Awareness of and Responses to the 2011 Flood Warnings Among Vulnerable Communities in Lagos, Nigeria

F. Olokesusi, F.B. Olorunfemi, A. Onwuemele, and M.O. Oke

1 Introduction

2007 marks a turning point in history: half of the world's population now lives in cities (UN-Habitat 2007). The total urban population is expected to double from two billion to four billion over the next 30–35 years (UN-Habitat 2006). An unwanted side effect of this rapid urbanization process is the increased susceptibility to flooding as a result of the concentration of people and assets in flood-prone areas, since many urbanized areas are located along major bodies of water. Furthermore, climate change may cause more frequent and more severe floods. This combination is likely to result in substantially larger flood impacts compared to former times, during which societies and environmental change drivers developed more slowly and societies continuously adapted to environmental changes (Zevenbergen et al. 2008).

The above accounts are corroborated by Sherbinin et al. (2007), according to whom cities are economic growth engines, centers of innovation for the global economy, and the hinterlands of their nations. The foundations the prosperity and prominence of most global cities are their longstanding commercial relationships with the rest of the world. Most cities are located on or near the coast, which has facilitated trade and contributed to their wealth. They are also often located in low-lying areas near the mouths of major rivers, which serve as conduits for commerce between interior agricultural and industrial regions and the rest of the world. Examples include Lagos, Marseille, Lisbon, Chennai, Shanghai, and New York. Such locations place cities at greater risk of current and projected climate hazards such as cyclones, high winds, flooding, coastal erosion and deposition, and a rising sea level.

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With the unprecedented rise in the number and severity of natural disasters, large urban settlements have become increasingly vulnerable. The concentration of substandard infrastructure and housing, material assets, and inherent socio-economic inequalities increases large cities and megacities' susceptibility to disasters. In addition to socio-economic and spatial vulnerabilities, these settlements' functions and geographical distributions make them especially prone to disaster risk (Sherbinin et al. 2007). This problem of high susceptibility to disaster risk is further compounded by megacities' extreme vulnerability to the impacts of climate change, especially if they are located in developing countries (Mehrotha et al. 2009; Adelekan et al. 2009; Satterthwaite et al. 2007). Most Nigerian cities are particularly vulnerable to disasters, especially floods, which have increased in frequency and intensity in recent years (Raheem et al. 2012; Gbadegesin et al. 2011; Olorunfemi 2008; Olorunfemi and Raheem 2007; Olokesusi 2011, 2004; Adelekan 2009). The vulnerability of Nigeria's cities to hazards is compounded by uncontrolled urbanization, widespread urban and rural poverty, degradation of the environment due to the mismanagement of natural resources, weak socio-economic infrastructure, and inefficient public policies (Raheem et al. 2012; Olorunfemi 2008; Olorunfemi and Raheem 2007; Olokesusi 2004).

Natural disasters that result from, or which are facilitated by, climate change can undermine decades of growth in urban regions in a single catastrophic event. Furthermore, low-lying cities situated near major rivers, deltas, coasts, and estuaries are especially vulnerable to the rising sea level (Stern 2006). As shown by Mortreux and Barnett – who analyze Funafuti, the main island of Tuvalu – floods badly impact the living conditions of local communities, who are forced to migrate in response to climate change (Mortreux and Barnett 2009). Lagos is both a megacity and a low-lying city located on the coast.

Recent global events indicate that floods are indeed increasing, both in terms of frequency and magnitude. Between 2001 and 2005, there were 818 flood disasters in the world, compared to 974 between 2006 and 2010. In addition, the estimated number of deaths from floods was 25,929 between 2001 and 2005, compared to 30,171 between 2006 and 2010 (International Federation of Red Cross and Red Crescent Societies (IFRC) 2011). Statistics also reveal the resulting economic costs of flood disaster damage (IFRC 2011; Stern 2006; Munich Re 2005; World Health Organization (WHO) 2002). Studies based on reported disasters (IFRC 2010) also suggest that there have been considerable shifts in flood event patterns and intensities, resulting in increased hazards for the world's growing urban population. Floods are also growing faster than non-climate-related hazards. It is predicted that increases in hazards due to climate change will impact different regions differently, but that increasing flood hazard is a shared future expectation. Under these circumstances, sustainable urban flood risk management is becoming an increasingly challenging task for urban communities and authorities. Unfortunately, many cities across the world are unable to keep up with the intensification of such challenges.

The flooding incidents in Lagos, too, have increased both in frequency and intensity and thus have had significant impacts (Mehrotra et al. 2009; Adelekan 2009; Gbadegesin et al. 2011). Perhaps in response to people's concerns and to

avoid further calamity, as experienced in 2010, the Lagos State government issued several warnings in 2011 (most recently on June 10, 2011) to residents and property owners along river banks and flood-prone areas, urging them to move to higher ground (Vanguard 2011, 37; National Mirror 2011, 18). The government was responding to the Nigerian Meteorological Agency (NIMET) forecast of heavy rainfalls that could create severe flooding in the State. NIMET had forecast that heavy rainfalls, accompanied by tsunami-like flooding, were expected to start earlier and end later than usual in 2011.

NIMET forecast 1,200–1,700 mm rainfall in 2011 and specifically noted that communities in the northeastern part of the State, which is naturally susceptible to flooding, were expected to be worst hit during heavy rainfalls. The State listed the flood-prone communities: Ikosi-Ketu, Mile 12, Agiliti, Ajegunle, Thomas Laniyan Estate, Owode-Onirin, Agboyi, Owode-Elede, Mairan, and Isheri North Scheme. The official who issued the warning said that to avoid a repeat of the 2010 flooding, which displaced more than 1,500 residents of a community in Ikorodu (also in Lagos State), the residents of the affected communities had to move to higher ground from June to mid-September and October, and possibly to January. According to the State government official, "this became necessary because the capacity of most of the canals cannot contain the volume of runoff expected from the rainfall" (Vanguard 2011, 13). This study was prompted by the flood warnings issued to the abovementioned communities.

Our study had two objectives: to conduct a survey of the awareness of and responses to the flood warnings, as well as to offer a rapid assessment of the affected communities' physical vulnerabilities to flooding. This article is divided into six sections. After the introduction, Sect. 2 clarifies some conceptual issues. Sections 3 and 4 provide information on the study area and the methodology. In Sect. 5, we discuss the study findings, while the final section provides recommendations for the effective communication of flood warnings in general and for the reduction of these communities' vulnerabilities in particular.

2 Conceptual Considerations

Flooding is widely viewed as the most dangerous source of disaster risk. A wide range of literature spanning the insurance industry (Munich 2005) and international humanitarian and development agencies (IFRC 2011; United Nations Office for Disaster Risk Reduction (UNISDR) 2004) support this. There are two main discourses on flood disasters. The first – and dominant view – is that flood disasters are inherently a characteristic of natural hazards (Dixit 2003; Adger 1999). Disasters are inevitable when hazard magnitude is high. This contrasts with the alternative discourse, which sees flood disasters as being produced by the interaction of the physical hazard and the social vulnerabilities. The latter discourse identifies social relationships, structures, institutions, and governance in the quest to better understand flood disaster. It posits that flood disasters are not only the result of natural

hazards, but also of socio-economic structures and political processes that render individuals, families, and communities vulnerable (Dixit 2003).

To fully understand urban flood risks, one should be familiar with the different components of risks. Risk is often understood only superficially as the occurrence of an extreme event or hazard (flood, drought, earthquake, storm, landslide, etc.) caused by natural forces or by a combination of natural forces and human influences. Although the occurrence of such a hazard is the primary precondition, it is only one component of risk. The second component of risk is that somebody or something is *at risk*; i.e., vulnerable to a hazard (World Meteorological Organization (WMO) and Global Water Partnership (GWP) 2008). This definition clarifies the basic structure of risks.

However, with reference to the term "vulnerability", a further distinction enhances our understanding of flood risk creation, since the notion of vulnerability in the abovementioned definition does not distinguish between physical exposure to hazards and the susceptibility of persons or things to hazards. This definition therefore does not address flood risk analysis or the question regarding which measures are most effective in reducing such risks. Hence, we adopt the definition of risk proposed by Crichton (1999), who defines risk as the probability of a loss. This loss depends on three elements: the magnitude of the hazard, vulnerability, and exposure. If any of these three elements in risk increases or decreases, the risk increases or decreases.

While exposure in the context of floods refers not only to the question whether or not people or assets are physically in the path of floodwaters, vulnerability may be defined as "[t]he conditions determined by physical, social, economic, and environmental factors or processes, which increase the susceptibility of a community to the impact of hazards" (UNISDR 2004, 16). Figure 1 shows the functional relationships between risks, hazard, exposure, and vulnerability. The UNISDR (2004, 17)

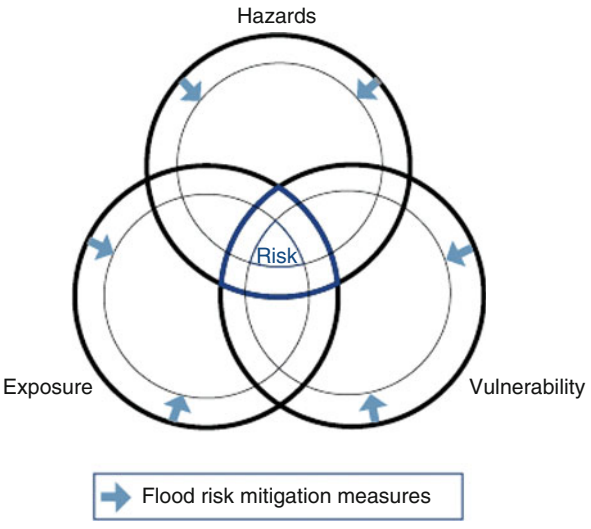

Fig. 1 Construct of urban flood risk and its reduction (WMO and GWP 2008, 3)

defines disaster as "a serious disruptions of the functioning of a community or society causing widespread human, material, economic or environmental losses which exceed the ability of the affected community or society to cope using its own resources".

This definition is complemented by a commonly accepted definition of flood risk, which defines it as a function of the probability of the flood hazard, of exposure to the flood hazard, and of the vulnerability of receptors of the flood hazard. There are many versions of such models for disasters generally (Thywissen 2006). Crichton (1999) formalizes this definition of risk with regard to floods in a risk triangle. In this triangle, hazard is a function not only of natural processes, but also of anthropogenic environmental changes that alter natural flow patterns and pathways to generate increased flood hazards from a similar magnitude weather event. In an urban context, this implies that upstream conveyance becomes part of the hazard that cities experience. This definition also encompasses the important notion of the difference in relative damage that those affected by a hazard experience. Such variations in the ability to cope with and to recover from a hazard are described either as vulnerability or as resilience to the hazard. Vulnerability and resilience are negative and positive measures of the same characteristic. Increases in the impacts and risks from flooding can, therefore, result from increases in the severity of hazards, from populations and their assets' exposure, or from the vulnerability of exposed populations and their assets to flooding.

Inherently, urban development creates larger risks, but those in higher income groups are better able to avoid or bear such risks than those with low incomes. There is a clear socio-spatial segregation concerning settlement locations' hazard exposure. Since urbanization is essentially an increase in population density, space becomes rare and expensive. Consequently, those who cannot afford to purchase or rent space in secure environments are forced to move to cheaper places. Given that the urban poor's livelihood often depends on their proximity to informal economies in the centers of large cities, many prefer to inhabit hazard-prone areas. Two further factors aggravate spatial marginalization. On the one hand, hazard-prone areas are often not privately owned and informal dwellers are therefore less likely to be displaced. On the other hand, however, many urban poor are migrants from rural areas who are not familiar with the various hazards and therefore tend to underestimate the risk of living in such exposed areas. This pattern is explained in Lagos's morphology by Adelekan (2009) and Olokesusi (2011).

3 The Study Area

Massive development to meet the socio-economic needs of emerging metropolises and megacities in Africa and Asia is usually carried out without adequate consideration of the hydrological environment (Actionaid 2006). Among the unresolved challenges faced as a result of this development are destructive flood incidents – even in regions previously considered safe. This is more prominent in the

Fig. 2 Growth of metropolitan Lagos from 1900 to present (Source: Adelekan 2009, 8)

developing world, which is characterized by inadequate spatial arrangements in growing cities and in their socio-economic structures, few new investments in physical infrastructure, poor planning processes, and weak political and economic bases.

Interestingly, besides being the industrial and commercial hub of Nigeria and the West African subregion, metropolitan Lagos is also West Africa's largest city. It is expected to be one of the world's five largest cities by 2015 (Mehrotra et al. 2009). Lagos is Africa's second most populous city after Cairo. It grew explosively from 300,000 people in 1950 to an approximately 18 million in 2010, when it ranked as one of the world's ten largest cities. Lagos is home to many industries and has a large commercial infrastructure. It has greatly benefited from Nigeria's natural resources in the form of oil, natural gas, coal, wood, and water. For an overview of the state of Nigerian cities, see UN-Habitat (2004).

Figure 2 is a map of Lagos showing the city's growth from 1900 to the present. For this study, the metropolis Lagos is conceptualized as the city of Lagos within the city's official administrative area (in Lagos State), as well as the northeastern incursion or extension of the city into neighbouring Ogun State (as shown in Fig. 3). The city has a relatively large land area with a very diverse and fast-growing population. Thus, normal urbanization pressures and modern development forces have resulted in the city expanding to nearby suburbs such as northeast Lagos, which politically covers Lagos State and Ogun State. Northeast Lagos falls within

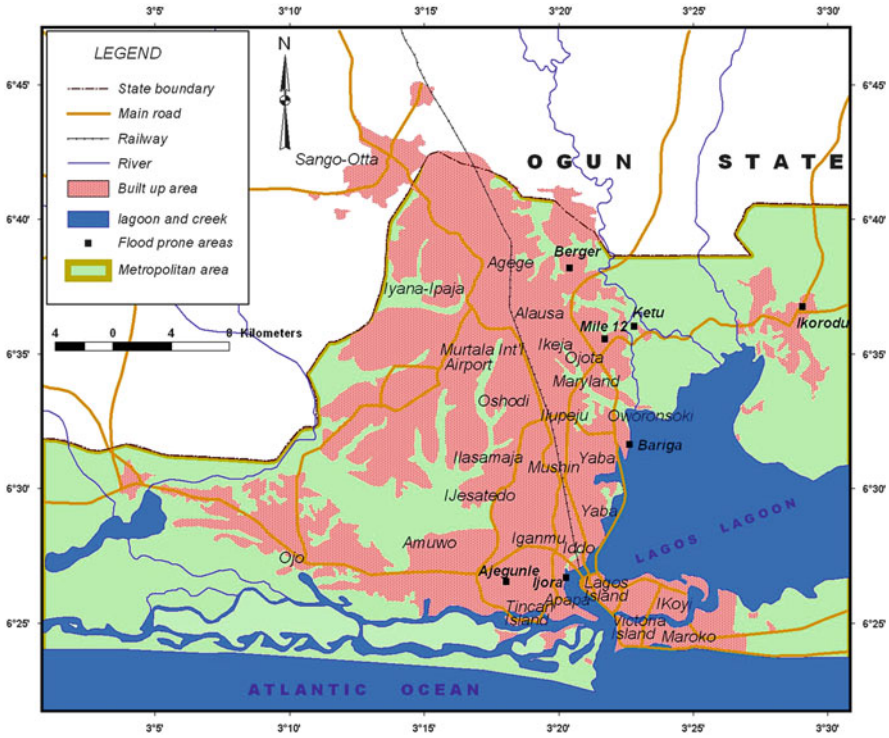

Fig. 3 Map of Lagos metropolis showing flood-prone areas (Composed by authors)

the lower part of the Ogun-Osun River Basin, with a larger portion of the region within the River Ogun floodplain. The region is part of Nigeria's Hydrological Area VI, with an annual runoff of $35.4 \times 109\ m^3$ (or a runoff depth[1] of 352 mm per year) and an average annual runoff increase of approximately 17 % (Federal Republic of Nigeria 2006).

The average population density of Lagos's local government areas is approximately 2,094 people per square kilometer, with a minimum of 164 people per square kilometer in Owode Obafemi Local Government Area (LGA) of Ogun State and a maximum of 55,939 people per square kilometer in Ajeromi-Ifelodun LGA in Lagos State. A better picture of the city's high population density can be inferred from a breakdown of each local government area's population density in built-up areas. The local government areas in Lagos State have an average population density of 13,194 people per square kilometer. Ajeromi-Ifelodun LGA, where most of the affected communities are located, has a staggering population density of 60,204 people per square kilometer (Mehrotra et al. 2009). This high population

[1] In hydrology, the runoff depth is determined by dividing the catchment's runoff volume by the catchment area. It provides a convenient way to compare runoff with precipitation in a given area and is usually expressed in depth units per unit time, usually as mm per hour (mm/h).

density has implications for flood disasters in terms of the number of people who would be directly affected. Figure 3 is a map of Lagos showing flood-prone areas.

Ocean and atmospheric interactions within and outside its environment, in which the Inter-Tropical Convergence Zone (ITCZ) is a controlling factor, affect Lagos's climate. The ITCZ movement is associated with a warm, humid maritime tropical air mass with southwesterly winds and the hot, dry continental air mass with dry northeasterly winds (Mehrotra et al. 2009). The maximum temperatures during the dry season are high, ranging from 28 to 33 °C when the region is dominated by the dry northeasterly winds. A minimum temperature of approximately 24–26 °C is experienced during the wet season (May to September).

Temperature Records from the two stations (Ikeja and Lagos) used in Mehrotra et al.'s (2009) analysis show that the monthly maximum temperature increased by approximately 0.1 °C per decade between 1952 and 2006, while monthly minimums decreased by approximately 0.5 °C per decade; since the 1900s, the average temperature has increased by 0.07 °C per decade. At the extremes, the monthly maximum temperatures for Lagos have reached more than 34 °C during seven of the past 200 years. The number of heat waves in Lagos has also increased since the 1980s. There were very few incidences of unusually cold months (less than 20 °C) since 1995. The temperature projected for Lagos for 2050 anticipates a 1–2 °C warming.

Precipitation According to historical records, the total annual precipitation in Lagos has decreased by 8 mm per decade since 1900. In keeping with the overall precipitation trends, most of Lagos has experienced rainfall decreases during the rainy season. For example, between 1950 and 1989, more than 20 months saw rainfalls over 400 mm. Between 1990 and 2006, however, only four rainy months recorded more than 400 mm. In the twenty-first century, precipitation in Lagos is expected to be less frequent but more intense. The projected precipitation for Lagos in 2050 anticipates an uncertain 5 % change in the mean (Mehrotra et al. 2009).

This megacity is sensitive to climate change owing to its flat topography and low elevation, location, high population, widespread poverty, and weak institutional structures. Many more vulnerabilities stem from these characteristics, including the high potential for water backups in drainage channels, inundation of roadways, and severe erosion (Mehrotra et al. 2009; Adelekan 2009; Awosika et al. 1993a, b). Thus, a large number of people are likely to feel the effects of any negative consequences of climate change and climate variability extremes – such as flooding – , especially the urban poor living in the city's marginal flood-prone areas.

4 Research Methodology

Since this study presents a brief assessment, primary data was mostly used. This data was obtained from a structured household survey questionnaire administered to the residents, as well as from focus group discussions (FGDs) with the key

stakeholders. The research team also used on-the-spot assessment to determine the survey communities' physical vulnerabilities. These are the communities to whom NIMET and the Lagos State government issued flood warnings. These include Agiliti, Ikose-Ketu, Ajegunle, Owode Onirin, and River View Estate, all in northern Lagos along the Ogun River Basin. Forty questionnaires were administered in each community, complemented by FGDs with key groups that included men, women, and young people. Interviews were also conducted with key government officials in charge of flood management in the Lagos State Ministry of Environment. This was done to obtain information on the government's preparedness for floods in the affected communities.

The survey questionnaire elicited information on the respondents' socio-economic characteristics, their awareness of the flood warnings, and responses to them. In addition, information was asked regarding the sources of information, the neighborhood characteristics, and the characteristics of the buildings in which the respondents reside. These are important indicators of the level of vulnerability to flood disasters. Relevant secondary data was obtained from published and unpublished material, including the internet, to complement the primary data. Of the 200 questionnaires administered, 193 were retrieved and analyzable. The data collected from the questionnaire survey was analyzed using Statistical Package for the Social Sciences (SPSS).

5 Results and Discussions

Early warning signals are important elements of disaster risk reduction. They provide vulnerable communities with ample opportunities to prepare for disaster risk, which help reduce the impact of disasters when they occur. The following section presents the study results and a discussion of the vulnerable residents' awareness levels and responses to this flood warning by the government and its agencies.

5.1 Respondents' Socio-economic and Demographic Characteristics

Demographic and socio-economic characteristics have remarkable impacts on social geography and environmental behavior (Onokerhoraye 1994). As shown in Table 1, more than two-thirds of the respondents (72.5 %) were males, while the remaining 27.5 % were females. The high percentage of males is indicative of the interviews targeting the heads of households (usually males). Also, more than two-thirds of the respondents were married (71.5 %). The survey results further reveal that 43.0 % and 31.1 % of the respondents were between the ages of 26 and 35 years, as well as 36 and 45 years, while 45.1 % had attained secondary education

Table 1 Socio-economic characteristics (authors' analysis (2011))

Variables	Number of respondents	Percentage
Sex:		
Male	140	72.5
Female	53	275
Total	**193**	**100.0**
Age (years):		
18–25	19	9.8
26–35	83	43.0
36–45	60	31.1
46–55	18	9.3
56–65	7	3.6
Above 65	6	3.1
Total	**193**	**100.0**
Marital status:		
Single	51	26.4
Married	138	71.5
Separated	3	1.6
Divorced	1	0.5
Total	**193**	**100.0**
Educational qualification:		
No formal education	15	6.8
Primary education	10	5.1
Junior secondary	2	1.0
Senior secondary	81	42.0
Tertiary	87	45.1
Total	**193**	**100.0**
Monthly income:		
Less than NGN 7,500	12	6.2
NGN 7,501–15,000	27	14.0
NGN 15,001–20,000	56	29.0
NGN 20,001–45,000	16	8.3
NGN 45,001–60,000	8	4.1
GN 60,001–75,000	40	20.7
Above NGN 75,000	11	5.7
No response	23	11.9
Total	**193**	**100.0**
Household size:		
0–2	13	6.7
3–5	69	35.8
6–8	111	57.5
Total	**193**	**100.0**

and 42.0 % had attained tertiary education. Only 6.8 % of the respondents had no formal education. The high number of adults and their reasonable educational attainment are considered good for a study of this nature, because the respondents are old enough and sufficiently educated to be well informed about the issues at hand. Of the respondents, 43.0 % were traders, 12.0 % artisans, 12.0 % public servants, 10.0 % active in the transport sector, while 1.0 % were farmers. The high proportion engaged in trading further lends credence to Lagos's position as Nigeria's commercial engine.

Large household sizes have implications for disaster impacts in the sense that when a disaster strikes, large numbers of people per household are likely to be affected. More than half of the respondents (58.0 %) had between 6 and 8 children, 35.8 % between 3 and 5 children, and 6.7 % between 0 and 2 children. By inference, the respondents had an average of 4.4 children per household. The rather large household size and the large number of children have implications for disaster risk in that high absolute numbers of casualties during disasters may be compounded by an increased need for disaster relief for survivors.

Analysis of the respondents' incomes indicates that 29.0 % of the respondents earn between NGN 15,000 and 20,000 per month.[2] Another 20.7 % of the respondents earn between NGN 60,000 and 75,000 per month. However, 7.1 % of the respondents earn less than NGN 7,500 per month. With absolute poverty defined globally below USD 1 per capita per day and given an average household of 4.4 people, the average family will need to earn NGN 19,800 per month to live above that poverty line. The implication is that one of every five of the respondents lives below the absolute poverty line. An individual's income also largely determines his or her capability to cope with and recover from disasters. Poverty makes urban residents vulnerable to natural disasters such as flooding.

The next section focuses on the impact that the demographic and socio-economic data has on the respondents' awareness levels and responses to flood warnings in Lagos.

5.2 Respondents' Awareness of Flood Warnings

The respondents in five of the communities were asked if they were aware of the flood warnings that the Lagos State government issued. The results indicate that more than two-thirds of the respondents (77.2 %) were aware of the flood warnings, while 22.8 % indicated they were not. Further analysis presented in Table 2 shows a strong correlation between the levels of educational qualification and flood warning awareness. In other words, a larger proportion of the respondents with higher educational qualifications was aware of the flood warnings compared to the less educated respondents. Specifically, 85.2 % and 69.0 % of respondents with

[2] During the study period, the currency exchange rate was USD 1 to NGN 155.

Table 2 Respondents' educational qualification and awareness of flood warnings (authors' analysis (2011))

Educational qualification	Awareness of flood warnings		Total
	Yes	No	
No formal education	2	2	4
	50.0 %	50.0 %	100.0 %
Primary education not completed	7	2	9
	77.8 %	22.2 %	100.0 %
Primary school	10	0	10
	100.0 %	0.0 %	100.0 %
Junior secondary school	1	1	2
	50.0 %	50.0 %	100.0 %
Senior secondary school	69	12	81
	85.2 %	14.8 %	100.0 %
Tertiary education	60	27	87
	69.0 %	31.0 %	100.0 %
Total	149	44	193
	77.2 %	22.8 %	100.0 %

secondary and tertiary qualifications were respectively aware of the flood warnings. A *t*-test analysis of the relationship between the two variables shows a calculated χ^2 value of 11.8, significant at 0.05, impliying a significant difference in the level of education and the awareness of flood warnings.

5.3 *Sources of Information on Flood Warnings*

We sought to establish the media through which the respondents received their information. The survey results reveal that 36.0 % of the respondents received their information via the radio, 32.2 % were informed by others, 20.0 % via television, and 9.0 % via newspaper. Although 77.2 % of the respondents were aware of the flood warnings, the large number of respondents who received the information via other people implies that the state agency in question should make an effort to disseminate information better by implanting different media – such as town criers – in affected communities and should work with community development associations (CDAs), of which there are many in many of the affected communities. The result of this analysis is presented in Table 3.

5.4 *Responses to the Flood Warnings*

While awareness of flood warnings is important, individual response patterns to such information is crucial, because the actions taken determine the extent to which

Table 3 Flood warning information sources (authors' analysis (2011))

Information source	Frequency	Percentage
Radio	53	35.6
Television	30	20.1
People	48	32.2
Newspaper	13	8.7
Other means	5	3.4
Total	**193**	**100.0**

Table 4 Response to flood warnings (authors' analysis (2011))

Response	Number of respondents	Percentage
Planning relocation	12	6.2
Clearing drainage channels	44	22.8
Sand-filling building surroundings	40	20.7
No action	97	50.3
Total	193	100.0

people suffered from the disaster impact. Hence, the study also identified the actions that individuals took in response to the warning.

Table 4 shows that the majority (73.4 %) of the respondents claimed that they had not made any emergency plans. Only 26.6 % stated that they had undertaken some preparations in anticipation of the flood. People's lack of preparation undermined the purpose of the flood warning.

As indicated in Table 4, 50.3 % of the respondents took no action at all, depending solely on "God and the government" for help. On the other hand, the actions taken by more than 40 % of the respondents involved clearing drainage channels and sand-filling the surroundings of their homes. These measures do not necessarily mean an improvement in these areas' infrastructures in that the drainage channels were not expanded. As a result, these measures may not prevent flood waters or mitigate the disaster impact. Despite the government's key measures to prevent a loss of life – which emphasized relocation, among others – , only 6.2 % of the respondents were willing to relocate.

During the focus group discussions, the respondents noted that the government flood warnings were an "attempt by government to acquire their land like it did in Maroko [a slum that was upgraded and allocated to the rich in another suburb of Lagos]". They also noted that the relocation camp that the government opened in Agbowa (for the victims of 2010 flooding) was "more or less like a psychiatric home." One respondent from the Ajegunle neighborhood noted that flooding is a regular phenomenon in their community, that it comes and goes and they therefore did not contemplate relocation. Others maintained that the relocation cost was beyond their reach. However, many believed that because the flooding would have no effect, they made no plans to relocate. They maintained that past predictions had led to nothing. Others noted that they are homeowners and therefore could not abandon their homes. The government's failure to properly inform the

residents that were at risk and to provide alternative safe havens or temporary shelters is an indication of the general poor readiness for the impending disaster.

5.5 *Vulnerability Assessment of the Studied Communities*

The state of the city infrastructure is a major factor that determines a city's vulnerability to flooding. The significance of infrastructure in the normal functioning of any city cannot be over-emphasized. For instance, the Intergovernmental Panel on Climate Change (IPCC 2007) notes that risks from flooding are greatly reduced by well-maintained flood control, sanitation infrastructure, and public health measures. Similarly, Olokesusi (2004) has noted that, in Nigeria, settlements' vulnerability to frequent environmental emergencies is largely determined by the following two variables:

- The vulnerability of the elements within them that are at risk, i.e., the ability of the built physical environment – the buildings, site improvement, and infrastructure – to withstand the stress of natural hazards.
- The hazards of locations of settlements; i.e., the extent to which they are subjected to environmental emergencies.

It is against this background that we analyze the state of the study area's infrastructure and environmental characteristics with regard to vulnerability. This analysis focuses on building characteristics, building locations, availability of drainage facilities, and waste disposal methods. In Table 5, we present and analyze the type, age, location, and condition of the housing that the respondents occupied.

37.3 % of the buildings are above 30 years of age, while 23.8 % are between 21 and 30 years old. Only 4.6 % of the buildings are less than 5 years old. The high percentage of buildings older than 20 years (61.1 %) shows that these city buildings are highly vulnerable to flooding, given that many of the houses are poorly maintained. This is revealed in the results of the analysis, which indicate that 75.0 % of the buildings need minor or major repairs. Only 24.9 % of the respondents indicated that their houses were physically sound. The implication of this is that, in the event of flooding, most of the houses might not withstand the flood's impact.

A physical assessment of some of the communities shows some coping measures in place due to past flood incidents. Many residents use wooden pedestrian bridges to reach their homes (see Figs. 4 and 5). Some of these measures actually strengthened the residents' resolve not to relocate.

A building's location plays an important role in increasing or decreasing its vulnerability to flooding. Buildings located close to floodplains are more vulnerable to flooding than those on higher ground. An analysis of the study data shows that 34.7 % of the buildings are located on floodplains or marshy land (see Fig. 6). On-the-spot assessment found that many dilapidated houses are located in unsafe places (Fig. 7).

Table 5 Characteristics of respondents' houses and neighborhoods (authors' analysis (2011))

Building characteristics	Number of respondents	Percentage
Age of buildings:		
Less than 5 years	9	4.6
6–15 years	49	25.4
15–20 years	14	7.3
21–30 years	46	23.8
Above 30 years		37.3
No response	3	1.5
Total	**193**	**100.0**
Building condition:		
Structurally sound	48	24.9
Poor, in need of minor repairs	67	34.7
Poor, in need of major repairs	78	40.4
Total	**193**	**10.0**
Location of buildings:		
Hilly terrain	9	4.7
Sloping terrain	19	9.8
Flat terrain	68	35.2
Very close to river or stream	30	15.5
On floodplain or marshy land	67	34.7
Total	**193**	**100.0**
Building construction materials:		
Laterite or mud	1	0.5
Laterite or clay blocks	8	4.1
Cement and sand concrete	176	91.2
Corrugated iron sheets	3	1.6
Wooden materials	4	2.1
Others	1	0.5
Total	**193**	**100.0**
Solid waste disposal method:		
Dump it in nearby stream	28	14.5
Put it in refuse bin or bag	34	17.6
Burn it	27	13.9
Dump it on the street or compound	69	35.8
Drop it in refuse dumps	35	18.1
Total	**193**	**100.0**

Of the homes, 15.5 % are located close to a stream or river, and 9.8 % on slopes (Figs. 8 and 9).

According to the analysis results, almost all the buildings (91.2 %) are constructed from cement or sand concrete. There is poor solid waste management in the affected communities. Of the respondents, 14.5 % dump their waste in the nearby bodies of water, 17.6 % use refuse bins, and 13.9 % burn their refuse, 35.8 %

Figs. 4 and 5 Wooden pedestrian bridges to houses in the Ajiliti community (Source: authors, June 8, 2011)

Fig. 6 A House in marshy land at Owode Onirin

dump their waste in the streets, and 18.1 % in refuse dumps. All the wastes in the streets and refuse dumps eventually find their way into the drainage systems, which often results in blocked drains. Most buildings in the study area are not sound and are therefore very vulnerable to flood disasters owing to their locations and structures.

Henderson (2004) stresses inadequate physical infrastructure with respect to the risks and vulnerability associated with climate change impacts, especially flooding. We paid attention to the availability and state of an access road, as well as the availability and nature of the drainage facilities. Table 6 reflects the respondents' opinions of the state of these facilities.

Fig. 7 A dilapidated house at Ikosi (Source: authors, June 8, 2011)

Fig. 8 A house at Ajiliti located on slopes very close to a stream

Table 6 shows that 60.6 % of the respondents indicated that there is an access road to their neighbourhood. However, the majority (54.7 %) indicated that these are not asphalted and are in poor condition. The importance of access roads cannot be over-emphasized. Poor access roads increase people's vulnerability to flooding and hinder rescue operations in cases of flood disaster. Similarly, 56.5 % of the respondents stated that there were drainage facilities in their neighborhoods. However, 94.8 % of the drainage facilities are open, making them dangerous during flooding. In addition, 75.1 % of the respondents noted that the drainage is already blocked. More than half the respondents noted that the drainage facilities are poor and not maintained. Well-kept drainage facilities are important, especially in areas susceptible to flooding, such as the study area.

Fig. 9 A similar structure at Ikosi-Ketu (Source: authors, June 8, 2011)

Table 6 State of infrastructure in the study area (authors' analysis (2011)

Infrastructure	Number of respondents	Percentage
Availability of access road:		
Yes	117	60.6
No	76	39.4
Total	**193**	**100.0**
State of access road:		
Not asphalted but good	52	27.1
Not asphalted and bad	105	54.7
Not asphalted but motorable	25	13.0
Asphalted	11	5.2
Total	**193**	**100.0**
Availability of drainage:		
Yes	109	56.5
No	84	43.5
Total	**193**	**100.0**
Nature of drainage:		
Open drain	183	94.8
Covered drain	10	5.2
Total	193	**100.0**
Condition of drainage:		
Blocked	145	75.1
Cleared	48	24.9
Total	**193**	**100.0**
Frequency of drainage clearance:		
Daily	9	4.7
Weekly	18	9.3
Monthly	30	15.5
No maintenance	136	70.5
Total	**193**	**100.0**

6 Summary and Conclusion

The study findings show that the affected communities are very vulnerable to flood disasters. The location of the buildings and the state of the available infrastructural facilities in these communities contributed immensely to their vulnerability to floods. The affected communities' responses to the flood warnings were poor, thereby rendering people vulnerable to flood disasters. Whereas the Lagos State government asked people who were vulnerable to flooding to relocate to higher ground, it failed to provide temporary shelter for them, thereby discouraging relocation. Based on these findings, we make the following recommendations.

- There is an urgent need for the government to continuously provide advocacy campaigns on the dangers of building on floodplains and indiscriminate refuse dumping.
- Lagos should increase its efforts to create awareness of climate change to the grassroots and to promote and sustain adaptation strategies to build the capacities of institutions and communities.
- The government should enforce building regulations to ensure people do not build on the flood plains.
- The government should explore new ways, particularly in terms of stakeholder involvement, to mitigate floods' impact.
- The government should utilize diverse means (including town criers) to disseminate flood warnings to communities. This will ultimately increase awareness levels in the various communities.
- The social and political aspects of flood management should be strongly emphasized to complement the hydraulic and engineering aspects that the government is currently addressing.
- Proper temporary accommodation should be provided for people at risk of flooding and for displaced persons to motivate them to relocate from flood-prone areas.
- Clearing of blocked drains should be an ongoing activity, rather than only occurring after the onset of rains.
- Removable concrete covers should be placed on open drains to reduce dumping of solid waste and to permit regular clearing. In addition, solid waste receptacles should be provided at strategic locations in the city, and households should be encouraged to practice sustainable waste management.

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