locations of study and the inaptness for calibration in places plagued by lack of quality data. As a result, existing methodologies have been limited in scope and application. Similarly, many aspects of the existing methodologies are based on economic, physical and environmental factors [6,35,44,54,55]. However, arguably, social vulnerabilities are not adequately discussed. Assessment of vulnerabilities based on economic, physical and environmental factors is well conceived and has significantly supported disaster risk assessment. However, with regards to flood hazard, it is a top-down approach to hazard mitigation. Within this approach, considerable attention is given to urbanization, climate change and land use scenarios at the expense of social factors. Using such approaches as a basis for measuring vulnerability is inadequate for providing information about the susceptibilities and lack of coping capacities of human populations to flood hazard [56].

In practice of reducing the threats of flooding on social systems, particularly human populations, the importance of knowledge about human vulnerabilities which social vulnerability assessment seeks to uncover should not be underscored.

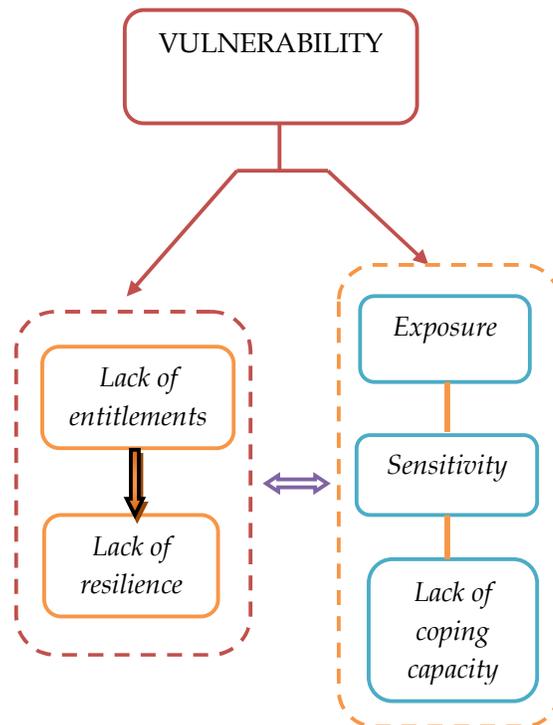
This is increasingly desirable given “best practices” in flood risk reduction and lessons learned from flood risk reduction in Europe and the US [42,57,58]. For the Lagos area, whilst in theory a methodology that focuses attention on assessment of social vulnerability to flooding and not underscoring the relevance of other components of vulnerability will be ideal. In reality, developing it, considering the limitations on the availability of good quality data, is unrealistic. However, considering the rapid urban growth and the increasing exposure of people and the lack of effective capacity to cope with flood hazard, it could be argued that expedience should predominate in developing a realistic social vulnerability assessment to flood risk in the Lagos area of Nigeria.

**Table 1. A summary of major flooding events and associated threats in the Lagos metropolis of Nigeria from 1968 to 2012**  
**Source: EM-DAT [74], FME [75] and previously published works**

S/no.	Date	LGA(S) affected	Duration (days)	Cause (S)	No of people displaced	Mortality	Economic loss (₦)	Affected houses / others
1.	Oct, 2012	Lagos city*	Many days, unspecified	Heavy Rain	Thousands	>50	Millions, unspecified	Many*, including interruption of traffic and other activities
2.	July, 2011	Lagos island, Mainland, Mushin	2 days	Heavy Rain	10,000	100	Millions, unspecified	Many*
3.	Oct, 2010	Lagos island, Apapa, Kosofe,	Many days, unspecified	Heavy Rain	Thousands	20	Millions, unspecified	Many* including interruption of traffic and other activities
4.	July, 2009	Lagos city*	Many days	Heavy Rain	Many	Nil	Millions, unspecified	Many*
5.	Oct, 2008	Lagos city*	N/A	Heavy Rain	Not specified	No data	Millions, unspecified	Many* including interruption of traffic and other activities
6.	August, 2007	Ikorodu, Kosofe and Abeokuta	15	Heavy Rain	5000	17	Millions, unspecified	5000
7.	July 2005	Lagos city	5	Heavy storm	3000	25	Millions	
8.	June, 2004	Lagos city	2	Heavy Rain	1000	Nil	Millions	Drainages
9.	July, 2002	Lagos city	3	Heavy Rain	200	2	Millions	Many*
10.	June, July Sept, 2000	Victoria Island &Ikoyi	2	Brief Torrential Rain	500	Nil	Millions, unspecified	Tens of thousands
11.	May, June, July, 1999	Mushin and Idiaraba	N/A				70,000,000	
12.	July, 1990	Lagos city	2	Heavy Rain	3000	5	Thousands	Many*, not specified
13.	July, 1990	Lagos city	2	Heavy Rain	500	Nil	N/A	Hundreds of inhabitants
14.	June, 1974	Idiaraba, Ikorodu, Surulere and Yaba	Many days, unspecified	Heavy rain	Thousands	Nil	N/A	
15.	June, 1972	Lagos Island	N/A	Heavy rainfall	Not specified	Nil	N/A	Traffic was disrupted, Few houses

16.	July, 1971	Lagos Island	5	Heavy rainfall	Not specified	Nil	N/A	Traffic was disrupted, Few houses
17.	July, 1970	Lagos Island	N/A	Winds, accompanied by short duration, high intensity rain	Nil	Nil	5000	Few
18.	June, 1969	Surulere and Yaba	10	Short duration, high intensity rain	Nil	Nil	N/A	Many*, not specified
19.	June, 1968	Lagos Island and Ijora.	N/A	Heavy storm	Nil	Nil	6000	Traffic was disrupted, Few houses

*\*Grouped outcomes – For the places and LGA(s) affected. It was not possible to identify discrete the spatial extents and damages houses*



**Fig. 3. Authors' concept of vulnerability based on a coupled framework of lack on entitlement and other components that determine vulnerability including sensitivity, exposure, lack of coping capacity and lack of resilience**

### 2.3 Social Vulnerability and Its Assessment

Social vulnerability which drives focus on social factors such as poverty, gender variation and socio-economic status is generally described as a product of place and social inequalities, which tend to determine the overall vulnerability of a wider population by scanning through their inherent characteristics [59,60]. Such vulnerability is also perceived as originating from day to day routine activities and social factors that place people in highly exposed areas, and go on to affect both their sensitivity to such exposures and their capacities to respond to and adapt [61,62]. These social factors are often not considered in hazard/risks mitigation activities given that besides emerging as the least known elements in disaster investigations, they are generally lacking following a post-disaster estimation of losses [63,64]. However, by using social factors as a basis for vulnerability, it is easier to appreciate the extent to which social vulnerability exerts significant influences on the wider society and underpins understanding of the impacts of hazardous events [7,65]. The contributions of social factors to risk mitigation

cannot be overemphasized. Taking into consideration that a likely important part of risk mitigation is to relate factors at risk to potential significant losses following a potential hazard event, social factors present important diagnostic parameters since they relate invariably to social systems which explain significant impacts within the context of risk analysis [60].

#### Importance of social vulnerability assessment towards flood risk reduction in the Lagos metropolis of Nigeria

First and foremost, social vulnerability to flooding may be intuitively conceived as an indicator of the susceptibilities and capacities of social systems to the hazard. Thus, for the Lagos area, assessment of social vulnerability to flooding underpins provision of crucial information that supplements flood hazard/risk assessment for use by the government and appropriate stake holders in the area, to improve on the social capacities of flood victims. Additionally, the assessment of social vulnerability to flooding will be able to extrapolate the particular causes of significant losses from a given vulnerable group [6]. The overall goal and uniqueness of such a

vulnerability assessment is the possibilities that it can provide more plausible foundations for flood risks mitigation such as comparing the overall susceptibilities and coping capacities of a wider population to flood hazard across different geographical locations at a given time [6,60,66].

Building on this framework and drawing from previous investigations by [8,51,67], the importance of social vulnerability assessment towards flood risk reduction in Lagos can be summarized as follows:

1. Social vulnerability assessment will assist in delineating where the greatest social needs of a wider population are and sets priorities for meeting them.
2. Since social root causes of vulnerability are explored, such assessment will enable the choice of action to be taken towards addressing those needs identified.
3. Social vulnerability assessment will assist in monitoring progress and patterns of improvement in meeting the social needs of those vulnerable to flooding.
4. Social vulnerability assessment will assist in measuring the effectiveness of flood risk mitigation approaches in the Lagos area.
5. Social vulnerability assessment will support anticipatory measures in case of undesirable outcomes from actions taken to address the needs of social systems.
6. Such an assessment can be a significant tool to informing policy makers and risk practitioners in Lagos towards best practices in flood risk reduction.
7. Social vulnerability assessment in Lagos will be desirable towards improving the awareness of flood risk in the general public as well as promoting social responsibility towards flooding.
8. Such assessment can support and stimulate public discussions and debates towards flooding and means of addressing its challenges.
9. The outcomes of assessment of social vulnerability to flooding underpins the generation of funds and humanitarian supports for addressing the challenges of flooding.

### 3. RESULTS AND DISCUSSION

From the literature search and various discussions relating to social vulnerability and its

assessment, the following factors discussed herein are relevant factors which influence social vulnerability to flooding in Lagos, Nigeria.

#### 3.1 Age Distribution

Older people and children are generally vulnerable to flooding and other disasters [6]. Arguably, the task of identifying how to prioritize such groups during disasters is a critical necessity for disaster risk reduction [44,68]. In the UK and many other European countries such as Germany and the Netherlands, the people most vulnerable to flooding are usually between the age ranges of 0-14 and 70 and above [69]. The majority of the people within these age groups are children (infants and toddlers mainly) and older people who are often isolated, infirm or totally dependent on care givers. Although some elderly people may be physically fit, but since they can no longer be actively engaged in employment, their capacities to cope with flood losses are arguably limited. For the Lagos metropolis of Nigeria, the roles played by age distribution are clear. More than 30% of the total sampled population during the 2006 national housing and population census is within the vulnerable groups (0-14 and 70-85+ age groups). With Eti-osa and Lagos Island LGAs where there seems to be large numbers of such groups, the need to build the capacity of the vulnerable people in the Lagos metropolis, to cope with flood hazard is underlined. Considerable number of aged people who migrate to the Lagos city from other parts of Nigeria (for health reasons, pursuance of their retirement's benefits and other exclusive reasons) and the number of births recorded daily in the area account for such large number of vulnerable groups. In addition to the number of vulnerable groups currently residing in the Lagos city, some of these migrants squat with relatives and friends. Apparently, additional difficulty is often created by such co-habitation of the vulnerable groups and the rest of the population. For example, households in which the vulnerable groups are children and parents of active individuals will undoubtedly experience reduced capacities to cope with flood hazard since the vulnerable groups will potentially become an added responsibility to the active individuals.

#### 3.2 Marital Status

For marital status in the study area, the following variables are fundamental: never married,

unmarried and widowed. Although there are about equal number of men and women in most LGAs within Lagos, up to 20% of the total sampled population are women who are widowed or without marriage partners. As extensively discussed by [12,67], the implication of widowhood with regards to vulnerability to flooding can be daunting. Arguably, many people in this category are poor and lack the educational power to improve on their circumstances. In the Lagos metropolis, substantial numbers of the women who are without marriage partners are also single parents and sometimes responsible for large numbers of children (can be up to 8 to 10 children). These individuals tend to take low quality accommodation such as slums often located along flood paths which essentially lack access to better urban facilities such as good drinking water, more convenient sanitation facilities, more convenient cooking energy, quality health care and better media and communication capacity. Losses incurred following flooding event are almost irrecoverable for people without marriage partners since they lack the facilities to get supports from insurance companies. Such situations suggest susceptibility and a lack of coping capacity to flooding.

### 3.3 Disability

Ultimately, disability predisposes anyone to be vulnerable to flood hazard. Although the number of disabled people in the Lagos metropolis of Nigeria is not considerable - only about 2% the total sampled population - the impact of their condition with regards to the overall vulnerability of the area to flooding can be significant. From the authors' (first author) local experience and discretion, disability is a poorly treated human condition in the Lagos metropolis and indeed Nigeria. On the streets, bus-stops, travel boarding garages and church gates many disabled persons can be found begging for alms. Many return to homes but the standard of these is often poor. It is possible there are studies (past and present) regarding the plight of the disabled people in the study area and how to address them, but to date, the authors have not been able to identify these. Critically, disabled persons in the Lagos metropolis substantially account for more people living in slum areas which for the best part increase the social vulnerability to flooding. Indeed, few disabled persons assisted by relief programmes (courtesy of the government and other stake holders) have acquired some level of capacity by means of

education and skill acquisition. However, in view of the poor attention they receive on average and the prevalence of climate change events, the extent to which disability conditions impacts the social vulnerability to flood hazard in the study area is critical.

### 3.4 Family Structure

Family structure simply defines the arrangement of various components of the home and the responsibilities of each member. How family structure generally influences the member of the home has been previously studied [70]. From the point of view of flooding, the relationship between family structure and vulnerability to flooding has also been considered [71]. Clearly, the socio-economic conditions and the relationships different family members share with the head of the family reveal various levels of coping capacity among different individuals. While nuclear and extended family arrangements which have relative merits and demerits are popular in the study area and indeed in Nigeria, there are possibilities that a range of behaviours which stem from complex human interactions often develop such as setting priorities and scale of preferences in view of limited resources. The dilemma of prioritizing attention as to who to assist in critical times such as during flooding is often confronted by most heads of families who will have to choose between his wife and the children, between his aged mother and his wife, between his sons and his daughters. What informs decisions at such critical times and how to weigh their outcomes is not part of this discussion, but the possibility that such critical decisions determine the social vulnerability of human population is undeniable. Moreover, since human behaviours seem to dominate in such family arrangements, the resilience of the active family members is reduced due to the effects of vulnerable members thereby increasing the vulnerability of the household in question. The contribution of the family structure towards social vulnerability is also evident in the Lagos metropolis of Nigeria through the existence of many ethnic groups. With the variables relevant for consideration in this regard which are: people without regular homes, those without a relationship with the head of family, renters, absence of regular sleeping homes, cases where there are more than four people in home, up to 50% of the sampled population in the Lagos area are vulnerable to flooding due to family structure.

### 3.5 Socio-economic Condition

Socio-economic condition may be described as a given condition in which an individual gets a measurable level of suitability to an environment. Such a condition is determined by social and economic factors including employment status, health facilities, literacy, etc. From the point of view of flood hazard, high socio-economic condition indicates less vulnerability, but the case is reversed under low socio-economic condition. How such an indicator influences vulnerability to flood hazard is well documented especially in the social science literature. In [5,44,68,72], socio-economic as a predisposing factor to social vulnerability in view of disasters is well acknowledged. In the Lagos metropolis of Nigeria, the lack of data for populating socio-economic condition is a key limitation to research. However, what may be the contribution of this indicator towards social vulnerability index in the study area seems to be considerable. For the Lagos metropolis of Nigeria, the following variables are fundamental towards the socio-economic condition of people: number of development projects, number of professionals, average tenement, number of primary health care, number of births, annual revenues considered per LGA. While it is well known that many poor urban areas generally lack the capacity to cope with flood hazard [3], it is undoubtable that the results obtainable by collating and aggregating these variables towards a social vulnerability analysis would not negate such knowledge [73].

Other factors that influence social vulnerability are female gender (which are generally vulnerable due to their average socio-economic status and their dominant roles in homes as care givers) and poor housing condition, revealed in lots of informal settlement types (rooms let in houses and houses made of traditional materials). For lack of possible solutions, many urban residents in the area inhabit collapsed buildings, live under the bridges, squat and co-habit crowded houses with the rationale of tendencies for mutual assistance, which tends to lessen the vulnerabilities. In densely populated places, the economic and social impacts of these factors are critical if neglected.

### 4. CONCLUSION

Urban flooding events have been traumatic in the Lagos metropolis of Nigeria and the question of

how to assist human populations to reduce their susceptibilities and develop capacities to cope with such increasing hazard requires more attention. With respect to recent integrated approaches to flood risk mitigation by United Nation International Strategy on Disaster Reduction (UN/ISDR) and Climate Change Adaptation (CCA) methodologies, the way-forward arguably involves, among other scientific approaches, assessment of vulnerability. In this regard, social vulnerability is for the most part considered since it takes social characteristics, such as age variation, gender differences, socio-economic status, etc., to compute indices which generally explain the variations to which human populations are easily affected by flood hazard. Such characteristics dynamically relate to disaster risk losses and generally drive focus on human beings. For the study area, this concept has been both less understood and under-investigated.

For this reason, the present study reveals the widespread flooding in the Lagos area and relevance of social vulnerability assessment in flood risk mitigation within the context of the Lagos metropolis of Nigeria. Some social factors such as age, socio-economic status and gender, etc., which influence the vulnerability of human populations and urban residents in the area, have been discussed.

Given the need for urgent attention with regards to building the social capacities of the human population in the Lagos area, the study recommends an investigation that harnesses the concept of social vulnerability as well as these relevant factors, identified in the present study to influence social vulnerability, to assess the social vulnerability to flooding of the study area.

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## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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