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Post-Disaster Housing Reconstruction: Flood Resilience in Suburban Area

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ABSTRACT

This research demonstrates the concept of disaster resilience in suburban communities that are vulnerable to floods with a comparative analysis research technique that involves a literature review examining existing research on flood resilience, urban and rural building techniques, and post-disaster housing reconstruction. Literature review to understand the characteristics of infrastructure repair and upgrade in suburban areas in different regions and different development levels that are vulnerable to flooding and affected communities and identify the mitigation strategies in the fields of disaster management, architecture, engineering, and culture to ensure the durability and stability of infrastructural structures from disaster in conserving the cultural heritage of Kogi state communities towards achieving sustainability.

INTRODUCTION

The United Nations Disaster Risk Reduction (UNDRR) describes post-disaster as a time when a disaster has already occurred and the government is involved in rescue activities Wannous and Velasquez (2017) or the aftermath of a disaster. The major activities in the post-disaster phase include rehabilitation, reconstruction, and recovery. Build Back Better (BBB), is defined by the United Nations International Strategy for Disaster Reduction (UNISDR) as "The use of the recovery, rehabilitation, and reconstruction phases after a disaster to increase the resilience of nations and communities through integrating disaster risk reduction measures into the restoration of physical infrastructure and societal systems, and into the revitalization of livelihoods, economies, and the environment".

Post-disaster housing reconstruction (PDHR) is multifaceted, undefined, and multi-stage that includes multiple actors and agencies in different dimensions, the approach of achieving resilient reconstruction houses to build back better involves architects, engineers, builders, project managers, construction companies, and government agencies. The sustainable reconstruction and recovery framework helps communities to BBB across the globe, turning challenges into opportunities. Research into local heritage and cultural practices and inspiring case studies has enabled the development of principles and an actionable framework for sustainable reconstruction around the globe (Amaratunga & Haigh, 2011).

Disaster Resilience is the ability to cope under pressure or the ability to adapt and respond to changing conditions while maintaining functionality, (UNISDR) also defines urban resilience as the ability of a city exposed to hazards to resist, absorb, accommodate, and recover from the effects of the hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions (UNISDR) in the rural perspective Rural resilience refers to the capacity of a rural region to adapt to changing external circumstances in such a way that a satisfactory standard of living is maintained while coping with its inherent ecological, economic and social vulnerability (Heijman *et al.*, 2019).

In cooperating urban and rural areas, suburban communities emerge, where Suburban areas are lower-density areas that separate residential and commercial areas from one another. They are either part of a city or urban area or exist as a separate community within commuting distance of a town (vocabulary definition). Suburban areas have some architectural features in building materials where some of the buildings are made of Concrete, wood, steel, plastic, stones, textiles, and glass, while some are made of lime plaster bricks mud, and mortar, these unique features can be particularly vulnerable to natural disasters, especially flooding (Eires *et al.*, 2014).

Flooding occurs due to slope (topography levels), rainfall intensity (climate change), distance to rivers (coastal areas), or even dam release (Njoku *et al.*, 2020). Nigeria is a country in West Africa, which suffers from the major effects of climate change caused by flood events. The country Shares a border with water bodies like Lake Chad towards the northeast and the Atlantic Ocean on the south with two major rivers (river Niger and river Benue) that flow within the country (Olayinka-Dosunmu *et al.*, 2022). Kogi state is one of the states that the two major rivers pass through making it the confluence state. The study will focus on Kogi state flood areas in finding solutions to cascading effects for the reoccurrence of the same problems in the long-term recovery reconstruction process and providing a necessary solution approach through comparative analysis in similar cases.

LITERATURE REVIEW

Work Case

This case is selected based on its geographical region,

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located in the western part of Africa sharing a border with the Atlantic Ocean from the southern part of the country. The types of disasters in the use case area are drought, and flooding, where flooding is a reoccurring event that is majorly attributed to climate change. Kogi State is among the high-flood risk zones in Nigeria (Figure 1) primarily due to the two major rivers (the Niger & Benue Rivers) passing through it, according to the article "Understanding Flood Vulnerability in Local Communities of Kogi State, Nigeria" (Ozedele *et al*., 2022). The authors analyzed that most of the selected communities in Kogi state based on flood vulnerability, are exposed to 90 % impact from flooding events. Areas such as Ogba Ojubu, Onzedega, and Odogwu of Ibaji local government and their settlements are jointly exposed. Furthermore, the urban areas within the city and the out sketch slums faced similar flooding risks. Moreover, the intensity of the damage (Figure 2) from floods can be linked to the building types of traditional hamlets that consist of mud-thatched roofs, and their agricultural activities of farming and fishing, which has a major influence on their settling close to the river banks (Oyedele *et al*., 2022).

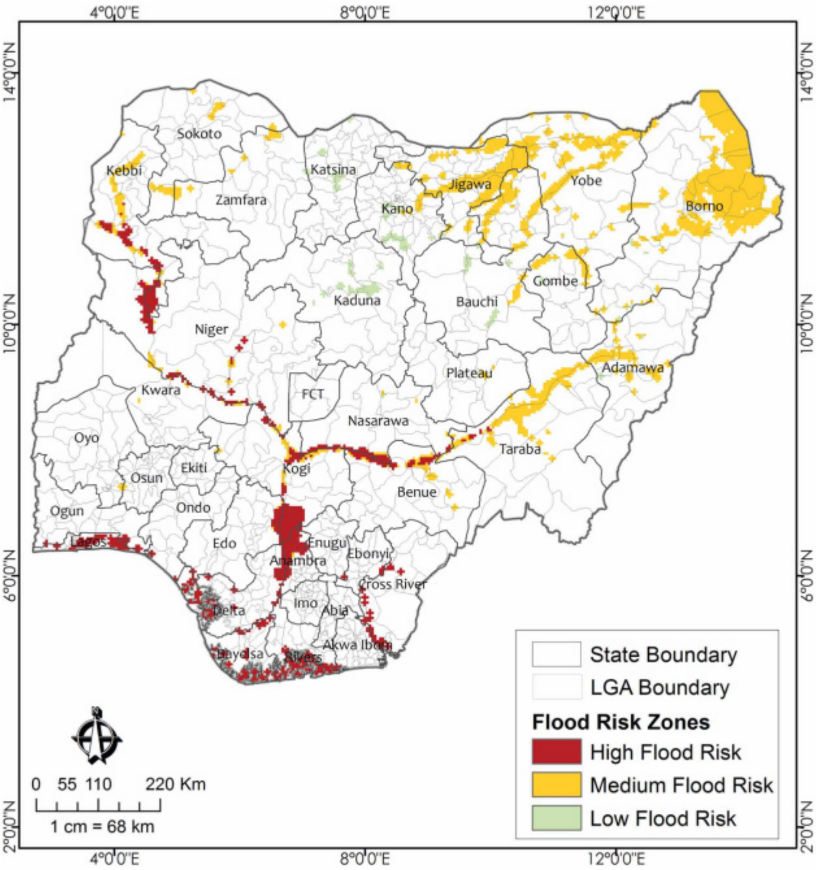

Figure 1: Map showing the level of flood risk zones in Nigeria (Njoku *et al*., 2020).

According to the DTM (displacement tracking matrix) under IOM UN migration describes IOM NIGERIA flood assessment (15 November 2022), the annual flood in Kogi state between 28th October and 1st November in collaboration with the National Emergency Management Agency (NEMA), the Kogi state emergency management agency (KGSEMA) and the Nigerian Red Cross Society (NCRS) quantify flood-affected population to be 472,218 within (9) local government areas (LGAs) Ibaji, Lokoja, Kogi, Ajaokuta, Bassa, Idah, Ofu, Igalamela-Odolu and Omala where the highly affected area with the number of 133,395 individuals was Ibaji LGA (IOM Nigeria, 2022).

IDPs that were living in the camp-like settings were 50,275, the number of persons living with disabilities was 599, the number of affected houses was 39,510, no of houses destroyed was 29,278, the number of houses not affected was 19,300 (IOM Nigeria, 2022) the types of shelter in the flood zone were quantified as shelters habitable but need repair 27 %, shelters partially damaged but need repairs 18 %, shelters destroyed were33 %, and shelters habitable but don't need repairs 22 %. In building type, the brick/block shelters are 71 %, self-made/makeshift shelters 22 %, and no shelter 7 %.

Most of the buildings in the flood areas were not developed according to the master plan some of them are designed in unplanned areas where residential buildings are not in the master plan, as stated in Adaji *et al.* (2024) according to their study of inadequate land-use planning, unregulated development of disaster-prone areas, and neglect of building codes were among the causes of flooding in Ibaji LGA. Nwigwe and Emberga (2014) established that illegal structures across drainage channels, erosion passages, inadequate drainage channels, collapsed dams/ embankments, and bridges (O & W, 2012) The Nature of the terrain and poor waste management were the major causes of floods in that area.

Figure 2: Past flood intensity in Kogi state (Shanono *et al.*, 2023)

The halfway execution of assistance in recovery to the poor dominant areas as politicized can lead to the reoccurrence of flooding in the same area by allowing the communities to complete the project on their own the use of low building standards is definite, as reported in (Adaji *et al.*, 2024) that the efforts to reconstruct houses for the beneficiaries in the event of floods have not yielded the desired result. Survivors in the flood-impacted areas are left confronting the significant challenges of recovering Ibaji (LGA) poorer residents from disasters as a result of the lesser capacity and fewer resources to prepare and recover (Adaji *et al.*, 2024).

Case 1

Kerala is among India's most developed states in terms of social fairness, governance, the Physical Quality of Life Index (PQLI), and religious harmony. With the August 2018 flood, it faced a catastrophe of enormous proportions. According to weather experts, it was the worst to hit the state in nearly a century, causing significant damage to all aspects of society. The flood that occurred in 2018 has been recorded as the most devastating catastrophic event compared to other flooding events that occurred in the consecutive years 2019, 2020, and 2021 (Vijayachandran & Singh, 2023).

In the field of building standards in Kerala widespread flooding in urban and suburban areas of Kerala has reaffirmed the absence of risk-informed urban planning, non-compliance to building design standards, and non-inclusion of resilient features in urban infrastructure. Incorporating flexible adaptive engineering and cost-effective disaster-resilient principles will improve the long-term sustainability of the reconstructed critical public infrastructure. There is a need to maximize the efficiency of scarce public investments in the development of infrastructure and delivery of services M and Philip (2022) government has also implemented a comprehensive flood recovery plan that includes reconstructing damaged homes using flood-resistant materials and techniques.

The traditional architecture of Kerala is significantly influenced by its specific climatic conditions, wood abundance, and unique community structure there was also a change in the preference from traditional wooden structures to reinforced concrete buildings. Contemporary houses in Kerala are predominantly concrete buildings built for and occupied by single families, which has resulted from the change in the familial structure (Choorapulakkal *et al.*, 2024).

Case 2

In the case of La Guérinière town France, which is boarded by the Atlantic ocean it's a coastal area that is open to flood a study was carried out on Vulnerability and costs of adaptation strategies for housing subjected to flood risks where it has been analyzed that coastal flooding along the Atlantic coast caused by Storm Xynthia killed 41 people where it is ironed out that the location and residential housing there are the main factors that contributed to the vulnerability of people To mitigate the situation a strategic solution was given based on protection, relocation, housing architectural adaptation, preventive warning, and evacuation, four strategies were identified to reduce the vulnerability of houses for people

(i) Protection with the reinforcement and increased height of existing flood defenses,
(ii) Retreat of buildings most at risk of flooding,
(iii) Housing architectural adaptation, and
(iv) Preventive warning and evacuation (Creach *et al.*, 2020).

The French government decided to implement a "black area policy" which involved demolishing houses located in areas of high flood-risk areas. This measure was criticized for its hasty implementation, the criteria used to delineate the black areas, and its high cost. The "black areas policy" involves expensive 'relocation' in the short term but is nonetheless effective in protecting human life against coastal flood risks. Nevertheless, several questions concerning the potential implementation were questioned as the French stakeholders regarded the risk as being sufficiently low to warrant continued urban development, (Creach *et al.*, 2020) even though Storm Xynthia in 2010 led to 41 fatalities caused by drowning Notably 93% of deaths occurred in residential buildings. Alternative measures include, the elevation of flood defenses should increase to protect vulnerable areas instead of demolishing houses and relocating people. In addition, single-story houses could be equipped with a "shelter floor".

MATERIALS AND METHODS

This research employed a comparative approach in analyzing similar case studies in the Kerala flood, India, and La Guérinière town France affected by storm Xynthia. to identify post-disaster housing recovery and reconstruction of the affected infrastructures and existing studies on each case to suggest strategies for enhancing coping mechanisms and mitigation strategies that can be applied in West Africa Kogi State, Nigeria. This process involves a systematic method using the top-down approach (Figure 3) to achieve the concept of "the deeper it goes the wider the achievement Yi *et al.* (2020)" by extracting the infrastructure failures and upgrades of the three cases and defining each infrastructure according to its context and categorizing the vision into a level of progress and defining it to achieve the level of infrastructure resilience of each case and comparing it to provide infrastructure resilience progress pattern (Figure 4) that can be applicable in place of another, providing insights, and proffering actionable strategies and recommendations.

Data Collection

Data were collected through site visits to Google Scholar, Research Gate, Science Direct and other Google search articles where English is the default language to specify using ARE, OR, NOT by putting in the keywords and related synonyms to capture the area of concentration, by customizing the year range 2010 to 2024 to get recent information, Article type were research articles, reports and relevant books by typing in the keywords and related words to capture focus and ensure in adding "scientific journal" to be precise.

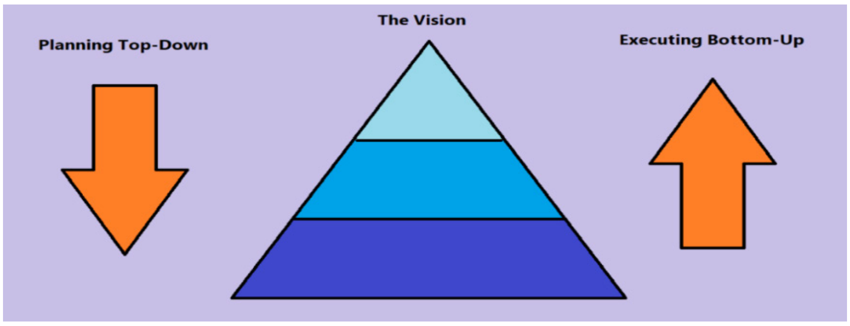

Figure 3: Top-down/Bottom-up approach (Rivera, 2019)

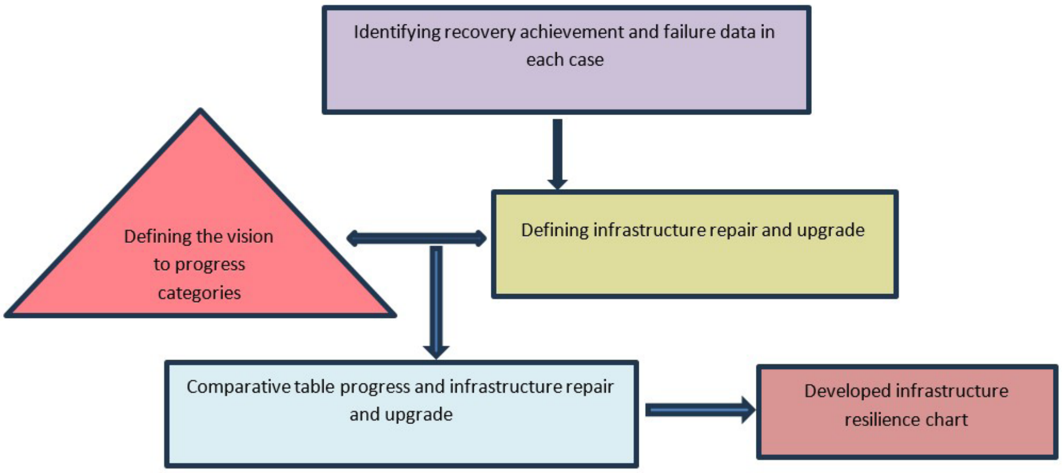

Figure 4: Showing the methodology flow

RESULTS AND DISCUSSION

Analytical Approach

In this area, the three cases Kogi, Kerala, and La Guérinière will be analyzed by identifying the post-disaster housing reconstruction and recovery achievement and failure in the infrastructure aspect of each case using the top-down approach will be applied to achieve the concept of (Yi *et al.*, 2020)". Using the "worse", "same", and "improved" categories as the vision against the "infrastructure repair and upgrade" sector to serve as the difference that will help us reach the final rating in average progress using Table 1 below.

Table 1: Shows the recovery achievement and failure data in each case

Work case	Case 1	Case 2
Developments not by the master plan	Absence of risk-informed urban planning	Protection with the reinforcement and increased height of existing flood defenses

Halfway recovery execution	Non-compliance with building design standards	The retreat of buildings most at risk of flooding
Poor use of standard building codes	Non-inclusion of resilient features in urban infrastructure	Implementing housing architectural adaptation
Illegal structures across drainage channels	Government engagement in the implementation of flood recovery plan in reconstruction	High risk of residential areas along the coast
Increase in slump areas		Preventive warning, and evacuation

Infrastructure Repair and Upgrade Defined

- Building elevations: repair or need to change elevations in the building.
- Building planning: drainage system, wastewater sewage, roads, and walkways.
- Reconstruction: rebuild of demolished or destroyed houses.
- Relocation: changing the location of an existing building to another location.
- Track recovery progress: ensuring building contracts are executed.
- Natural barriers: restore wetlands and other plants to help absorb flood water.
- Building code: ensure the use of resilient materials against flood.

Progress Categories Defined

- Same: the same as it was before the disaster.
- Worse: worse than it was after the disaster.
- Improved: rapid positive change after the disaster.

Table 2: Comparative table of Infrastructure repair and upgrade against Progress categories

	Work case	**Case 1**	**Case 2**	
Relocation				Worse
	▲	▲		Same
			▲	Improved
Reconstruction				Worse
	▲			Same
		▲	▲	Improved
Building elevations				Worse
	▲			Same
		▲	▲	Improved
Building planning	▲			Worse
		▲		Same
			▲	Improved
Track recovery progress	▲			Worse
				Same
		▲	▲	Improved
Building codes	▲			Worse
				Same
		▲	▲	Improved
Natural barriers	▲			Worse
		▲	▲	Same
				Improved

From the comparative table, we developed a chart analyzing the case of "work case against case 1" and "work case against case 2" to know the level of improvement needed in the used case by converting the progress categories into figures using the probability formula If "worse" 2 > 0 < 2.5 > 2 ≠2.5, if "same" 3 > 2, 1, 0 < 3.5 > 3 ≠ 3.5, if "improved" 4 > 3, 2, 1, 0 ≤ 4.5.

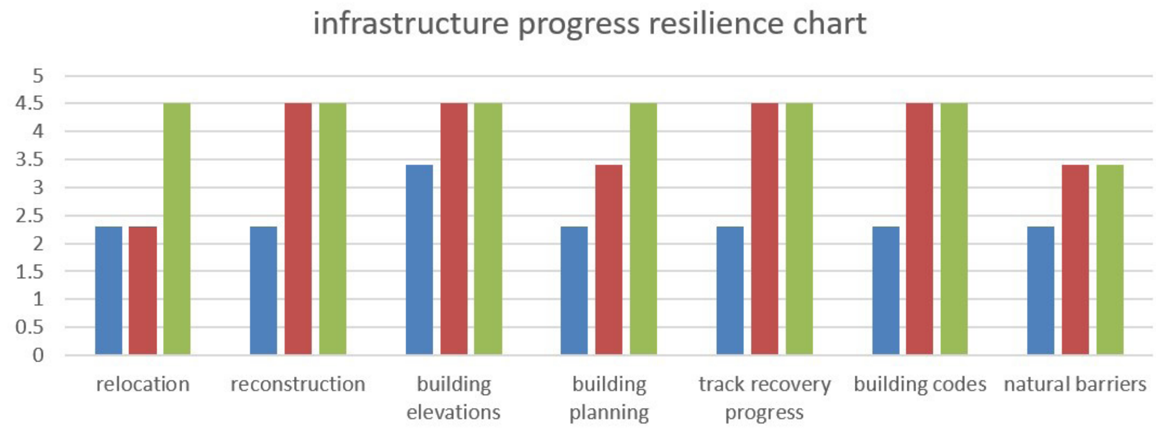

Figure 5: Chart showing the infrastructure progress resilience level in each case

Discussion

From the infrastructure progress resilience chart, we were able to see the difference in each case and know where efforts need to be improved, in the work case the result shows that there is a need for improvement in building elevation, and a high demand for improvement in relocation, reconstruction, tracking recovery progress, building planning, building codes, and natural barriers. For case 1, improvements are majorly focused on relocation, building planning, and natural barriers. For case 2 there is a positive change in their infrastructure repair and upgrade except for the natural barrier which has not been modified.

From the result, the case that tends to be more vulnerable is the work case, the need for emphasis on tracking recovery progress in the context of "understanding and ensuring building contracts are executed" needs to be monitored from the initial stage to the completion stage it is advisable to use a "monitoring evaluation accountability and learning (MEAL) system for a successful project in an organization where it helps in providing data and assessments without leaving any loophole in achieving a goal.

Building planning and elevations considering building standards Include the site plan, roads, drainages, water and waste sewages, mechanical and electrical fittings M&E, units and building functionality, neighborhood, and proximities, and building material following building codes. This needs to be considered by improving the quality and ensuring it is up to standard with close supervision.

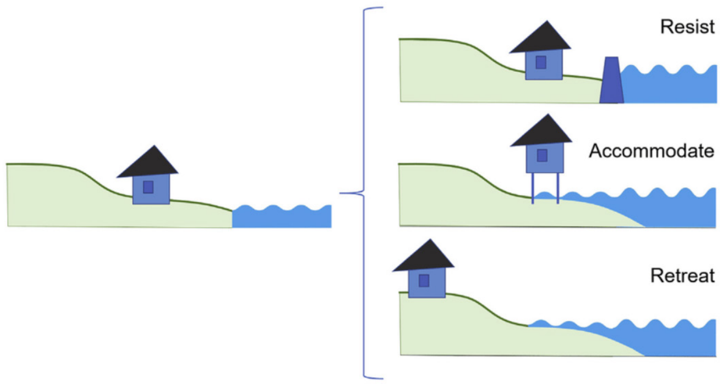

Figure 6: Diagram showing adaptation strategies on buildings (extracted from Danladi *et al.*, 2024).

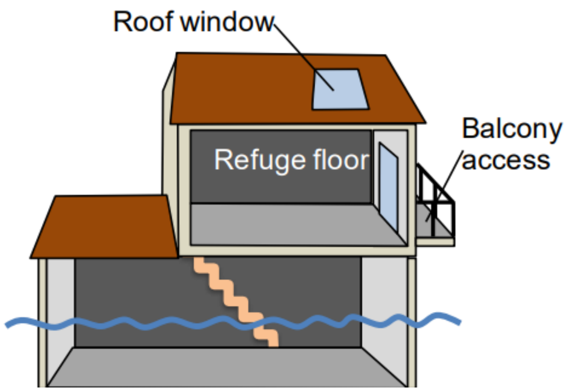

Figure 7: Diagram showing building elevation technique in flood resilience (Creach *et al.*, 2020)

Adopting the method (Figure 6) of Resistance; planting grasses helps absorb water and restore the wetland, Planting trees along the river or building retaining walls can also serve as barriers against flood. Retreat; Changing the location of the building is necessary if proximity to water is thin as in Storm Xynthia "The black area policy" was implemented. Accommodate; creating gaps between the ground level and the floor of a building or building basements (Figure 7) that have a connection to the upper floor for easy escape access in case of flood emergency can also improve resilience.

RECOMMENDATION

This research has universal significance and offers practical solutions for other cities, especially in low-developing countries with similar disaster and environmental contexts. Although this study concentrates specifically on resilience in reconstruction and recovery areas, the findings could be more broadly applicable in legal and law-making policy and post-disaster recovery cost implications, especially in low-lying regions where frequent floods occur. This study contributes to the theoretical understanding of community-based resilience in flood-prone areas. Where it has concentrated on cases of the Kerala flood in India, and Storm Xynthia in La Guérinière France, this study supplements the growing collection of literature in relevant fields. The solutions and lessons from the Kogi state case study could substantially contribute to creating more resilient communities. In addition, the focus on mitigation approaches and sustainable land-use practices can be adopted as best practices in flood risk management.

CONCLUSION

Flooding cannot be completely avoided, but damages from severe flooding can be reduced if an effective flood prevention scheme is implemented. Mitigation is hence the cornerstone of emergency management. Achieving the sustainable development goals (SDG) goal 11 "make cities and human settlements inclusive, safe, resilient and sustainable" which means ensuring access to safe and affordable housing, upgrading slum settlements, creating green space, and improving urban planning and management", by integrating disaster risk management into architecture UN-Habitat focuses on "promoting transformative change in cities and human settlements through knowledge, policy advice, technical assistance, and collaborative action to leave no one and no place behind"(Pearson & Pelling, 2015) towards achieving SDG goal 11.

Post-disaster housing reconstruction that promotes flood resilience is crucial for not only mitigating these risks but also improving the quality of lives and preserving these cultural assets and the well-being of their inhabitants to ensure safety (Onyima, 2016).

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