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Contextualizing Household Adaptation to Flooding in Urbanized Floodplain Areas: Pre-disaster Adaptation, Coping Capacity and Post-Disaster Intervention

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ABSTRACT: *As physical flood vulnerability continues to increase in urbanized floodplain areas; understanding and improving household adaptation is an important step towards disaster risk reduction. The study provides an assessment of household adaptation using the resilience model to identify pre-disaster preparedness, household coping capacity, and intervention received during and in post-severe flooding scenarios within communities located in the urbanized floodplain areas of Kosofe. Lagos, Nigeria. Kosofe is the most vulnerable residential area out of the 20 local government areas in Africa's most populated city, based on flood vulnerability map of the entire city. The study is based on a positivists' philosophical paradigm, using the deductive approach to gain understanding of resilience model and then tested through a cross-sectional survey involving 324 household heads/representatives in the study area, to contextualize the model in terms of its application in assessing household adaptation. Findings indicate that there is little practice of flood preparedness measures despite high levels of flood risk awareness learnt from previous flood experiences within the area. Similarly, households within the study area rarely use building-based adaptation strategies in coping during severe flooding. Also, government support are very minimal as the most common interventions received by household during and after severe flooding are prayers, savings/thrift contribution, and support from friends and families. The implication of this finding is that by encouraging investments in pre-disaster preparations, deploying adaptive building-based flood disaster risk reduction strategies in new and existing houses, and improving government involvement and support in marginalized urbanized floodplain areas; vulnerable households are better positioned to deal with, cope with and recover from future flood risks.*

KEYWORDS: coping capacity, flooding, household adaptation, post-disaster, pre-disaster, resilience.

INTRODUCTION

Adaptation within the context of disaster risk management is the process of adjusting and preparing systems, societies, and ecosystems to cope with and respond to the impacts of climate change (Munyai, Musyoki & Nthaduleni, 2019). One of the goals of climate adaptation is implementation of proactive measures and strategies to reduce vulnerability and increase resilience to changing weather conditions (Satterthwaite, Archer, Colenbrander, Dodman, Hardoy & Mitlin 2020; Meng, Dabrowski & Stead, 2020). Today, climate change and urban phenomenon, such as poorly managed growth; change in land-use; poverty and migration are increasing flood risk in coastal cities of developing counties (Kolawaole & Okonkwo, 2022). These risks and associated impacts are more acute in informal settlements like urbanized flood plain areas due to physical exposure, limited resources and marginalization of these communities (Satterthwaite et al., 2020). Yet, these areas provide home to some 1 billion people, thereby increasing vulnerability of households within the areas to severe flood losses (Rentschler Salhab, Jafino, 2022).

Empirical studies (Malgwi, Fuchs & Keiler, 2020; Hossain & Fahad, 2020); indicate that physical vulnerability is a primer for other vulnerability dimensions, as such the capacity to understand and address physical vulnerability is increasingly seen as an important step towards climate adaptation. Vulnerability is a multifaceted concept used to explain the potential for casualty, destruction, damage, disruption or other form of losses in a particular element (Nguyen-trung & Forbes-mewett, 2019; Gu, 2019; Munyai et al., 2019). It is conceptualized as consisting of three factors, namely, exposure, susceptibility and resilience (Hossain & Fahad, 2020). Where, exposure is the predisposition of a system to be disrupted by hazard due to its location in the same area of influence (Hamidi, Jing, Shahab, Azam, Atiq, Rehman & Ng, 2022); susceptibility implies elements exposed within the system, which influences the probability of damage (Ahmed, Alrajhi, Alquwaizany, Maliki & Hewa, 2022), and resilience is the adaptive capacity of a system to adjust to actual or expected climate impacts (Liao, 2012). It thus implies that households in at risk communities become vulnerable to flood disasters because of exposure and susceptibility, they however recover or adapt or cope based on their resilience.

As such, building resilience to flood risk is fundamental in reducing climate-induced flood losses; however, it depends on an understanding of perceived risks, vulnerabilities, and local efforts to mitigate them (Rahman, Azad & Rahman, 2023). Efforts to mitigate physical vulnerability of residential properties and improve flood resilience are documented in literature. For instance, a number of building-based adaptation strategies have been developed; such as elevated structures, flood resistant construction, flood-proofing, property flood resilience, sustainable urban drainage systems (SUDs); flood-resistant landscapes, early warning systems, land-use planning, infrastructure development, awareness programs, and so on (Kometa Petiangma, & Kang, 2021; Ishiwatari & Sasaki, 2021; Lucas, 2021; Surminski, Mehryar, Maryam, 2020). However, implementing these adaptation measures is challenging due to combined personal, financial, informational, and infrastructural factors (Mondal Murayama & Nishikizawa, 2021; Twerefou, Adu-danso, Abbey, Delali, 2020; Ani, Ezeagu, Nwaiwu & Ekenta, 2020). It is observed that households respond differently to hazard based to their physical, social or economic capacities (UNEP, 2021). It thus implies that adaptation is dynamic and context-dependent.

In Nigeria, flood adaptation and mitigation efforts is limited, and much of the available information is low quality, inconsistent or outdated (Lucas, 2021). Yet, flooding has remained a recurrent environmental problem with devastating impacts (Ajijola, Bello & Arayela, 2020; Mfon, Oguike & Eteng, 2022). The dearth of knowledge on household flood adaptation strategies coupled with the nature of Nigeria's housing sector which is characterized by qualitative and quantitative housing deficiencies, and weak housing right makes it difficult to achieve housing resilience (Bello, Durosinmi & Abdulkarim, 2017; Olotuah, Olutuah, Olotuah, 2018; Brisibe, 2018; Brisibe, 2020). As flood risk tends to increase in the future, empirical studies to bridge the obvious knowledge gap in household flood mitigation efforts are needed to support flood management. This study adopts resilience thinking in household adaptation, with a view to encourage long-term planning that is transformative, robust and futuristic. Based on the aforementioned, this research examines households' level of awareness of flood risk and their preparedness in pre-disaster, coping strategies used during disaster and intervention received during and in post-disaster. The present study proceeds as follows. First, a review of literature on the concept of resilience, and resilience perspective in flood risk management. Next, information on the materials and methods is presented, followed by description of data and discussion of findings.

LITERATURE REVIEW

Resilience Perspectives to Flood Management

The word "resilience" takes its origin from the Latin word resi-lire, meaning to spring back. Prior to the 19th century, resilience, as a design principle was an inherent aspect of traditional building construction knowledge in which buildings were designed to provide for unknown uses and adaptation (Hassler & Kohler, 2014). Afterwards, the 19th century engineering concept of resilience emerged. This concept had its origin in material technology, and was based on the elastic behaviour of materials over a single equilibrium (Liao, 2012). Today, resilience as a concept involved a shift from the engineering approach to ecological system which is based on the assumption that socio-ecological systems, like urban systems are characterized by multiple equilibrium and diverse adaptive capacity (Mofrad & Baastani, 2018). The application of resilience in natural hazard management is relatively new, as such, understanding the distinctions is fundamental to defining and approaching hazard management. Fundamentally, engineering resilience and ecological resilience are two divergent and opposing system properties. On the one hand, resilience in engineering is usually perceived as the ability of a system to return to equilibrium or a steady state after a disturbance or to a state that existed before perturbation occurred (Liao, 2012; Bhattacharya-mis & Lamond, 2014). In this case, resilience is measured exclusively based on recovery, this implies that the faster the full functionality of the system is restored, the more resilient it is. Thus, in engineering resilience, the system may undergo risks and stresses but still maintain the old stable state of functionality. Ecological resilience on the other hand challenges the universality of a stable state for every ecosystem, to which it is assumed to eventually return after a disturbance

(Mofrad & Baastani, 2018). It is believed that open systems do not operate near equilibrium; as such, studies have challenged the equilibrium paradigm based on the idea that ecosystems contain many components and diverse processes, and returning to the previous state is extremely difficult if not impossible (Schaefer et al., 2020).

While the recovery characteristics of engineering resilience are pertinent if a system is to be considered resilient; socio-ecological systems will require some level of self-organization, adaptive capacity, and redundancy to be considered resilient (Liao, 2012). It thus means that resilience in flood management indicates the capacity of a vulnerable community or household to resist, adapt, accommodate and reclaim from the impacts of flooding in a timely and efficient manner, including reclamation its vital infrastructures and functions (Hossain & Fahad, 2020). As such, engineering resilience and ecological resilience theories are applicable in managing flood risk within the built environment. Howbeit, effective resilience planning must recognize that flood is a natural process which societies can adapt to by being prepared and having the right attitude towards flood damage reduction (Loggia, Puleo & Freni, 2020).

Therefore, effective flood risk management from a resilience perspective stems from two ideologies. First is the recognition that flooding cannot be completely prevented as integral environmental dynamics; in order words, socio-ecological system loses resilience when these environmental dynamics is artificially suppressed to promote stability through command-and-control management. Second is the understanding that flooding itself is an agent for resilience because each flood presents a learning opportunity for cities to adjust their internal structures and processes and to build knowledge that leads to diverse coping strategies cumulated over time so as to become better prepared for future risks (Meng et al., 2020).. Hence, resilience in flood management is focused on building adaptive capacities as opposed to maintaining stability

Ecological Model of Resilience in Household Flood Adaptation

The ecological model of Resilience developed by Norris, Stevens, Pfefferbaum, Wyche & Pfefferbaum (2008), highlights various levels of influence on resilience, and suggests that the resilience of a system is influenced by a combination of pre-disaster factors, coping capacity during the disaster, and post-disaster intervention. Consequently, the model proposes that resilience can be measured in three layers: adaptation in the pre-disaster, coping capacity during the disaster and intervention in post-disaster (See Table 1).

Table 1 : The Three Layers of Measurement of Resilience

Phase	Description of variables	Indicators
Pre-Disaster	Baseline level of preparedness, and adaptive capacity of households prior to the occurrence of a stressor	Resistance to maintain stability, or Transient dysfunction that lead to re-adaptation or continued dysfunction
Disaster	Coping Capacity (resources, characteristics and conditions)	Improved resilience and post-disaster adaptation
Post Disaster	Intervention	Adaptive capacity for resistance in pre-disaster, and resilience during the event and in post-disaster.

Source: Adapted from the Norris, et al. (2008)

Each layer is considered to have different characteristics and lead to specific outcome. The first layer entails the pre-disaster level of adaptation and the occurrence of a stressor/event. There are two pathways in this layer, either stability is maintained through resistance, or there is a transient dysfunction which may lead to a re-adaptation or continued dysfunction in post-disaster. In the second layer of the model, adaptive capacities are considered. These include the factors that influence the resilience process and affect the trajectory towards post-disaster adaptation. The third layer of the model is the interventions, which are in twofold: during the pre-disaster and post-disaster. Pre-disaster interventions can be used to improve the adaptive capacity for resistance, while post disaster intervention can be used at the time of the event and after to support resilience.

MATERIALS AND METHODS

Study Context

This study is part of a larger research work conducted for the award of Doctoral degree in Architecture. The study area consists of Owode-Ajegunle, Agboyi and Oworonshoki areas of Kosofe. Lagos, Nigeria, precisely communities adjoining River Ogun (see Figure 1). Kosofe is the most vulnerable residential area out of the 20 local government areas in Africa's most populated city, based on flood vulnerability map of the entire city (Kaoje & Ishiaku, 2017). Kosofe is currently a highly built up area having houses built on floodplains and natural water channels, and with an estimated population of 1,570,376 as at 2021 (Awodumi, 2020). Notably, till date, the study area suffers incessantly from unmitigated flooding, often resulting in building damages, disruption of communication, loss of lives and properties (Ajijola, Bello & Arayela, 2020).

Figure 1: Satellite imagery showing Kosofe Local Government Area
Source: Google earth imagery, 2023

Research Design and Approach
The study adopts a cross-sectional survey design involving primary data collection through questionnaire administration to households in the study area. Secondary data were drawn from academic journals, textbooks and government documents. The research is based on a positivists' philosophical paradigm adopting a deductive (quantitative) approach (Blackwell, 2018; Holden & Lynch, 2004). In the current study, theories were used to gain understanding of resilience and then tested through survey to contextualize the model in terms of its application in assessing household adaptation. The numbers of households surveyed was selected using a systematic sampling method, based on a random starting point, but with a fixed sampling interval of six houses, as appropriate to the size of the communities.

The questionnaire was structured into four sections, focused on: i) the demographic characteristics of respondents; ii) their awareness of flood risks; and the source of information on awareness; and iii) various household coping strategies used; and iv) interventions received during and in post-flood scenarios. At the end of the survey, a total of 324 fully completed questionnaires out of an effective sample size of 385, representing an acceptable 84.15% of the survey were returned and included in the analysis. Statistical Package for the Social Science (SPSS) software was employed for the descriptive and inferential statistics.

RESULTS AND DISCUSSIONS

Demographic characteristics of Respondents
Analysis of the demographic characteristics (see Table 2) of the respondent shows that majority (62.3%) are male, while 37.7% are female. This finding shows that more than one-half of the respondents were male. It was also discovered that majority of the respondents are between the ages of 31 years and 43 years (28.1%), this is followed by those between 18 years and 30 years

(26.9%); 44 years and 56 years (19.1%); 57 years and 65 years (12.7%); and above 66 years (12%) respectively. The results of the present study also seem to confirm that the category of people living in the study area is mainly made up of people of working age; suggesting that residents may not be economically vulnerable as more people can work to recoup economic losses (Rentschler et al., 2022). However, results of the employment status of respondents showed that 30.2% of residents were unemployed, suggesting some degree of economic vulnerability given the limited financial resources of these residents. Studies have shown that income affects vulnerability to disasters as it affects an individual's ability to prepare, cope and recover (Diarte, Bang & Obonyo, 2020; Halima & Hiroaki, 2022). Further analysis of the employment pattern showed that 14.5% of residents in the area are self-employed, suggesting that when the environment is flooded, income and livelihoods would suffer. This finding corroborates previous studies that found that flood events have a negative impact on local employment (Hamidi et al., 2022).

Table 2. Respondent's Demographic Characteristics

		Frequency (N=324)	Percentages (%)	Cumulative Percentage (%)
Gender				
	Male	202	62.3	62.7
	Female	122	37.7	100.0
Age				
	18-30	87	26.9	26.9
	31-43	95	29.3	56.2
	44-56	62	19.1	75.3
	57-65	41	12.7	88.0
	66- above	39	12.0	100.0
Employment Status				
	Self employed	79	24.4	24.4
	Employee with Private org.	49	15.1	39.5
	Government employee	52	16	55.5
	Unemployed	98	30.2	85.7
	Retiree	46	14.3	100.0
Highest Level of education				
	Primary education	54	16.7	16.7
	Secondary education	69	21.3	38.0
	Tertiary education	201	62.0	100.0
Tenancy status				
	Official Resident	3	.9	.9
	Tenant	197	60.8	61.7
	Owner Occupied	124	38.3	100.0
Duration of Residency				
	1-5	32	9.9	9.9
	6-10	75	23.1	33
	11-15	64	19.8	52.8
	16 and above	153	47.2	100.0

Regarding the level of education of the residents surveyed, the result showed that 38% of respondents did not have a college degree. This is important because the level and quality of education of a population are very indicative of its vulnerability. A more educated population has the knowledge to mitigate flood damage and implement viable solutions for reasonable post-disaster reconstruction; while low-educated households are more likely to be at risk of flooding and less prepared for flooding (Ishiwatari & Sasaki, 2021). Furthermore, concerning the tenancy status of respondents, 61.7% live in rented apartments, while 38.3% live in self-owned buildings. Also, result as shown in Table 2 shows that a higher proportion of respondents have lived in the study areas for more than 16 years, thus, indicating that most households in the study area have experienced flooding in the past. This finding has a positive impact on vulnerability, as recent study has explained that increased exposure to past flooding increases vulnerability (Hallegatte et al., 2020).

Pre-disaster flood risk awareness and Preparedness of Households

Findings on the level of awareness of flood risks in the study area (see Table 3) suggest that majority (70.4%) are aware. Similarly, many of the surveyed household representatives (76.9%) attribute the source of information about their knowledge to previous flood experiences.

Table 3: Flood risk awareness in the study areas

Awareness of risk attributed to flooding	**Frequency**	**Percentage**	**Cum. percent**
Strongly disagree	16	4.9	4.9
Disagree	41	12.7	17.6
Not sure	39	12.0	29.6
Agree	128	39.5	69.1
Strongly agree	100	30.9	**100.0**
Total	324	**100.0**	
Source of information on awareness			
Previous flood experiences	249	76.9	76.9
Official information	14	4.3	81.2
Environmental signal	61	18.8	100.0
Total	324	100.0	

To develop a better understanding of the relationship between flood risk awareness and previous flood experiences, a chi-square test was carried out on the two variables. Results of the test as shown in Table 4 confirmed a significant relationship between flood risk awareness and past flooding experience (x2 = 218.602, P = 0.000). The results of this survey are consistent with previous study which suggested that many residents of flood-prone areas are fully aware of the risks associated with living in the area (Salami et al., 2017).

Table 4: Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	218.602[a]	8	.000
Likelihood Ratio	238.140	8	.000
Linear-by-Linear Association	101.199	1	.000
N of Valid Cases	324		

a. 5 cells (33.3%) have expected count less than 5. The minimum expected count is .69.

The results of the survey on the level of preparedness to deal with future flood risks show that very significant percentages (91.9%) of respondents were "unprepared". This result seems to be consistent with previous studies which asserted that very few homeowners in at risk areas adopt any mitigation measure despite the overwhelming public awareness of flood risk (Halima & Hiroaki, 2022). Similarly, 66.4% of the respondents have never practiced any form of preparedness measures, while 33.6% indicate practicing sometimes. The findings corroborates the docile attitude of many households in investing in flood mitigation measures; and thus highlights the challenges policymakers face in encouraging residents of flood-prone areas to protect themselves against future floods and their associated impacts as documented in several literatures (Atufu & Holt, 2018; Lucas, 2021; Munyai et al., 2019).

Household coping capacity during flood disaster

Table 5 provides information on household coping strategies. The results shows that out of the 15 variables used to assess household coping strategies, 2 returned with a moderate mean score (3.15 -3.09), while 5 reported a low mean score (2.53- 1.91). The remaining 8 variables had very low mean scores (1.89-1.00). This implies that many households practice fairly low coping strategies.

Table 5: Household Coping Strategies

Coping Strategies	Mean	Std. Dev.	Rank.	Interpret.
Rainwater harvesting system	3.15	1.463	1	Moderate
Use of drainage system	3.09	1.410	2	
Periodic maintenance of drainages	2.53	1.439	3	
Raised building ground floor	2.45	1.312	4	
Raised electrical services above flood line	2.14	1.335	5	Low
Exterior paving with permeable materials	2.00	1.107	6	
Rain garden to reduce run-off	1.91	1.119	7	
Tree planting to reduce run-off	1.89	1.110	8	
Roof garden to reduce run off	1.36	.480	9	
Standby pump	1.35	.973	10	
Location of living accommodation on first floor	1.26	.437	11	Very Low
Use of flood alarm systems	1.16	.368	12	
Use of flood barriers across external doorway	1.13	.333	13	
Anti-flooding devices fixed to sewage systems	1.00	.000	14	
Use of non-return valve in bathrooms	1.00	.000	14	

The result also shows that the most common coping strategies used by households are rainwater harvesting systems (3.15), use of drainage systems (3.09) and regular maintenance of drainage systems (2.53). The result further shows very minimal use of resilient measures (*such as: tree planting, roof garden, backup pump, arrangement of first floor living spaces, use of flood warning systems and barriers against storm surges above the outside door, overflow devices on sewers and the use of non-return valves in bathrooms*) in many households in the study area. The finding provides support for previous studies suggesting that there are limited household coping strategies practiced in many flood-prone areas of Lagos city (Nkwunonwo et al., 2016; Adelekan, 2016).

Past studies also show that flood management measures employed by most households in vulnerable communities are usually dependent on their own resources and income (Mondal et al., 2021; Twerefou et al., 2020; Abebe, Ghorbani, Nikolic, Manojlovic & Gruhn, 2020). Thus, on the one hand, the low level of household coping capacity shown by most households in mitigating flood risks in the study area may thus be informed by the high rate of unemployment and low income among the residents. On the other hand, the low uptake of building-based adaptations suggests that residents have only a superficial understanding of the effectiveness of these adaptive coping measures, as previous research has shown.

Intervention During and in Post-Disaster

Despite the low level of household coping capacity demonstrated by households in the study area, further analysis of the results (see Table 6) shows that prayer is the most common intervention respondents (38.9%) receive during and after severe flooding. This is followed by loans/gifts for savings purposes (24.1%) and support from friends and family (21.3%). Government support appears to be insignificant, however, and none of the respondents said they received any form of flood insurance cover. This finding therefore confirms the low level of adaptive capacity previously suspected in the households in this study.

Table 6: Intervention during and in post-disaster

Intervention	Frequency	Percentage	Cum. percent
Government support	51	15.7	15.7
Insurance	0	0	15.7
Support from family and friends	69	21.3	37.0
Prayer	126	38.9	75.9
Borrowing/ thrift	78	24.1	**100.0**
Total	324	**100.0**	

Source: Researcher's Result via SPSS Version 23, (2023)

CONCLUSION AND RECOMMENDATIONS

This study is based on the assumption that resilience thinking in flood adaptation can encourage a robust, transformative, and sustainable planning, that is effective in addressing growing flood risk in coastal communities. The study provides an assessment of household adaptation using the resilience model to identify pre-disaster preparedness, household coping capacity, and intervention received during and in post-severe flooding scenarios in the urbanized floodplain areas of Kosofe, Lagos, Nigeria. Based on the findings of the research; the following conclusions were arrived at. First, there is little practice of flood preparedness measures despite high levels of flood risk awareness learnt from previous flood experiences within the area. The implication of this is that insufficient flood preparedness increases the risk to human lives and properties during flooding, and communities may suffer significant economic losses. Therefore, by encouraging investment in pre-disaster preparations; the socio-economic and physical impacts of flooding are reduced and households are better positioned to deal with future flood risks, thus are more likely to build resilience in the long run. Second, households within the study area rarely use building-based flood adaptation strategies in coping during severe flooding. This implies that many of the flood-prone houses were not designed with consideration for flood risk mitigation, thus amplifying the susceptibility of critical infrastructure and services to flood damage. Therefore, it is very essential to improve the coping capacity of vulnerable households by integrating adaptive building-based flood disaster risk reduction strategies in new and existing buildings. It is believed that households with high building-based coping capacity can promote and reinforce their resilience, as well as contribute to the overall resilience of their neighborhood and communities. Third, government support are very minimal as the most common interventions received by households during and after severe flooding are prayers, savings/thrift contribution, and support from friends and families. The implication of this is that the marginalization of informal settlements further compounds physical vulnerability and continued environmental degradation of coastal floodplains. It is therefore pertinent to improve government commitments in alleviating risk in vulnerable communities. This study therefore fills the gap in analyzing household adaptation to flooding in urbanized floodplain areas.

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