Research Paper

Assessment of Vulnerability of Makoko Low Income Settlements in Lagos.to Environmental Hazards

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Abstract
Most low-income settlements emerge without planning and thereby illegal as they are outside formal town planning processes. They are typified by squalid conditions of poor housing, lack of essential services and environmental degradation. The dwellers' means of survival create circumstances under which the inhabitants are exposed to various environmental risks and hazards. The study investigates Makoko's vulnerability to several environmental hazards. Consistent with this aim, the study wanted to achieve the following objectives: determining the types and conditions of dwellings within Makoko's low-income settlements, studying the facilities provided and assessing the residents' satisfaction with the provided facilities. The study relied on primary data, while secondary data complemented the findings. A multi-stage sampling technique was adopted to administer the questionnaires. A total of 334 dwelling units were selected from a sample frame of 250,000 people to investigate their conditions vis-à-vis the terrain's nature of the house vicinity and the availability of some basic house facilities. The study revealed that residents were dissatisfied with the condition of health facilities (2.53), toilet location (2.63), and water availability (2.66). The vulnerability formula, as used by Domingo (2020), formed the model for vulnerability assessment. The study found that the vulnerability of Makoko to the hazard of flooding (20/24) and disease (20/24) was high. The upgrade and provision of essential facilities such as health, road, drainage, water supply, sewerages through urban renewal actions which are pro-poor can reduce vulnerability to issues of flooding and disease in Makoko.
Keywords: Vulnerability, Makoko, Hazard, housing, low-income settlements

I. INTRODUCTION

Living in low-income settlements is associated, theoretically, with the exposure and vulnerability to Environmental Problems (Forsyth, 2002; Dasgupta, Deichmann, Meisner and Wheeler, 2005). Most of these settlements develop around urban centres as poor people migrate from rural areas to seek a better life (Mugisha, 2006). The perception that cities offer better opportunities for a better life has, in reality, enforced a strong rural-to-urban migration among poor people (Gilbert, 2002; Mugisha, 2006). Consequently, the poor migrants establish low-income settlements at their destination. In this way, the formation of low-income settlements around urban centres involves, at heart, the transference of poverty from rural to urban areas (Anan, 2003).

The low-income settlements emerge spontaneously without planning and remain illegal outside formal town planning processes (Anan, 2003). Inevitably, these settlements are characterized by squalid conditions of poor housing, lack of essential services and environmental degradation (Anan, 2003; Mugisha, 2006; DEDET, 2007). These conditions, together with the dwellers' means of survival, create circumstances under which the inhabitants are exposed to a variety of environmental risks and hazards (Satterthwaite, 2002; Dasgupta et al., 2005). Among these environmental considerations are the problems of filthy water, indoor pollution, inadequate sanitation and poor waste management (Forsyth, 2002; Anan, 2003; Mugisha, 2006). These problems are collectively denoted Environmental hazards (Forsyth, 2002). Contrary to the Green Environmental concerns, the Environmental hazards primarily affect poor people who settle within low-income settlements (Forsyth, 2002).

However, these problems operate in ways that have become difficult to legislate against. For instance, the poor migrants in shanty towns burn dirty fuel for cooking and heating because the clean sources of energy are beyond their means (Satterthwaite, 2002; Dasgupta et al., 2005). Research has demonstrated that despite the

seriousness of these Environmental hazards, international debates on environmental management have largely circumvented them (Forsyth, 2002; Anan, 2003). As a result, the poor people's nature and level of vulnerability to these environmental problems within the low-income settlements in developing countries remain largely unattended. The developing countries' approaches to risk and vulnerability management have continued to be technocratic, ignoring the political-economy considerations involved in the realization of disasters (Forsyth, 2002).

Vulnerability has been defined so far in various ways, with the definition often reflecting to a greater or lesser extent the discipline of the author. A definition of "vulnerability" suitable to this research refers to inability to withstand the effects of a hostile environment, which involves measures of possible future harm (Ciurean, et al. (2013). People become vulnerable to hazard when it threatens their lives, livelihoods, infrastructure, economic productivity and natural resources, (European Environment Agency, 2021) The responses they adopt to handle the risk can, in turn, have long-term implications for the sustainability of their communities. Both governmental and non-governmental organizations have a crucial role in managing vulnerability and response to natural or human-induced hazards.

Vulnerability models, with their inclusion of social sources of vulnerability, work best where the social circumstances of people are well-understood. Yet recognizing that social factors greatly influence hazard response does not mean they are easily identified and evaluated. Social factors vary from community to community, culture to culture, thereby making a broad theoretical model of behaviour which poorly predicts human actions and the likely impacts of a disaster. However, these factors are crucial to a vulnerability approach to hazard studies, especially at a local level. Vulnerability is thus highly contextual (Jones and Preston, 2007). The magnitude of vulnerability to hazards and disasters varies in terms of geographical location, seasonality and exposure of population and infrastructure. Other factors include economic and social conditions, natural resource capital, political and institutional mechanisms, equity in resource distribution and gender, and coping and adaptive capacity. Socio-cultural and economic factors play a vital role in the vulnerability of certain groups to disasters.

The critical problems facing cities of the developing world include deteriorating living conditions, increasing rates of death and diseases caused by pollution and poor sanitation. The environmental and social consequences of urbanization are pretty visible. The conversion of environmentally fragile areas to shantytowns by indigent migrants highlights the inextricable relationship between environmental degradation and poverty. Environmental degradation is both a cause and consequence of poverty. The slum is the poster child of urban environmental degradation. Poverty puts pressure on people to engage in unsustainable and environmentally unfriendly practices. According to Mabogunje (2002), today's Nigerian city is typified by substandard and inadequate housing, slums, lack of infrastructure, transportation problems, low productivity, crime, and juvenile delinquency. Poverty is also endemic in Nigerian cities. The National Bureau of Statistics (NBS) highlighted that 40 percent of the total population (almost 83million people) live below the country's poverty line of 137,430 Naira [$381.75 per year] (World Bank, 2020). These are evident indicators showing the bundle of challenges ranging from physical, social and economic, persistent in the country.

Lagos represents the epitome of urban decay. The metropolis is replete with environmental problems ranging from slums and squatter settlements to crime and delinquency. As far back as 1984, 42 settlements had been identified as blighted (UNCHS/Lagos State Government). The number has risen to about 140, according to the Lagos State Urban Renewal Agency (2020). This study examines vulnerability to hazards through the lenses of housing and environmental conditions in Makoko.

II.   LITERATURE

The following terms are mutually used in the literature, including but not limited to slum, squatter and informal settlements, shanties, and unplanned towns. These settlements are described as places built outside the land-use scheme without planning permission. They are composed mainly of makeshift houses that stray from the approved building regulations. These areas are synonymous with water poverty (access, quality, and cost), poor sanitary conditions, erratic power supply, and inadequate or unavailable roads. Besides, situations such as overcrowding and tenure insecurity define this type of settlement (Odundo, 2012).

Globally, the environmental vulnerability and hazards in informal settlements have been established in the literature (De Risi et al., 2013). K'Akumu and Olima (2007) demonstrated that the number and size of these settlements have continued to grow, despite the poor living conditions, numerous demolitions, fires and natural disasters. In this direction, the vulnerability of informal settlements to hazards is often categorised into four areas: physical, economic, environmental, and social vulnerabilities. The location of several informal settlements on flood plains, marshy areas, low-lying areas, and river courses) coupled with high population growth, poor planning, and housing quality often increases environmental vulnerability [King and Amponsah, 2012; De Risi et al., 2013).

People residing in these settlements have weak economic capabilities (Durst, 2015) that severely impact their capacity to adapt appropriately to any hazard. These people are primarily low-income earners, in-migrants, and under/unemployed, making them incompetent to rent a house or room in a planned residential area. Their economic status thrusts them to rent rooms in informal locations, as they have more affordable residential opportunities. Besides, their financial situation restrains their capacity to invest in measures to reduce environmental vulnerabilities.The rapid urbanisation of a city like Lagos triggers increased demand for natural resources such as land for residential and industrial development. The needs result in natural vegetation destruction in these areas to accommodate the growing construction activities, which increases settlers' susceptibility to several hazards. Land-use changes resulting from increased population changes from agricultural land-use to residential or industrial land-use reduce infiltration and permeability of run-off water through the soil (UNISDR, 2009). The physical appearance of low-income settlements demonstrates that income and poverty are closely related and mutually reinforcing (Dasgupta et al., 2005).

Housing

Self-made shelters usually characterize poor income settlements. These poor housing conditions, which normally distinguish informal settlements, usually include the shacks built from cheap material like cardboard, scrap or corrugated material, and plastic (Gilbert, 2002). The severity of the housing problems for the low-income group is typified by Olotuah and Bobadoye's (2009) statement on the inadequacy. They noted that 60% and 75% of the people in this group are homeless or live in a self-made temporary structure, which negates planning regulations and development control. These problems are compounded by overcrowding issues, resulting in 4.6 persons per room (Agbola and Agunbiade, 2007; Adelekan, 2009 cited in Ngoma, 2010). The poor housing conditions make these dwellers vulnerable to health threats. The severity of the housing problems for the low-income group is typified by Olotuah and Bobadoye's (2009) statement on the inadequacy. They noted that 60% and 75% of the people in this group are homeless or live in a self-made temporary structure, which negates planning regulations and development control. These problems are compounded by overcrowding issues, resulting in 4.6 persons per room (Agbola and Agunbiade, 2007; Adelekan, 2009 cited in Ngoma, 2010). The poor housing conditions make these dwellers vulnerable to health threats.

Similarly, Hoelzel (2016) asserted that the persistent housing problems ranging from lack of access to basic facilities, poor quality and physical conditions, and the proliferation of informal settlements were responses to the government's inability to provide adequate housing teeming the low-income population. These challenges stretch the vulnerability limits of these groups, making them defenseless. Concerning people not defending themselves in Lagos, these low-income groups dwelling in informal settlements are slammed with forced evictions. It is argued that the state operates a maladjusted land market that has eluded many residents from accessing formal affordable housing (World Bank, 2016). The case of forced eviction in OtodoGbame (a waterfront community in Lagos) highlights the predatory power used by the government in grabbing the land for other types of property development. Furthermore, the report from Amnesty International revealed the flaws of the government complying with international human rights laws, timely notice, emergency relief, and resettlement plans. Thus, the eviction was unjust, violating housing rights and family protection. Noteworthy, the urban poor often lose out when human rights issues arise, as the level of vulnerability continues to widen.

Health risk

Air pollution from cooking with polluting (dirty) fuels such as kerosene, stoves, coal, kerosene, wood, charcoal, crop residues, and animal manure are global environmental health problems. Approximately 2.45 billion people in developing countries are affected by this (Lim, Vos and Flaxman, 2010; Schraufnagel, Balmes Cowl, 2019) as it causes between 2.8 and 4.3 million premature deaths each year, equivalent to 7.7% of global mortality (Forouzanfar, Afshin, Alexander, 2016). This transmission is often caused by overcrowding and inadequate ventilation standards in small shacks where most low-income populations live (Mugisha, 2006). Of these premature deaths, 3.8 million are caused by non-communicable diseases (NCDs). Among those NCDs, air pollution is estimated to cause 25% of all stroke deaths, 15% of ischemic heart disease deaths, 17% of lung cancer deaths, and more than 33% of all deaths from the chronic obstructive pulmonary disease [COPD] (Naghavi, Wang, Lozano, Davis, Liang and Zhou, 2015). These incidents are worse when overcrowded accommodation is made from temporary materials and open fires like candles, paraffin stoves, etc. (Franklin, 2007).

According to WHO (2020), air pollution has a broad and dreadful impact on children's health and survival. The adverse effects of climate change are widespread; 1 in 4 deaths of children under five (5) years of age is directly or indirectly related to environmental risks. Both ambient and home air pollution contribute to respiratory tract infections, which in 2016 caused 543 000 deaths of children under five (5) years of age related to environmental risks. It is against the backdrop of a country where 30% of the population are between 0-9 years (Statista, 2021). With two in every three persons residing in slums in Lagos, vulnerability to health risk is

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high (The Cable, 2017). The Interface of Low-Income Settlements Living Conditions, the Environmental Hazards and Vulnerability. According to WHO (2009), persons with poor health and negative wellbeing are more likely to live in a slum and informal settlements. Several diseases have been linked with poor housing conditions, such as depreciating paint in old homes found to be the leading cause of lead poisoning for children (Jacobs, 2002). With many living in the riverine areas, such as Makoko in Lagos, issues of health vulnerability are prominent. WHO (2009) reported that people residing in damp and mouldy homes are vulnerable to health challenges such as asthma and respiratory infections. Mould in buildings pose a health risk to children, the elderly, and to babies. babies (Spengler et al., 2004; Jaakkola et al., 2005). According to Tomlinson (2007), the author explained the connection between poor housing conditions, HIV and AIDS as multiple and complex. For instance, in places with high density, overcrowding and housing conditions increase the risk of opportunistic infections. Inadequate water and sanitation increase the probability of being infected. Cooper et al. (2008) established that overcrowding and some other aspects of a poor home environment contribute to mental stress and reduce people's sense of general wellbeing. Agbo et al. (2012) established that some health disorders such as typhoid and paratyphoid fever, diarrhoeas, dysenteries, cholera, hookworm, ascariasis, viral hepatitis, guinea worm diseases, schistosomiasis, genito-urinary tract infections and many other intestinal and parasitic infections could be contacted through poor toilet facilities which may be a breeding ground for harmful bacteria, viruses and parasites. Furthermore, Goebel (2007) asserted that environmental problems are the primary cause of disease and deaths in low-income settlements. Mitigating Vulnerability to the Environmental hazards.

Andrade et al. (2011) argued that informal settlements (Makoko been one) have become complex forms, where social and environmental problems have been significant challenges for the government and the population for decades. In enhancing the quality of life of people living in these areas while lessening vulnerabilities caused by the land occupation without infrastructure, slum improvement is imperative. Jaitman and Brakarz (2013) agreed that enhancing the quality of life in informal settlements signifies one of the most significant challenges that city governments face, given the high growth forecasts for most cities in developing countries. However, Arimah (2011) disputed that any effort to enhance the lives of slum dwellers by providing choices to new slum formation in African countries must be preceded by a decent recognition of the factors that underlie the development and increase of slums. On this strand, Sticzay and Koch (2015) opined that the fundamental issue in urban vulnerabilities is tied to the developing number of urban residents and how housing and infrastructure services can be financed. Turley et al. (2013) opined that in situ slum upgrading includes changing the physical environment of the existing area, such as improving and installing essential infrastructures like solid waste collection, electricity, water, drainage, sanitation, roads and footpaths, street lighting, health services, housing condition improvements and tenure security. In all, these interventions should cover an array of actions to improve the living conditions of slum dwellers. According to Jaitman and Brakarz (2013), these interventions usually include infrastructure works, provision of urban services, activities in education and health, and community development. Consequently, UN-Habitat (2016) recommended putting housing at the centre of the new urban agenda. These include providing adequate housing for low-income urban residents in areas located close to the city centre. This strategy addresses the social and spatial implications of "housing at the centre" while linking with broader urban renewal strategies for planned city-infill and local economic development and meeting the density, diversity and mixed-use requirements.

CONCEPTUAL FRAMEWORK
The pressure and Release Model (PAR)

As conceived by Blaikie et al. (1994) and revised by Wisner et al. (2004), the pressure and release model assert that socio-economic and political forces progressively accumulate disaster risk and vulnerability within minor geographical areas in cities and communities. The PAR model envisages that 'Disaster-Risk equals Hazards multiplied by Vulnerability' (DR = H x V). It is logically slated this way as vulnerability and its progression often causes disasters. This progression is exacerbated by root causes, dynamic pressures, and unsafe conditions.
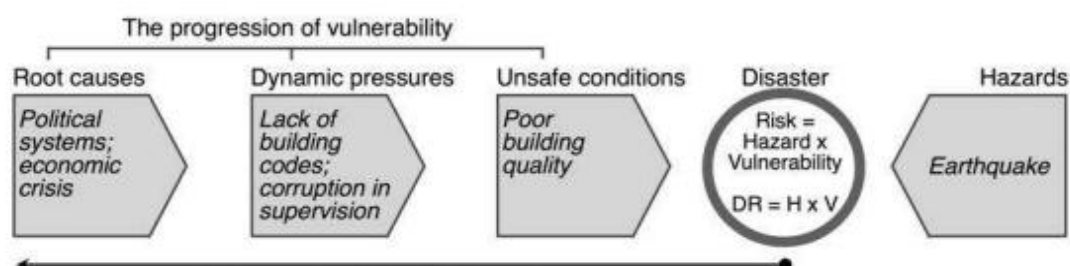
Figure 1: The PAR model describing the progression of vulnerability
Source: Wisner et al., 2004, p. 51)

Pelling (2003a) and Wisner et al. (2004) theorised that the root causes of disasters might be locationally scattered and temporally far from the affected area. To this end, root causes are an interrelated set of broad and general processes within a society and the world economy" (Wisner et al., 2004, p. 52). These include political regimes or economic crises. Root causes may also trigger dynamic pressures such as lack of prevention and preparedness. Besides, dynamic pressures may create unsafe conditions where people live in hazardous locations or poor housing. Going forward, this model provides the conceptual framework for the study.

III. RESEARCH METHODOLOGY

For this study, the survey design is used. The benefit of this design is its usefulness in describing the characteristics of a large population as it ensures broad capability, accuracy in drawing conclusions and making important decisions. It is equally most appropriate for social research. Data utilized for this study were obtained from primary and secondary sources. Primary data were gathered through the use of; questionnaire, personal interview and survey. The questionnaires were divided into two sections; Section A for the Lagos State Urban Renewal Agency [LASURA] to examine their legislative roles, efforts toward effective urban renewal, and challenges inhibiting their effectiveness. Section B obtains information on residents' socio-economic characteristics, housing characteristics and conditions, environmental quality conditions. These questionnaires were designed in a close-ended format to allow the respondents to express their opinion about urban renewal and slum clearance activities in the study area.

Secondary data on past and present urban renewal and slum clearance programmes from various parts of the world, together with private and public sector initiatives on urban renewal as practised all over the world, were also sought. Other physical planning issues, policies and regulations relating to environmental sustainability were also obtained. Also, to be consulted are published and unpublished reports, official documents and records, photographs, maps and other information. The sample frame for this study comprises all the households in Makoko. It is divided into zones having their corresponding household data, as shown in Table 1. The figure of the sample frame was adapted as sighted in the study of Ogunlesi (2016).

Table 1: Sample Estimate

S/n	Population Wards	Sample Frame	Sampled Dwelling units	Percentage (%)
1	Makoko North	69,964	83	24.8
2	Makoko Central	45,572	87	26.2
3	Makoko South East	58,983	84	25.1
4	Makoko Waterside (on water)	75,481	80	23.9
Total		**250,000**	**334**	**100%**

Source: Ogunlesi and Feld survey, 2018

A multi-stage sampling technique was employed; first, simple random sampling was applied in selecting the buildings. Second, the selection of households was made in a systematic order. Hence, samples were collected by randomly selecting one unit and adding elementary units at evenly spaced intervals of three until the desired number of units was obtained. Data were collected through a structured questionnaire administered by four research assistants to household heads or representatives over four weekends when the availability of the household heads is certain as many go to their various places of work on weekdays. Due to the peculiarity of the topic, physical observation of the buildings and photographs were done to complement and substantiate the reliability of the result. Consequently, a total of 334 copies of questionnaires were successfully administered and used for this study, connoting a response rate of 100%. The data collected and collated from the study were analysed using descriptive (frequency tables, Likert scale of summation). Also, photographs are used in presenting the physical situation and condition of the study area. Noteworthy, this study has no inclusion or exclusion rule as studies (Patowary, 2014; Ogunlesi, 2016; Ottaviani, 2020) have established that Makoko is a slum with poor building and living conditions.

IV. RESULT AND DISCUSSION

The socio-economic characteristics of respondents are pertinent to the study because, one way or the other, they influence inequality, which is a causative factor of vulnerability form of social vulnerability to health and sanitary issues. The features examined in this section include gender and the monthly income of respondents.

Gender of Respondents

Table 2 below indicates that most of the respondents in the study area (50.6%) were males, and the rest (49.4%) were females. The observed predominance of males among the respondents might be because the questionnaires were focused on the household heads. In most cases, females were interviewed only in the absence of male heads.

Table 2: Gender of Respondents

Gender	Frequency	Percent
Male	169	50.6
Female	165	49.4
Total	**334**	**100**

Source: Fieldwork, 2018

Table 3 presents the distribution of respondents by monthly income. The Table shows that more than 70% of the respondents earn less than N100,000 per month, with only 26.4% earning more than N100,000 per month. From the Table, it is deduced that most of the respondents belong to the low-income group. The low-income received signifies that the majority live below the poverty line [$381.75 per year]. It further relegates these people to live in places they cannot afford as they cannot meet living conditions (Jose, 2017). It signals economic vulnerability, which reflects living and housing conditions.

Table 3: Respondent's Monthly Income

Monthly Income	Frequency	Percentage %
19,100-50,000 (46-120USD)	82	24.6
50,100-100,000 (120-244 USD)	164	49.1
100,000-150,000(244-365USD)	64	19.2
150,100 and Above (Above 244 USD)	24	7.2
Total	**334**	**100**

Source: Fieldwork, 2018
N.b: Dollar to naira rate 1USD=409 Naira, Based on exchange rate as at January, 2018

Housing Condition

Vulnerability can be deepened by the condition of housing which could affect one's health. Nevertheless, housing is essential for many aspects of healthy living and well-being. Likewise, the environment in which most people spend most of their time imparts on their vulnerability to certain risks and hazards. It includes vulnerability to crime, diseases due to lack of access to water and good sanitation, services, and the opportunity to ensure they remain physically active. Hence, the relevance to examine housing conditions.

It is observed from Table 4 that 41.9% of the respondents were fairly satisfied with the condition of roof materials. 50% were fairly satisfied with the condition of wall materials, while 18.9% of the respondents were unsatisfied with the condition of wall materials. 45.2% of the respondents were fairly satisfied with the condition of flooring materials, with 25.1% not satisfied. 35.9% of the respondents opined satisfactory condition of doors in their households while 21.6% noted unsatisfactory. 36.5% of the respondents stated satisfactory of staircase steps, while 18.6 expressed dissatisfaction. Concerning windows, 40.1% of the respondents were satisfied while 16.2% were dissatisfied with the condition of windows

Table 4: Housing Condition

Roofing materials	Frequency	Percentage (%)
Highly Satisfactory	39	11.7
Satisfactory	70	21.0
Fairly satisfactory	140	41.9
Unsatisfactory	85	25.4
Total	334	100.0
Wall Materials	**Frequency**	**Percentage (%)**
Highly Satisfactory	5	1.5
Satisfactory	99	29.6
Fairly satisfactory	167	50.0
Unsatisfactory	63	18.9
Total	334	100.0
Floor Finishes	**Frequency**	**Percentage (%)**
Highly Satisfactory	40	12.0

Satisfactory	59	17.7
Fairly satisfactory	151	45.2
Unsatisfactory	84	25.1
Total	334	100.0
Doors	**Frequency**	**Percentage (%)**
Highly Satisfactory	18	5.4
Satisfactory	120	35.9
Fairly satisfactory	124	37.1
Unsatisfactory	72	21.6
Total	334	100.0
Staircase Steps	**Frequency**	**Percentage (%)**
Highly Satisfactory	17	5.1
Satisfactory	122	36.5
Fairly satisfactory	115	34.4
Unsatisfactory	62	18.6
Total	316	94.6
Windows	**Frequency**	**Percentage (%)**
Highly Satisfactory	23	6.9
Satisfactory	134	40.1
Fairly satisfactory	123	36.8
Unsatisfactory	54	16.2
Total	**334**	**100**

This section discusses the level of residents' satisfaction with the housing facilities of kitchen, toilet, bathroom, water supply and health facility in the study area. The study employed a 5-Likert scale ranging from Very Dissatisfied to Very Satisfied. It was coded as; 5- Very Satisfied represented as "VS", 4- Satisfied represented as "S", 3- Neutral represented as "N", 2- Dissatisfied represented as "D", and 1- Very Dissatisfied represented as "VD". The Sum Weighted Value is coded as SWV, while the Mean Weighted Value is coded as MWV.

It can be deduced in Table 5 that the mean value is 2.67. This assertion was arrived at using a weighted mean system to describe their level of satisfaction on each of the facilities presented as variables. The weighting was given at 3.0; any score on/ above 2.67 is satisfactory, and values below are unsatisfactory. Regarding kitchen facilities, studies have established that kitchens in slum and squatter settlements are always shared, with corridors of housing used as kitchen locations and backyards close to toilets used for cooking purposes. This study reveals that respondents were dissatisfied (2.64) with privacy regarding their kitchens. It sometimes compels many to practice indoor cooking in tight spaces with limited ventilation, with one window is not of standard with little or no room for cross-ventilation. It makes them vulnerable to indoor air pollution, which is common in such environments because their financial status does not allow them to live in better housing facilities, with limited space to cook in the housing environment. For size (2.73) and location (2.71), they rated this satisfactory.

Regarding the condition of toilet facilities, respondents were dissatisfied with the location of toilets as they often have the same characteristics as that of kitchens. Some slums do not have toilets. They are left to practice open defecation along streets, canals, drainage channels, among others. It further degrades the environment leading to vector-borne disease, making them vulnerable to typhoid, malaria, diarrhoea, hepatitis, among others. Respondents were satisfied with the type (2.72) and privacy of the toilet (2.68). Concerning bathroom and water, respondents expressed satisfaction with this. Finally, on the health facility, the residents were dissatisfied with this facility in the context of distance (2.56) to the nearest health institution (hospital, clinic, dispensary) and also the cost (2.51) of accessing quality medical service and care. It often makes them vulnerable to picking up side effects from chemists (local drug sellers) drugs due to the cost of assessing quality health service. Cases of side-effects of drugs not meant for the right ailment are often pronounced in the slums.

The mean weighting showed that they were generally not satisfied with their health facility, with a MWV of 2.54. It implies that residents are more vulnerable to health hazards.

Table 5: Level of Residents Satisfaction

Variables	Criteria	HS 5	S 4	FS 3	US 2	HS 1	SWV	Mean value	Ranking	MWV
Kitchen	Privacy	10	30	28	60	22	396	2.64	3rd	
	Location	7	37	23	72	11	407	2.71	2nd	2.69
	Size	7	43	17	68	15	409	2.73	1st	
Toilet	Privacy	9	31	29	65	16	402	2.68	2nd	
	Location	6	36	27	72	9	395	2.63	3rd	2.68
	Type	5	37	30	68	10	408	2.72	1st	
Bathroom	Privacy	6	36	32	64	12	409	2.73	1st	
	Location	4	39	30	64	13	407	2.71	2nd	2.71
	Type	4	39	21	79	7	404	2.69	3rd	
Water	Quality	6	39	40	57	8	428	2.85	1st	
	Cost	4	34	36	69	7	409	2.73	2nd	2.72
	Distance	4	30	34	70	12	395	2.63	4th	
	Availability	4	38	27	65	16	399	2.66	3rd	
Health	Distance	10	24	29	64	23	384	2.56	1st	2.54
	Cost	5	25	28	76	16	377	2.51	2nd	
	TOTAL									13.34
Overall satisfaction level: Mean of ΣMWV = 13.34 / 5 = **2.67**										

Source: Author's Field survey, 2018

Environmental Condition

The observation of the site reveals a state of poor environmental condition, which reflects inadequate drainage facilities, increased pollution, poor waste management and poor road condition. Virtually all the streets do not have any form of planned landscape through field observation. The whole area is built with little or no vegetation apart from the swamp. The area is generally flooded. It could have resulted because of the presence of the blocked drainages that were present. Also, the absence of proper drainage in some areas too must have been caused. Apart from this, the presence of the canal and surrounding water bodies has resulted in the flooding of most parts of the area.

Plate 1: Existing drainage and environmental condition in Makoko
Source: Author's Field survey, 2018

Pollution of different kinds ranging from water to air can be seen to dominate this area due to illegal and indiscriminate dumping of refuse (Plate 1 refers). The state of environmental pollution here is indeed very high. The rate of congestion of both buildings and population is fast increasing at an alarming rate. A situation whereby more than five5 people live in a room is fast spreading; this *exceeds the occupancy ratio of 2 persons per room (*Adebayo and Iweka, 2014). It is a reflection of housing inadequacy. This housing pressure leads to cases of overcrowding, increased waste, pollution, among others. And could cause air pollution and overuse of buildings. The study area generally lacks basic amenities such as pipe-borne water and electricity; the only trusted source of water supply is a borehole. The other one is from the river which is usually polluted. In other

words, the water from the river is not safe for drinking and other domestic uses. Even the borehole is not adequately distributed to every part of the area. There is no adequate and proper sewerage in the study area. The river and canal have been turned to sewage disposal. The residents dispose of both their solid and liquid refuse into the river too. The drainage type in the study area is generally open, making it possible for refuse to be dumped in it, which has made the flow of water impossible. The road network in the study area is poorly maintained, and they are not well planned, and the roadsides have been converted to refuse dumps. There are few and substandard facilities in this area. The present state of these facilities is very poor too, especially in the area of educational facilities and others such as health. Generally, the condition of the buildings is very bad. Most of them are not habitable, and they violate proper building requirements and standards.

Plate 2: Existing poor Environmental condition in Makoko
Source: Author's Field survey, 2018

In the design of the roads, there is no provision for pedestrian traffic, making residents vulnerable to cases of accidents, hit and run (Gonzalez et al., 2018). Consequently, poor road conditions lead to travel delays (Ministry of Economic Planning and Budget, 2013). Besides, the poor state of roads affects noise level. For instance, given the road is in poor condition and cars are travelling fast, this causes more noise than if the road is in good condition (Hence, many residents are vulnerable to noise pollution (Roadex Network, 2018). Also, the roadbed serves as a terminal point for buses, taxis and motorcycles, which contributes to the chaotic traffic situation around Makoko Road and Church Street. Meanwhile, aside from Makoko road, Igbehinadun, Church streets, which are major roads, all other routes are not motorable throughout the year. They can only be reached by footpath constructed with timber structures and raised on piles and suspended

Above the water surface level as with the housing units. As a result, 25% of the roads have been bituminous while the rest, i.e.75%, are lateritic, making them prone to flooding all year round, as asserted by Road Network (2018). Water is one of the essential amenities needed within any layout/settlement/neighbourhood; it possesses a big problem in the Study Area. The source of public water supply is Iju water works which is entirely inadequate, irregular, and not portable and sub-standard, which needs improvement. 70% of their inhabitants get their supply from shallow wells, 14% have pipe-borne water and the rest, 16%, depending on water vendors. Only one house along Falodun Street has a private connection from the main, while another has a private borehole (Igbehinadun). Few others sink their wells within their compounds.

Plate 3: Showing poor road condition with illegal roadside activities
Source: Author's Field survey, 2018

HAZARD RISK INDEX ANALYSIS FOR MAKOKO

The starting point for reducing disaster risk and for promoting a culture of disaster resilience lies in the knowledge of the hazards and the physical, social, economic and environmental vulnerabilities to disasters that most societies face and of the ways in which hazards and vulnerabilities are changing in the short and long term, followed by action taken on the basis of that knowledge. (United Nations 2005; Domingo, 2020). A Community Based Indicator system (a means for community and people to track issues that matter to their community) for Makoko generated individual indicators analysed according to Hazards (H), Exposure (£), Vulnerability (V) and Coping Capacity (C). In the end, a factor scale weighting process was conducted by assigning cut off points to each indicator as observed or recorded in the questionnaires and or the focus group discussions according to the likely impact the indicator had on the vulnerability issue being analysed then. The study used the vulnerability formula used by the United Nations Development Programme (2005) and Domingo (2020) to compute vulnerability.

Vulnerability =   Hazard X Risk
                      Coping Strategies

Hazard (H) Factor Analysis

Hazard, in this context, refers to the inherent danger of the threat or disaster (cited in Domingo, p.1). The hazard disaster analysis in Makoko identified floods, Waste, fires and diseases as the most common hazards in the area. The impact of these hazards on the vulnerability of Makoko residents was weighted according to the following hazard Indicators:

1.   Hazard probability of occurrence (Frequency in the recent years, Probability of possible events)
2.   Hazard severity (Intensity of worst event in the recent years, Expected intensity of possible events)

According to questionnaires, focus group discussions, and interviews conducted in Makoko, the corresponding indicators for hazards in the area were weighted using the following standard scale generated by Bollin (2003). Where the scale: *0 = No impact; 1 = Low impact; 2 = Medium impact; 3 = High impact* is applied. It is important to note that a hazard-specific weight has to be applied based on the respondents since some indicators are more important than others, contributing differently to each factor. In this case, respondents rated the following hazards based on which had the highest impact on living conditions. The hazard analysis for Makoko was generated, as shown in Table 6.

Table 6; Analysis of Hazard Factors Level of Residents Satisfaction

HAZARD FACTORS		Indicator Variables			
		Flood	Waste	Fire	Disease
Probability		3	3	3	3
	Makoko North				
	Makoko Central	2	1	2	3
	Makoko South East				
	Makoko Waterside (on water)	2	2	3	2
		3	3	2	3
Severity		3	1	2	3
	Makoko North				
	Makoko Central	2	1	2	2
	Makoko South East				
	Makoko Waterside (on water)	2	2	2	2
		3	2	2	3
Total		20/24	15/24	18/24	20/24

Source: Author's Field Survey, 2018

From Table 6, it is clear that in Makoko slums, the probability and severity of fire, disease and flood-related hazards are very high. Unlike waste, which only has a total score of 15 concerning frequency, likelihood, severity and expected intensity in possible events, it's evident based on findings in Table 6 that the predictability of these hazards is a clear manifestation of the low quality of living conditions in the study area. Besides, the probability and severity levels indicate the high vulnerability of the community to issues of flooding, waste, fire outbreaks. Thus, the possibility of any of these occurring severally will lead to severe impacts on the people of Makoko.

Exposure (E) Factor Analysis

The poverty levels within Makoko slums [roughly half of the Makoko people lives below the official poverty line, on less than 1.25 US$ per day] enhance the level of exposure of the residents to hazards. Besides, the lack of gainful employment opportunities for the residents of Makoko reduces the resilience within the community to respond effectively to the various hazards that occur within this area (Hölzel, 2014). It is further reflected by the weak building materials used in housing construction in the settlement. As the study discovered, most of the houses in Makoko were constructed using fragile construction materials and, in most cases, without evidence of clear planning guidelines from the Authorities. Hence, Makoko Informal settlements are highly exposed to fire outbreaks. Most housing structures are wooden, densely packed, lacking setbacks, and fire-preparedness, such as fire extinguishers, water facilities, and hydrants and water tankers, among others (Kumah, 2012). In addition, the population density within this settlement exposes more residents to such hazards, especially the fact that the locally generated GDP in constant currency is low. The survey reviewed the monthly economic situation of the respondents, where it emerged that 70% of the respondents earn meagre monthly income. The study found that the house rent paid monthly is insufficient with barely any convenience, indicating poor housing quality. Most of the respondents have rented houses. The houses are constructed hastily without due regard to the safety principles envisioned in the regulatory requirements for safe buildings. The materials used in the construction processes are also of poor quality. Over time, the lack of maintenance of the houses has led to the continual deterioration of the quality, increasing their exposure to vulnerability indicators.

The floods, Waste, fires and disease hazards in Makoko have a massive impact on the vulnerability of Makoko due to the quality of living apartments, how many houses with piped water, of the total resident population. As discernible, the study found that a significant proportion of residents lived in poor housing structures comprising of corrugated iron sheets, mud and wood. Most of the houses are constructed using temporary and recycled materials. The walls are made of iron sheet, timber and mud, while recycled tin, iron sheet, carton paper, polythene and even sacks are used for roofing.

From the household survey conducted, all the sampled dwelling units had iron sheet roofs, and only two houses were permanent. The rest were either semi-permanent, made of mud, iron sheet, or wood. The structures belong to individuals, but the government owns the land. As such, tenants are left at the mercy of the structure owners - more often resulting in conflicts of rent, land and tenure rights. According to the survey results, 70% of Makoko households rent their dwelling units, while 30% live in their own houses. Most of the families (78%) stay in one or two-room dwelling units.

Vulnerability (V) Factor Analysis

The socioeconomic characteristics of Makoko were found to be enhancing the vulnerability of the residents to hazards. In this case, it has a large poor population with no access to minimum services, living mainly in structures made out of temporary and recycled building materials - or made out of timber, mud walling, and roofing made up of substandard materials such as sacks, cartons, paper and polythene. There is no proper sanitation and waste management. Water reticulation is limited, and the road network is inadequate or non-existent. The other indicators which enhance vulnerability in Makoko include the population density, population growth rate, the homes in hazard-prone areas, the % of population below poverty level, literacy levels, and the portion of self-generated revenues. The other indicators for vulnerability are economic marginalisation and environmental degradation. These factors were analysed based on the questionnaires and the focus group discussions.

Primarily, the vulnerability of Makoko to environmental hazards is driven by economic factors for all the four hazards (fires, diseases, Waste and floods) identified. It is followed closely by social factors, which indicate a weak resilience compounded by poor physical infrastructural factors in the area. In defining vulnerability indicators for Makoko, it's important to note that, like other slums, Makoko suffers from poor drainage, inadequate access to water and sanitation facilities, as well as essential services. However, the Makoko Slum Upgrading Programme has re-energised the provision and improvement of infrastructure and services in the area. The roads, main sewer lines, drains, bridges and water points where the residents can purchase water are particularly noticeable. The finding manifested that 76% of the households had access to piped water, 25% used private water vendors, and 14% used roof catchment. Results from community members revealed that three-quarters of the households consumed between 1 to 5 twenty-litre jerry cans per day, while the expenditure on the water was high per day per household. Further interviews with community members revealed that water quality is poor, polluted, and unsafe to drink. It makes them practically vulnerable to water-borne diseases such as typhoid, dysentery, diarrhoea, cough, and cholera (Africans Slum Society Associations Funds (2015).

Regarding sanitation, however, household waste is noticeable in open spaces, near rivers and drains, indicating a lack of waste collection services. A sizable informal market serving the area throws most of its waste indiscriminately every and anywhere. Plastics and other human waste could be seen floating in the river, while at the same time, children playing in the water as other people used the water for washing large plastic bags for recycling. Even with the main sewer line in the area, pit latrines are still popularly used: 87% of the households reported using pit latrines. Several households share them. From the survey, approximately 85% of households interviewed did not have access to a sanitation facility (septic tank). Some are very close to the houses while others are right next to the rivers. In some cases, the raw sewer (from toilets or the full ones) is directly emptied into the rivers or drainage trenches, posing a health hazard.

Coping Capacity (C) Analysis

A closer analysis of the coping capacity of Makoko revealed that the coping capacity of Makoko was frail. The Makoko Community Residential Association was recognised as a positive measure towards enhancing the adaptive capacity of the slum to hazards and disasters. There is also significant organisation of community-based organisations, women groups and youth groups initiatives. Summarily, the problems identified in the Study Area are highlighted below. It does not include the housing improvement measures

V.   CONCLUSION AND RECOMMENDATIONS

As established, the process of conducting vulnerability assessment is a comprehensive exercise that requires an analysis of detailed myriad essential variables that have robust bearings on the issue of vulnerability. This study has succeeded in detailing vulnerability assessment to understand the risks inherent in the informal settlements developed within Makoko Community. The maturity of informal settlements is challenging to prevent, notably in developing countries with weak policies to check urban population growth. The upsurge of population density of Makoko makes them vulnerable to disaster as it, directly and indirectly, advances hazard vulnerability and levels of exposure. Besides, the interplay of vulnerability and exposure serves as disaster traps for the poor in Makoko. Because the eruption of disaster hazards cannot be prevented, it is imperative to reduce the vulnerability and exposure level in Makoko.

Policy environment (social, environmental/land use and communication policies) should be based on a solid foundation for reducing vulnerability and exposure to disaster risk. Community resilience and adaptive capacity can effectively deal with floods, fires, diseases, and waste. The community can have physical planning measures such as an enforceable land-use plan, applied building code regulations, regular maintenance and sanitation of the environment and drainage channels. Besides, Makoko can be resilient to hazards through emergency response drills, frequent public awareness programmes on hazards and disasters. The upgrade and provision of essential facilities such as health, road, drainage, water supply, sewerages through urban renewal

actions which are pro-poor can reduce vulnerability to issues of flooding and disease in Makoko. Adequate communication policies through urban planning can alter the characteristics of Makoko and minimise vulnerability and degree of exposure, which invariably reduces disaster risk.

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