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Research article

Mainstreaming resilience to flood risk among households in informal settlements in Kisumu City, Kenya

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Abstract: The frequency and severity of flooding in urban areas have escalated in recent years, and the worst affected urban areas are those in Africa. Despite the escalating flood risks accompanied by the growing vulnerability, cities and urban areas in Africa are struggling to build resilience. One of the actors in urban resilience building are the households in the urban settlements. Indeed, their contribution forms an important component of many flood risk response strategies. Nonetheless, the knowledge about this remains limited and is often confined to specific regions or case studies. In this study, we sought to identify the measures put in place to respond to flood risk by the households in Nyamasaria and Manyatta and explored the potential of mainstreaming resilience to flood risk in these settlements. We adopted a survey design. The settlements were purposively sampled, while the sampling procedure for the households involved transect lines established parallel to the major roads within the settlements. A transect walk was made to mark the households, and then simple random sampling was used. Data collection through personal interviews using questionnaires followed. Descriptive statistics were used to analyze the primary data. The findings showed that both settlements suffered frequent flood events, with 79 % of households having suffered inundation by floods in the past. About 46 % of the households have put in place flood risk reduction measures, including using sandbags, digging trenches around the houses, and raising floor levels. There were also cases of households temporarily relocating from the risk areas to safer places. The findings showed that the households' response measures were short-term and were aimed at addressing immediate risks. We concluded that the existence of capacities and actions to reduce flood risk among households provides a viable starting point for mainstreaming the resilience to flood risk in these settlements. We therefore recommend that households need to transition from short-term measures to risk-sensitive resilience

measures, including flood-resilient designing of buildings, installation of risk-reducing infrastructure, and risk-sensitive urban planning.

Keywords: resilience; coping; adaptation; informal settlements

1. Introduction

The frequency and severity of flooding in urban areas have escalated in recent years [1,2]. The worst affected urban areas are those in Africa where urban growth remains largely unregulated, and the vulnerability of urban communities is quite high [3]. In these areas, the level of flood risk is greatly influenced by the spatial patterns of the settlements and the magnitude of response strategies among the urban dwellers, among others [4]. Accordingly, uncontrolled and unplanned morphologies across African cities have increasingly exposed the residents to flood risks. Despite these escalating risks and the growing vulnerability, urban Africa is struggling to build resilience [5].

There has been a growing global interest in policy responses to enhance urban resilience and adapt to future changes [6]. Specifically, the interest in households' response strategies, aimed at boosting resilience, has gained center stage [7]. Despite these interests, the global and regional initiatives to enhance urban resilience have targeted mostly cities in the global north, with the majority of urban areas in sub-Saharan Africa being underserved [8]. Moreover, the understanding of African urban pathways to resilience has remained patchy and minimally represented [9]. Consequently, the knowledge about the households' response to hazard risk and mainstreaming of resilience remains patchy and is often confined to specific regions [10]. While some researchers argue that households' response actions can boost resilience to hazard risks [11], others point out that households merely engage in protective actions to minimize the immediate impact of hazards on themselves and their properties with no long-term implications [12].

Past studies in cities in Kenya and Tanzania revealed that individual and household-based actions aimed at reducing flood risks are legion [13]. These actions are however unsupported by governments with households left to fend for themselves to ward off the existential flood threats [14,15]. Although households play a significant role in flood risk reduction in informal settlements in Kenya, how resilience can be mainstreamed into their actions has not been given much scholarly attention. Similarly, even though some studies document that urban resilience is being mainstreamed into planning policy and practice [16], the extent to which urban households are involved in this process particularly in Kenya, has not been clearly understood. Thus, knowledge is limited in helping to illuminate the status of resilience to flood risk in Kenyan urban areas. Therefore, we seek to examine the response to flood risk by the households in Kisumu city and explore the potential of mainstreaming resilience to the annual flood incidences. Understanding of these response measures is crucial for successful adaptation as urban areas and cities move towards resilience.

1.1. Literature review

1.1.1. The concepts of resilience, coping, and adaptation to hazard risks

Resilience has gained prominence as a new approach to managing and mitigating hazards, given the ongoing global urbanization [1]. The concept of resilience is not new, rather, the interest in it is what has gained currency in the past two decades as a means for understanding how communities successfully respond to adverse events [17]. This relates to ability to cope with immediate impacts and the capacity for long term adaptation [15,18]. A system could thus be said to be resilient when it is less vulnerable to shocks and can recover from them [19]. Based on this, resilience is, therefore a combination of both coping with and adaptation to a wide array of shocks and stresses. The concepts of coping and adaptation have dominated the disaster risk and climate change literature for decades.

The terms coping and adaptation are often used to describe how households deal with shocks [20]. These terms exist as parallel concepts serving epistemic communities with different origins [21]. The differentiation is, however, not clear-cut and is very context-specific. Coping encompasses strategies, measures, and actions that are related directly to specific hazard impacts during or after the disaster strikes [20]. Adaptation, on the other hand, means any adjustment that is put in place as a means for ameliorating the adverse consequences associated with climate change [22].

The terms coping and adaptation are sometimes used synonymously. This, however, is problematic, since such use does not shed light on the fundamental differences between them [20]. The different viewpoints are manifested in various schools of thought. The first school of thought views coping as being the preliminary phase of adaptation [23]. Thus, coping precedes adaptation and is considered as its stepping stone in response to hazard risks. In this case, coping and adaptation are on a continuum, with actions aiming for short-term stability (coping) at one end and those directed toward the long-term change (adaptation) at the other [21].

The second school of thought perceives coping to be distinct and separate from adaptation. Here, coping is generally short-term actions to ward off immediate risk [24] while adaptation is characterized by long-term adjustments that correspond to efforts regarded to be addressing climate change (Figure 1). Adaptation, therefore, is larger in scale and scope than coping [25].

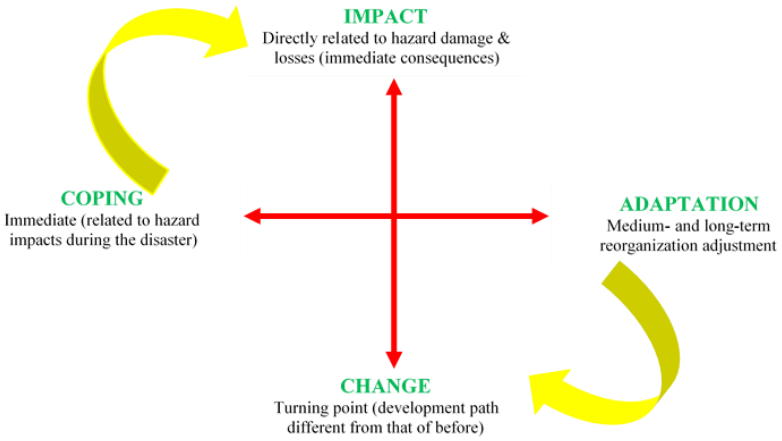

Figure. 1. Distinction between coping and adaptation [26].

The third school of thought completely ignores coping and identifies adaptation as the sole response to hazard risks [27]. Adaptation is further disaggregated in various ways. First, adaptation can be classified based on timing, where there is anticipatory adaptation (which takes place before hazard risks are experienced) and reactive adaptation (which takes place after hazard risks have been experienced). Second, adaptation can be understood in terms of degree of planning. Based on this, we have planned adaptation (which is a result of a deliberative policy decision) and autonomous (which is a spontaneous response and is usually reactive) [22]. Adaptation can further be understood as a public approach and as a private action.

Planned adaptation corresponds with public adaptation and is initiated and undertaken by the government, while autonomous adaptation corresponds to private adaptation and is the initiative of private actors [28]. However, opinion is divided on the notion that autonomous adaptation in the form of private actions constitutes adaptation to hazard risks which has a bearing on resilience. Grothman and Patt [29] point out that adaptation by private actors does not qualify as adaptation as such, but is merely a response to short-term impacts and thus cannot guarantee resilience.

1.1.2. Households' response to hazard risks: Evidence from past studies in cities in the global south

Households have increasingly had the responsibility for reducing the risks posed by hazards to their property [7]. They take a wide range of actions to respond to such hazards, and the actions have a significant potential to reduce damage to properties and foster resilience [10]. Brody et al. [7] point out that households favor response measures that require the least amount of effort and expense. There is a common mistake in the literature of conflating the act of adaptation with that of coping, with authors largely treating the temporary coping measures as equivalent to adaptation strategies [30]. It has however emerged that the coping measures are largely spontaneous or 'impact minimizing' rather than planned or 'preventive' [31]. Thus, the measures lack an element of planning and focus more on short-term outcomes than long-term risks. This, it is argued, could exacerbate vulnerability to hazard risks and undermine resilience [30,32].

At the household level, response to flood risk mainly involves modification of housing structures and the surrounding built environment to cope with the threats. For instance, the response strategies may include those done within the house, such as blocking entryways so that water cannot come in and creating outlets so that water can flow out easily. They may also include modifications to the housing structure or modifications around the house, such as digging water channels, building dykes, and laying sandbags [10]. In other areas, households place old tires along drainage channels, while in others, the responses include putting possessions on high shelves or roofs, hanging furniture and other possessions from hooks high up on walls, and sleeping on tables [33]. It is viewed that these responses by households are autonomous, spontaneous, and short-term in nature and may not guarantee resilience.

A study done in Dar es Salaam in Tanzania indicates that the households living in informal settlements respond to floods by constructing embankments or protection walls, raising door steps, rubble filling around dwellings, and also fixing cracks on walls to make them strong [34]. Similarly, some residents raise the foundation of the buildings above the ground and construct protective walls in front of the buildings while others temporarily relocate to their neighbors, friends, and relatives during flood events [34]. In Accra in Ghana, households in informal settlements cope with floods by digging temporary channels from their homes to the main drain to ensure free flow of water during the rainy season. Other residents temporarily vacate their homes during the rainy season. We, however,

point out that these strategies are not only reactive but are also less effective and less reliable [35]. Amoako [36] also studied flood responses in informal settlements in the same city of Accra in Ghana. He classified the households' response actions as tangible and intangible. The intangible actions include evacuation or relocation to church houses and the tangible actions being putting sandbags and/or bamboo pegs in pathways of the stormwater runoff, and raising the foundation, walls, and entry points of their houses. Similar cases exist in Lusaka city in Zambia, where it was observed that households living in informal settlements responded to flood risk by raising the bases of their houses using crushed stones, soils, cement, or blocks while others dig drains around their homes to reduce the risk of flooding [37].

Twum and Abubakari [19] studied the determinants of households' coping strategies to floods in informal settlements in Accra, Ghana. They found out that households took deliberate steps to cope with flooding with the coping strategies yielding some positive outcomes. The study however observed that the households' coping strategies could only help them adapt to minor flood events. As such, there is minimal contribution toward building resilience to flood risk. Okunola et al. [38] found out that the response strategies adopted by the residents in their study area of Port Harcourt, Nigeria were reactive or ex-post adaptations that support the households in coping with the effects of climate change. The households relied on personal efforts rather than government intervention.

The case study review shows that coping is occurring in the informal settlements of cities and urban areas of the global south [30]. There is also evidence that coping strategies' contribution to flood risk reduction has not been significant. Pointedly, the main reason why households have yet to develop resilience can be pointed to the deficiencies in basic infrastructure, which greatly compromises the residents' capacity to adapt to the frequent flood events. Notably, cities and urban areas in the global south face major infrastructure deficit [33]. It is acknowledged that good quality and functioning infrastructure can reduce vulnerability to hazard risks. Resilience to hazard risks therefore cannot be achieved independent of good quality urban infrastructure and services.

1.1.3. Effectiveness of the coping measures in enhancing resilience to hazard risk

Coping measures are needed to guarantee that households are capable of dealing with the hazard risks. Evidence from the literature suggests a divergence of opinion on the effectiveness of the coping measures in enhancing resilience amongst households. For instance, Twerefou et al. [39] argue that the simple coping measures undertaken by households can make some contribution toward resilience to hazard risks. Twum and Abubakari [19] support this viewpoint by stating that households can use their coping strategies to inform their adaptation to hazards which eventually helps them reach a state of resilience over time. It is the belief of these authors that residents can systematically learn from their coping strategies (short-term) to inform actions with long-term impacts that reduce their vulnerability to shocks and help them reach a state of resilience to flood risk. In other words, resilience to flooding is inextricably linked to capacities, capabilities, and processes that exist on a day to day basis within the households.

While these researchers believe in the efficacy of the coping measures, others point out that the coping measures may be effective only in the short term and are ineffective in the long term. Moreover, evidence from the literature indicates that coping strategies are effective only in low-magnitude hazard risk. It is argued that the measures put in place to cope with hazard events do not necessarily build the necessary capacity for resilience [40]. Thus, coping actions may only ward off immediate risk and fail

to help in adjusting to continuous and long-term threats posed by hazardous events. It is, however, argued that building resilience to flood risk calls for an adaptive approach with short-term measures while keeping track of developments that may require adaptation in the long term. Thus, household-based actions provide opportunities to address or increase resilience to flood risk [41].

1.1.4. Strategies for developing resilience among households

Building flood resilient urban settlements in Africa requires considerable attention to and use of land. Uncontrolled and unplanned morphologies characterizing informal settlements across African cities remain a threat to building resilience [5]. Some residents in the cities in the global south are addressing the issue of resilience through informal settlements upgrading projects, whereby the necessary basic infrastructure for water, sanitation, and drainage are developed and housing structures are improved [42]. It is believed that such upgrading projects can provide the foundation into which resilience and flood risk reduction can be fully integrated. This reflects a paradigm shift from the perspective of merely coping to ward of immediate risks to long-term risk reduction strategy, which builds resilience.

2. Methods

2.1. Study area description

This study was conducted in Manyatta and Nyamasaria informal settlements (Figure 2). These two residential areas are in Kisumu city, situated between longitudes 00°06′ south of the Equator and latitudes 34°35′ and 34°55′ east of Greenwich [43]. The city is in the western part of Kenya in Kisumu County (Figure 3). It is at the eastern extremities of Lake Victoria called Winam Gulf, and bordered to the north by the Nandi escarpment, which rises to over 2000 meters above sea level; Lake Victoria to the southwest, with an elevation of about 1140 meters above sea level; and Kano plains to the east [44]. The city is divided into two topographic regions: The hilly north peaking at over 2,000 meters above sea level and the southern plains. The hilly north and the north-western part of the city is well drained, but the relatively flat lands east and south-east of the city are often exposed to extensive riverine floods [45].

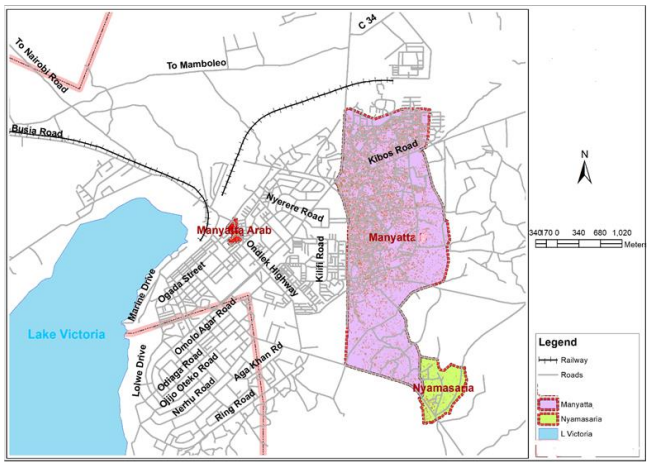

Figure 2. The location of Manyatta and Nyamasaria in Kisumu city.

Figure 3. The location of Kisumu city in Kenya. Source: https://www.worldometers.info/maps/kenya-map/.

2.2. Research design

We began with a desk study research approach where a review of the literature on the concepts of resilience, coping, and adaptation was done. Thereafter, a survey design was used to examine the response measures put in place by residents living in the two settlements.

2.3. Sample size and sampling procedure

Purposive sampling was used to select two informal settlements. The two settlements were particularly selected because they are within the low-lying plain areas of the city which are potentially susceptible to flooding. Another consideration was that the settlements developed informally with one (Manyatta) having been partially upgraded, and the other (Nyamasaria), not upgraded at all. The target population was the residents of the two settlements as well as the key informants on flood risk management in Kisumu City. The total number of households in the settlements was 36,774 [46]. The size of the sample for this study was determined by the formula given by the oft-cited Yamane (1967):

$$N_0 = \frac{N}{1+N(e)^2} \quad (1)$$

A 95% confidence level and p = 0.5 were assumed for the above formula and using the population data obtained from the 2019 census report, Manyatta, which had 24,461 households a sample size of 394 was obtained while for Nyamasaria which had 12,313 households, a sample of 387 was derived (Table 1).

Table 1. Total households and sample size.

Manyatta		Nyamasaria	
Total Households	24,461	Total Households	12,313
Sample	394	Sample	387

2.4. Source: Authors

The sampling procedure involved using transect lines, which were established parallel to the major roads. These transect lines were established with an interval of about one kilometer from each other; thereafter, a transect walk was made to determine and mark the households, and simple random sampling was used to select the households for the study. The sampling method used however, had some limitations that were attributed to non-existence of lists of houses in the two settlements. This made it quite difficult to conduct pure simple random sampling. Similarly, the organic nature of the settlements made the use of other random sampling methods to be somewhat challenging. These challenges were addressed by eliminating any form of bias and selecting, purely by chance, the number of households in the sample sizes for the two settlements.

2.5. Data collection procedure

Primary data was collected through personal interviews using a semi-structured questionnaire with the heads of the households. Four research assistants were engaged in this exercise. We ensured contents validity of the survey instruments by piloting them in Nyalenda informal settlement, which is also in Kisumu city. Key informants, including the Physical Planning Officer and the Kenya Meteorological Department officer responsible for flood monitoring, were also interviewed. Additionally, data were obtained through observations.

2.6. Data analysis

Descriptive statistics was used to analyze the primary data, and the results were presented as %ages, frequencies, and counts. For secondary data, content analysis was applied to sieve out the important information.

3. Results

Our findings reveal that more than half of the respondents in the two settlements have been staying in the area for at least 10 years or more before the date of the survey. Thus, they have spent considerable time in the two areas for them to know about recurring events like floods. In the Manyatta area, for instance, 50% of the respondents indicated that they had lived in the settlement for 10 or more years. The other 50% had lived in the settlement for periods ranging from less than a year to 9 years. Nyamasaria had a larger population of respondents (70%) who had lived in the settlement for more than 10 years. Only 30% have lived in the area for periods ranging from less than a year to 9 years.

Most (65%) of the respondents in Manyatta were tenants, with just about 35% of the respondents being homeowners. In contrast, a majority (60%) of the respondents in Nyamasaria were homeowners who either bought the land they are living on or are living on their ancestral lands. Only 40% of the

respondents in Nyamasaria were tenants. No land use plans have ever been prepared for the two settlements since they fall within an 'extended area'. The development pathway prevalent in them is that of the 'build-occupy' model as opposed to the 'plan-service-build-occupy' model envisaged in the Kenyan planning legislation. Such development model leads to the creation of settlements with infrastructure deficits. Indeed, the two settlements fit the description of [42] as those that the city government has not extended the risk-reducing infrastructure and services relevant to resilience. As such, they face particularly high risks of flooding with the responsibility of risk reduction largely falling to individuals, households and community organizations without external support.

3.1. Experience of floods in the past in the current place of residence

More than 91% of homeowners and 90% of tenants in Nyamasaria had suffered floods in the past in their current place of residence. In Manyatta, 88% of homeowners and 57% %of tenants had experienced floods in the past in their current place of residence (Table 2 and Figure 4). The majority of the tenants in both settlements who had suffered floods indicated 2008 and 2009 as the years when they suffered what they considered to be the worst inundation, while some homeowners in both settlements cited the 1997 El Nino floods as the worst inundation. There is, however, a section of respondents who indicated that floods are an annual event with just slight variations in intensity (Figure 5). Similarly, the information obtained from Meteorological Department also suggests that flooding incidences in Kisumu are annual events, albeit with variations in intensity.

Table 2. Households who have experienced floods in the past in their current place of residence. Source: Field survey.

	Home-owners			Tenants		
	Frequency	Percentage	N	Frequency	Percentage	N
Nyamasaria	211	91%	232	140	90%	155
Manyatta	121	88%	138	146	57%	256

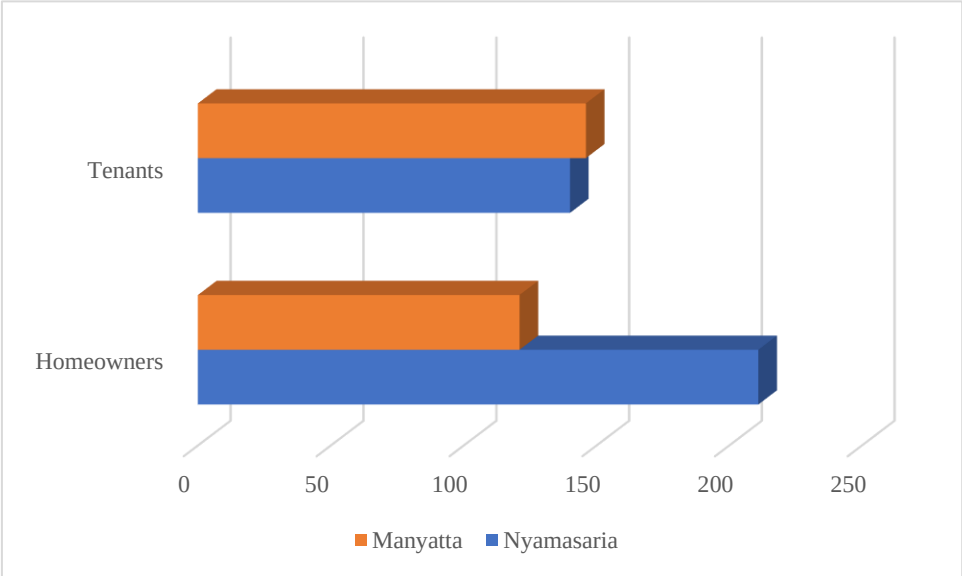

Figure 4. Experience of floods in the current place of residence.

Figure 5. Flooded church compound in Nyamasaria settlement.

From the survey, 29% of the respondents indicated that floods entered their houses. About 25% of them estimated the depth of the flood water within their houses to be more than 20 centimetres above ground level with some extreme cases where the houses got flooded up to knee length. Nyamasaria had the highest percentage of respondents experiencing high inundation depths within their houses. For example, 16% of the respondents whose houses had been inundated indicated that flood levels rose knee-high, while 14% indicated flood levels slightly above the ankle. In Manyatta, flood levels within the houses were not as high with a majority of the respondents (62%) indicating flood levels below the ankle. Literature suggest that previous experience of floods potentially influences households' decisions to undertake risk reduction measures in their places of residence. Similarly, it has been observed that in frequently disturbed areas, resilience is derived from experiencing and learning from disturbances. The implication of this past experience of floods by the households is that such disturbance precedes and lays the foundation for resilience building.

3.2. Household coping measures in the settlements

Households employ a range of portfolio of measures to reduce flood risk. The response measures were mostly structural and semi-structural and included modifications to the physical and the built environment. Nyamasaria had the highest percentage of respondents (60% of homeowners and 50% of tenants) who had experienced floods in the past, indicating that they had measures to reduce flood risk. Manyatta had 40 % of homeowners and 25% of tenants who had experienced floods in the past putting in place flood risk reduction measures (Table 3 and Figure 6). This high percentage of respondents who have measures in place in Nyamasaria could be explained by the high number of homeowners. Owner occupation carries with it notions of a specific responsibility for the property and putting in place risk reduction measures is driven by this perceived responsibility.

Table 3. Households who have put in place flood risk response measures.

	Home-owners			Tenants		
	Frequency	Percentage	N	Frequency	Percentage	N
Nyamasaria	127	60%	211	70	50%	140
Manyatta	48	40%	121	37	25%	146

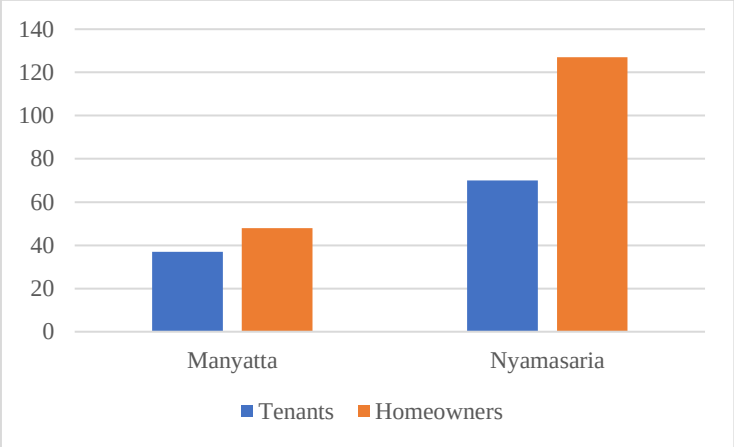

Figure 6. Households who have put in place flood risk response measures.

In contrast, the low percentage of respondents who have risk reduction measures in Manyatta could partly be explained by the relatively high number of tenants in the settlement. Tenants are relatively footloose and often shift from one residential area to another. Again, tenants lack the motivation to invest in mitigation measures because their dwellings are owned by others. This is in line with the findings of previous studies that indicate that homeowners are more inclined to adopt flood risk reduction measures as compared to households living in rented houses. Researchers like Mulligan et al. [14] observed that tenants do not have incentives to invest significantly in and around structures that they neither own or have the security of long-term rental tenure.

The relatively low numbers of households reporting taking risk-reduction measures, particularly in Manyatta, is an indication of how little the efforts to build resilience in these settlements is bearing fruit. Without taking actions, the households in these settlements will remain vulnerable to risks and suffer disproportionately whenever flooding materializes.

3.3. Digging of trenches around homes and houses to control floods

There were residents who responded to flood risk by digging trenches around houses to convey flood waters away from dwelling places. This practice was the most predominant measure in both settlements. More than 70% of homeowners in Nyamasaria who had in place risk-reduction measures, had dug trenches. In Manyatta, more than 50% of homeowners (n = 48) cited digging trenches around houses as the measure they adopted (Table 4).

Table 4. Households who have dug trenches around houses.

	Home-owners			Tenants		
	Frequency	Percentage	N	Frequency	Percentage	N
Nyamasaria	93	73%	127	29	42%	70
Manyatta	26	54%	48	16	43%	37

While a majority of homeowners had in place flood risk-reduction measures (Figures 7 and 8), fewer tenants had taken the initiative to mitigate flood risks. For example, in Nyamasaria, less than half (42%) of the respondents who were tenants and had experienced floods in the past had put in place

risk-reduction measures. Likewise, in Manyatta, 43% of tenants who had experienced floods in the past had in place this particular flood risk-reduction measure.

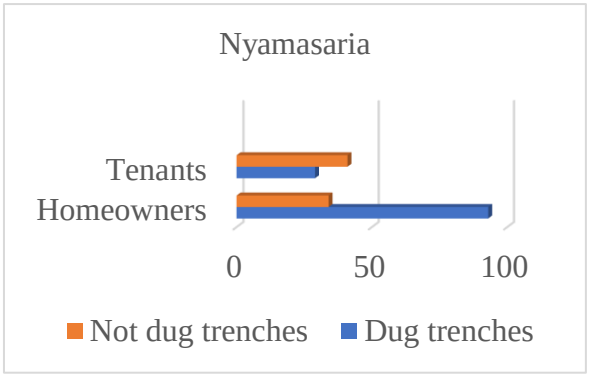

Figure 7. Digging of trenches in Nyamasaria Settlements.

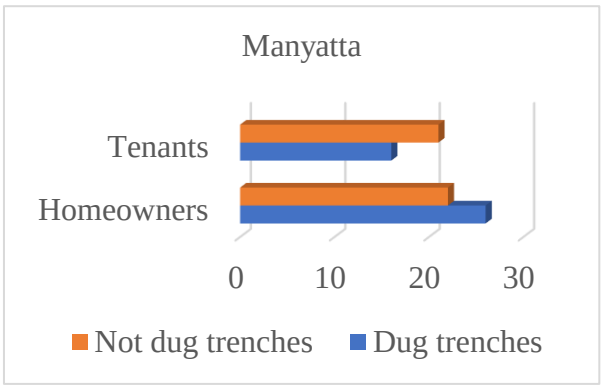

Figure 8. Digging of trenches in Manyatta Settlements.

There were cases where the dug trenches were lined with stones and concrete (Figure 9), but in other cases, the trenches did not have any lining. Trenches lined with concrete were predominant in Manyatta while Nyamasaria had trenches that were mostly without any form of lining (Figure 10).

Figure 9. A trench in Manyatta.

Figure 10. A trench in Nyamasaria.

Some residents dug the trenches during flood events with periodic maintenance done annually. Most of the respondents affirmed that the trenches were to assist in flood risk reduction just for that particular period without considering any possible future risks. When asked about the challenges faced in making the trenches, financial constraints and lack of government assistance were the main reasons cited by the households. Evidently, the trenches that were dug around the houses were not designed to accommodate the volume of floodwater generated by serious flood events. Non-conformity with the technical considerations in making trenches is likely to render them technically unsuitable for flood risk reduction.

3.4. Use of sandbags to control flood waters

Another response measure by households was the use of sandbags. In certain areas, sandbags were used to complement the dug trenches, while others used sandbags alone. The sandbags were placed next to the doors or next to walls in the direction of expected flood waters (Figures 11 and 12). Using sandbags alone to respond to flood risk was more prevalent in Manyatta than in Nyamasaria. More than 57% of the tenants who had put in place a flood risk-reduction measures indicated the use of sandbags as the only response they applied. It also emerged that more tenants than homeowners preferred using sandbags. This may be explained by the fact that the use of sandbags does not lead to any major modifications on the houses and the surroundings. Moreover, the use of sandbags is the easiest and less costly, short-term measure that can be applied to reducing flood risk. Relative affordability and simplicity of construction were the major reasons cited by residents as to why they chose to use this measure. This is consistent with the findings of other researchers [39], where the effort and materials needed and the investment required largely determines the flood risk reduction strategy chosen by a household.

Figure 11. Use of Sandbags in Manyatta.

Figure 12. Use of Sandbags in Nyamasaria.

All the respondents who indicated to have used sandbags as a flood risk-reduction measure confirmed that they often put them in place after experiencing inundation. When asked whether they put sandbags for future flood events, all the residents gave a negative response. Thus, the use of sandbags is not aimed at addressing future flood risks rather it is for ameliorating current risks. This unmasks a distinct reactionary response, and a stop-gap measure that protects the present rather than future risks. This agrees with the observation of Mulligan et al. [14], where the flood risk reduction measures were mainly done during the rainy season and were, thus, greatly reactive. Urban resilience however, advocates for the ability of the households therein to anticipate, reduce, or recover from the effects of a hazardous event in a timely and efficient manner. Thus, there is a deficit in resilience in the two settlements where the use of sandbags to reduce flood risks is reactionary rather than anticipatory. Nonetheless, the actions by these households lays the foundation upon which resilience can be built.

3.5. Retrofitting/elevating foundation or floor levels

Another response to flood risk by the residents included the buildings and involved retrofitting and/or elevating the foundation of buildings to higher levels (Figure 13). Nyamasaria had more cases of houses with elevated floors/foundations than Manyatta. In all cases, those who indicated to have

elevated the foundations of their houses were homeowners. Thus, about 6% of homeowners in Nyamasaria and less than 2% of homeowners in Manyatta had this response measure in place. The higher number of cases in Nyamasaria than in Manyatta can be explained by the high levels of home ownership in the former than in the latter. This conforms to the findings in the literature that suggest that homeowners are likely to invest in modification of their houses to reduce flood risk while tenants may be less motivated in doing so [47]. When asked why they have not considered retrofitting/elevating foundations or floor levels, virtually all the respondents who were tenants stated that the impediment is the long process of seeking and obtaining approval from the owner before making considerable changes to the building.

Figure 13. Raising of floor above flood level in Nyamasaria.

Although retrofitting and elevating the foundation of buildings is considered effective in reducing flood risk, it is also one of the most expensive risk-reduction measures, particularly for existing buildings. It usually has significant financial implications for the house owner. All the homeowners who had done retrofitting/raising of floor levels indicated that as a risk reduction measure, it is the most expensive to the residents. This is consistent with the findings of Twum and Abubakar [19] who found that the cost of raising the foundation of buildings was considered to be very high among the households concerned.

As flood risk-reduction strategy, the effectiveness of retrofitting is also in doubt. For example, about 40% of those who had raised the foundation/floor in Nyamasaria reported safety during normal floods but suffering inundation during severe floods. Nonetheless, the existence of this risk-response strategy provides an opportunity to leverage on in the process of building resilience among households in the settlements.

3.6. Relocation of households to an evacuation center

Another response strategy was the temporary relocation from the flooded areas to safe places. This entailed movement of households to an evacuation center and their return once the flood risk has subsided. This form of response was evident in Nyamasaria where about 30% of the residents who had suffered floods in the past indicated that at one time or the other they had to relocate to Rae Kanyaika

evacuation center. In this place, there is a building constructed with its floor above flood level (Figure 14). Most (93%) of those who reported having relocated to an evacuation center were homeowners with just about 7% being tenants. It also emerged that the tenants who reported to have relocated previously were households that had stayed in Nyamasaria for more than 15 years. The period of stay in the evacuation center for the relocated households ranged from one week to more than one month depending on the extent of flood inundation and damage to the house. Once the inundation subsides, the households find their way back to their houses and homes. According to the respondents, there are some challenges with relocation, including the inconvenience of moving household items to the evacuation center as well as the safety of what is left behind in the inundated houses. Relocation as a form of response to flood risk has been observed in previous studies. For example, Owusu and Obour [35] found that, during floods, some households adopt reactive response strategies like relocating to safer areas.

Figure 14. Rae Kanyaika evacuation center in Nyamasaria.

3.7. Institutional support in response to flood risk in Kisumu city

In Kenya, the direct responsibility for hazard risk management rests with both the national government and the County governments [46]. The primary responsibility for policy, guidelines, and framework legislation lies with the national government, while detailed regulation, implementation, operation, and maintenance of hazard risk management lies with the county government. Accordingly, the national government provides a broad policy framework for the country. This policy direction is consistent across all 47 counties. County governments, on the other hand, provide localized policies that are relevant to their jurisdiction and set more focused objectives or directions for hazard risk reduction.

From the key informant interviews, it emerged that Kisumu County has a County Disaster Management Committee tasked with advising the County government on matters relating to disaster management. The county has a Climate Change Policy, which has, as one of its policy measures, enhancement of the adaptive capacity of the poor urban dwellers living in informal settlements. In theory, the policy includes anticipation and preparation for impending flood events. In practice, however, flood risk reduction in the county favors and emphasizes emergency response and relief. The information obtained through document analysis and corroborated by key informant interviews reveal

a weak link between Kisumu County Government and the residents of Nyamasaria and Manyatta who are exposed to flood risk.

Another institution that is linked with the response to flood hazards in the country is the Kenya Meteorological Department (KMD). KMD principally conducts weather forecasts for the country. In the process of carrying out weather forecasts, KMD can execute flood forecasting and early warning for the entire country. The early warning released by KMD is usually not about a particular settlement, urban area, or city but about regions within the country. Content analysis of information on institutional responsibility in flood risk reduction reveals that there is a weak link between the institutions and the households in urban areas. The response to hazard risk by government institutions unmasks a typically reactionary approach that renders resilience-building completely impossible. Exposure to hazard risks like flooding receives attention only after the occurrence of the hazard with the problem being forgotten and remembered only when another one occurs.

4. Discussion

This study was conducted in two informal settlements in Kisumu City. It was found that no land use plans have ever been prepared for these two settlements. They therefore developed without any form of land use planning. The implication of this is that the development happened without the installation of flood risk-reducing infrastructure. There is near consensus in past studies that increased vulnerability to flood risk is exacerbated by a lack of infrastructure [12]. Most of the households have suffered floods in the past in their current place of residence. This conforms to the findings in the literature that suggest that households in settlements with infrastructure deficits are exposed to hazard risks [33]. This past experience of floods by households in the settlements provides an opportunity for resilience building. Authors like Liao [48] observed that flooding is an agent for resilience because each flood experience creates a chance for the households to adjust their response strategies and build knowledge.

We found out that a number of the households who had experienced floods in the past employed a range of measures to reduce flood risks. The findings, however, demonstrate that there is no collective action or centralized form of flood risk reduction in the settlements. Instead, the households rely on personal efforts rather than government interventions in responding to the flood risks. This echoes the findings of Ncube et al. [15], Okunola et al. [38], and Mulligan et al. [14] that the response actions against hazards within the cities in developing countries are largely household-based with little or no government support. Achieving urban resilience, however, calls for significant investment in risk-reducing infrastructure, which requires government intervention. However, the residents have been left to their own devices in responding to the risk and are constrained in making large-scale infrastructure investments due to a lack of resources and capacity at the household level. This is consistent with the findings of Twum and Abubakar [19] who found that governments do not provide flood risk-reduction infrastructure to households in informal settlements. It should however be noted that despite the backlog of demand for risk-reducing infrastructure the households continue to live in the settlements. This reality echoes the concept of resilience by Zevenbergen et al. [41] as the notion that residents learn to live with floods and mitigate only disastrous consequences and do not seek to avoid them entirely. Indeed, resilience is conceptualized by authors like Liao [48] as the capacity to remain in a desirable regime while experiencing floods. Thus, some form of inherent resilience can be inferred even with the trunk infrastructure deficit.

The flood risk-reduction measures put in place by households were structural and semi-structural and included modifications around the homes and, in some cases, on the house. Nonetheless, they were a motley of individual approaches and private efforts, characterized by the pursuit of immediate fixes aimed at protecting life and property during flood events or in the immediate aftermath. This finding resonates with those of a study by Okunola et al. [38] who found that households adopt reactive response actions that occur after the hazardous events have been experienced. It has, however, been observed by researchers that household coping measures may yield some positive results and provide a foundation upon which resilience can be built.

Moreover, response measures were heavily dependent on the tenancy of the residents. Tenure influences the occupants in taking responsibility for making changes in and around their houses to reduce flood risk. While homeowners have the right to make alterations in the buildings, tenants are usually more restricted. This is consistent with the findings of previous studies such as Twerefou et al. [39] and Mulligan et al. [14] who concluded that house owners are more likely to adopt more response strategies as a protective measure against their properties than tenants who have little stake in the housing property.

Another risk reduction action is temporary relocation to an evacuation center for a period ranging from a few hours to several weeks, and included the return of the affected households to their houses once the inundation subsides. This risk reduction strategy, however, gives only the affected households some immediate, short-term relief but fail to address the underlying flood risk. This corroborates the findings of [34] who found that relocation provides a short-term relief rather than a long-term solution to the flood risk. It can thus be argued that temporary relocation as a form of flood risk-reduction measure is a failure of *in situ* adaptation. Nonetheless, this coping measure assists in the process of returning from a flood-impacted state to the normal state and that is one of the tenets of resilience.

Even though the household response measures are in place, respondents reported experiencing floods as almost an annual event. It is arguable that these measures could be addressing only immediate flood risks but are insufficient for long-term adaptation purposes and guaranteeing resilience. This is consistent with the findings of Amoako [36] who observed that such responses merely reduce the effects of flood hazards but do not eliminate them. Therefore, this calls for interventions that can help reduce vulnerability to flood risk and strengthen resilience.

5. Conclusion

We sought to find out about the measures put in place to respond to flood risk by the residents of Nyamasaria and Manyatta. The results indicate that a number of households have taken deliberate steps to cope with the recurrent flood incidences. However, these measures are reactive in nature with very little government or other external intervention. The actions have failed to eliminate flood risk and guarantee resilience. The ineffectiveness of these measures is evident in the continued flooding of houses in the two settlements. Despite the continued flood risks, the households' coping measures have enabled them to survive and thrive no matter the shocks and stresses brought about by the perennial flood events. This ability to live with the disturbances and disasters provides a viable starting point for mainstreaming resilience to flood risk among these households in Manyatta and Nyamasaria. Households' resilience to flood risk cannot be built in a vacuum, and the coping measures provide the foundation for resilience in the two settlements.

6. Recommendations

There is a need to upscale the flood resilience of the residents in Manyatta and Nyamasaria. One way of building resilience is through implementing comprehensive risk-sensitive upgrading programs. Upgrading entails provision of infrastructure and services and improving the quality of housing structures. This upgrade can be done through cooperation between households in the settlements (both owner-occupiers and tenants); the Kisumu County government; and the National government and other development partners like UN Habitat [49]. It is only when households' efforts are supported by the government that effective adaptation that boosts resilience is possible. The national government in collaboration with the county government can initiate the affordable housing projects, first by installing infrastructure and utilities, and thereafter working with land and/or structure owners to improve their houses.

Such upgrading will assist in the improvement of housing in the two settlements through retrofitting to guarantee flood-resilient design of buildings. Such improvement would require expert input by architects and engineers to achieve the resilience standards so desired. It is further suggested that buildings in these two settlements be constructed with raised plinths using durable building materials. This way, water cannot enter houses during normal floods. It is also noted that upgrading is anticipatory as it builds resilience to future disasters.

There is also a need to shift focus to pre-emptive prevention considering the unpredictability of flood events. One way of doing this is to avoid locating in flood-prone areas. Thus, we advocate for the application of risk-sensitive urban planning by the Kisumu County government, where development control instruments would be used to limit development in flood risk areas. The County government, together with the residents of the flood-prone areas, can jointly prepare flood risk maps detailing high-risk areas where residential development should not be permitted and low-risk areas where risk-sensitive developments are allowed. Thus, there is the need to integrate urban flood resilience into Kisumu city laws, rules, and regulations. Such integration is necessary to make sure that resilience actions and measures are recognized and implemented.

Use of AI tools declaration

The authors declare they have not used AI tools in the creation of this article.

Conflict of interest

The authors declare no conflict of interest.

Author contributions

Adoyo Laji was responsible for the conceptualization, methodology, data collection and writing of the draft article. Dr. Jeremiah Ayonga was responsible for supervision, review and editing of the write-up.

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