
THE ARCHITECTURAL DESIGN OF DISASTER RESILIENT HOUSES AS THE
DETERMINANT OF BUILDING SUSTAINABILITY AGAINST ENVIRONMENTAL HAZARD IN
AKWA IBOM STATE

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ABSTRACT

The architectural design of disaster-resilient houses plays a critical role in determining building sustainability against environmental hazards in regions like Akwa Ibom State. This study provides an overview of the key concepts, features, and impacts pertaining to the study. The study highlights the significance of adopting resilient housing design principles to mitigate the impact of natural disasters such as flooding, erosion, and storms, which are prevalent in the region. By integrating principles of resilience, sustainability, and community engagement into architectural practices, houses can be transformed into robust structures capable of withstanding the forces of nature while ensuring the safety and well-being of occupants. The study emphasizes the importance of understanding the environmental vulnerabilities specific to Akwa Ibom State, including its proximity to the Atlantic Ocean, low-lying topography, and susceptibility to tropical storms and hurricanes. Against this backdrop, the need for proactive measures to enhance building resilience becomes evident. Principles of disaster-resilient housing, including risk assessment, structural integrity, adaptive design, resource efficiency, and community engagement, are discussed as essential components of sustainable building practices. The study concludes that by embracing principles of resilience, sustainability, and community engagement, architects can contribute to the creation of homes that not only withstand the challenges posed by natural disasters but also promote the long-term well-being and prosperity of communities. One of the recommendations was that the government in Akwa Ibom State should prioritize the integration of disaster resilience criteria into building codes and regulations.

KEYWORD: Architectural Design, Disaster Resilient Houses, Building Sustainability and Environmental Hazard

INTRODUCTION

The architectural design of disaster-resilient homes becomes increasingly important in light of the growing environmental risks, especially in areas like Akwa Ibom State. Akwa Ibom State, located in Nigeria's Niger Delta, is prone to a number of natural disasters, such as storms, erosion, and flooding. The need for resilient housing design is paramount to mitigating the impact of these hazards and ensuring the long-term sustainability of the built environment (Odufuwa & Nduka, 2017). Initially, it is

imperative to comprehend the environmental vulnerabilities of Akwa Ibom State. The state's close proximity to the Atlantic Ocean renders it vulnerable to tropical storms and hurricanes, which can cause extensive damage to homes and infrastructure. Furthermore, the region's low-lying topography makes flooding more likely, particularly during the rainy season. In light of these factors, the architectural design of houses assumes a crucial role in safeguarding structures against these hazards and guaranteeing the safety and well-being of inhabitants.

Moreover, the concept of disaster resilience in architectural design transcends mere structural robustness; it encompasses holistic approaches that integrate environmental, social, and economic considerations. In Akwa Ibom State, this entails adopting sustainable building practices that minimize resource consumption, reduce carbon footprints, and enhance community resilience. By incorporating principles of green architecture, such as passive design strategies, renewable energy systems, and efficient water management, architects can create homes that withstand environmental hazards while promoting sustainability (UN-Habitat, 2018). The role of local knowledge and indigenous building techniques cannot be overlooked in designing disaster-resilient houses in Akwa Ibom State. According to Adebayo (2019), Indigenous communities often possess valuable insights and traditional building methods that are adapted to the local environment and resilient to natural disasters.

Additionally, collaboration among various stakeholders, including architects, engineers, government agencies, and local communities, is indispensable in advancing disaster-resilient housing design in Akwa Ibom State. The architectural design of disaster-resilient houses stands as a cornerstone of building sustainability in Akwa Ibom State, offering a proactive approach to mitigating the impact of environmental hazards and fostering resilience in communities (International Federation of Red Cross and Red Crescent Societies, 2019). By embracing principles of sustainability, integrating local knowledge, and fostering collaboration, architects can contribute to the creation of homes that not only withstand the forces of nature but also promote the well-being of residents and the long-term viability of the built environment.

CONCEPT OF ARCHITECTURAL DESIGN

Architectural design is considered the basis and the first phase before bringing the idea to reality. Architectural design contains a diverse range of disciplines that focus on more than just construction. According to Moenning (2023), architectural design is broadly defined as the planning of structures that focus on functionality and aesthetics to create a suitable experience for the user or client. Because this field strictly concentrates on a structure's design process, an architectural designer is typically responsible for the process, but architects can also fill this role.

Anna (2023) mentioned that architectural design is defined as a domain that covers and establishes the needs and bases required to create a living space using specific equipment and ingenuity. The purpose is to conflate the technological and the aesthetic. An architectural design represents an abstract idea that serves as the guiding principle and core identity of a project.

Architectural design is a discipline that focuses on covering and meeting needs and demands to create living spaces using certain tools and, especially, creativity. Therefore, the aim is to combine the technological and the aesthetic, despite the general

belief that architecture is only a technological task. In the same way, it mixes design, understood as the creative process, and architecture, which is based on the creation and presentation of solutions at a technical level. By mixing both disciplines, architectural design seeks the values and formal qualities of the works through spatial experiences (MCH, 2020). Architectural design is a technological and artistic concept of designing or fabricating structures and understanding various building materials and forms. Generally, the architect works in coordination with the internal and external environment of the structure, but when designs go against human tastes and cultural preferences, the result is disastrous (Arcvertex, 2018).



Fig. 1: architectural design

CONCEPT OF DISASTER RESILIENT HOUSES

Resilience in the housing sector has become an urgent need in the development of the performance of the housing system to continue to meet the housing needs in the housing market through a set of measures that increase their resilience to risk (Mesquita & Kós, 2017). Disaster resilience is defined as the ability of a community or a system to prepare for, respond to, recover from, and adapt to the impacts of disasters (Sou, 2019). It involves minimizing the loss of lives, assets, and livelihoods while enhancing the capacity to withstand and bounce back from the adverse effects of disasters.

Akabogu (2023) stated that disaster resilience is the practice of designing buildings that can withstand and quickly recover from various hazards, including natural disasters such as earthquakes, hurricanes, and floods, as well as human-made threats such as terrorist attacks and cyberattacks. It involves the use of robust materials, advanced engineering techniques, and intelligent design to create structures that can resist damage and maintain functionality even under adverse conditions. Disaster-resilient houses encompass a holistic approach to designing and constructing homes that can withstand various hazards, including earthquakes, floods, hurricanes, tsunamis, and wildfires, while ensuring the safety and well-being of occupants. Disasters, whether natural or human-made, pose significant threats to communities worldwide, resulting in loss of life, destruction of property, and disruption of livelihoods (UNDRR, 2019). Disaster-resilient houses represent a paradigm shift in the approach to housing design and construction, emphasizing proactive measures to reduce vulnerability and enhance resilience to disasters. Resilient housing initiatives contribute

to building safer, more sustainable communities resilient to a range of hazards (FEMA, 2018).



Fig. 2: disaster resilient house

CONCEPT OF BUILDING SUSTAINABILITY

Central to the concept of sustainable development is the recognition of the interdependence between environmental, social, and economic factors. This understanding acknowledges that environmental degradation, social inequality, and economic instability are interconnected issues that must be addressed collectively. The Sustainable Development Goals (SDGs), adopted by the United Nations in 2015, provide a comprehensive framework for advancing sustainable development by addressing a wide range of interconnected challenges, including poverty, hunger, health, education, gender equality, clean water and sanitation, affordable and clean energy, decent work and economic growth, industry, innovation and infrastructure, reduced inequalities, sustainable cities and communities, responsible consumption and production, climate action, life below water, life on land, peace, justice, strong institutions, and partnerships for the goals (United Nations, 2015). Achieving sustainable development requires a transformational shift in the way societies produce and consume goods and services. This entails promoting sustainable patterns of consumption and production, transitioning to renewable energy sources, investing in green infrastructure, and adopting sustainable agriculture and forestry practices. The private sector plays a crucial role in advancing sustainable development through corporate social responsibility (CSR) initiatives, sustainable supply chain management, and investments in environmentally friendly technologies. Governments also play a critical role in creating enabling policy environments, providing incentives for sustainable practices, and regulating industries to ensure compliance with environmental and social standards.

Key principles underpinning sustainable development include the precautionary principle, which advocates for taking preventive action in the face of uncertainty to avoid potential harm to the environment and human health (UNEP, 2021) the polluter-pays principle, which holds polluting parties responsible for the costs of environmental damage they cause (OECD, 2022) and the principle of intergenerational equity, which emphasises the obligation to consider the needs and interests of future generations in decision-making processes (WCED, 2016).



Fig. 3: building sustainability

CONCEPT OF ENVIRONMENTAL HAZARD

Environmental hazards encompass a wide range of threats to human health and the natural world, arising from various sources such as pollution, natural disasters, and human activities. These hazards pose significant risks to ecosystems, biodiversity, and human well-being, highlighting the need for effective mitigation and adaptation strategies. One of the most pressing environmental hazards is air pollution, which results from the release of harmful gases, particulate matter, and chemicals into the atmosphere. Sources of air pollution include industrial emissions, vehicle exhaust, and agricultural activities, contributing to respiratory diseases, cardiovascular problems, and premature death (WHO, 2016).

Pollution is another critical environmental hazard, with contaminants such as chemicals, heavy metals, and pathogens compromising the quality of freshwater sources. Industrial discharge, agricultural runoff, and inadequate wastewater treatment are major contributors to water pollution, endangering aquatic ecosystems and threatening human health through waterborne diseases and exposure to toxic substances (UNEP, 2016). Natural disasters, such as hurricanes, earthquakes, floods, and wildfires, pose significant environmental hazards with devastating consequences for communities and ecosystems. Climate change has intensified the frequency and severity of these events, leading to widespread displacement, loss of life, and ecological disruption (IPCC, 2021).

Human activities such as deforestation, habitat destruction, and land degradation also contribute to environmental hazards by disrupting ecosystems and accelerating biodiversity loss. Deforestation, driven by agricultural expansion, logging, and urbanization, not only diminishes carbon sequestration and exacerbates climate change but also increases the likelihood of soil erosion, landslides, and loss of wildlife habitat (FAO, 2020). Land degradation, resulting from unsustainable land management practices, compromises soil fertility, water quality, and food security, posing significant challenges to sustainable development goals (UNCCD, 2017).



Fig 4: environmental hazard

THE FEATURES OF ARCHITECTURAL DESIGN OF DISASTER RESILIENT HOUSE

Designing disaster-resilient houses is a crucial aspect of architecture, especially in regions prone to natural disasters such as earthquakes, hurricanes, floods, and wildfires. The Resilient House features a number of innovative strategies, including a roof made of fire-resistant materials, a rainwater harvesting system for irrigation, and a modular design that allows for easy expansion and customization (Fidanci, 2023). The architectural features of disaster-resilient houses are meticulously crafted to mitigate the impact of these disasters, ensuring the safety and well-being of occupants while minimizing damage to property. Here are the key features of the architectural design of disaster-resilient houses:

- **Structural Integrity:**

The foundation of any disaster-resilient house lies in its structural integrity. Designs prioritize sturdy construction techniques and materials that can withstand the forces exerted by various disasters. This often involves reinforced concrete, steel framing, and robust connections to ensure the building can withstand seismic activity, high winds, or other catastrophic events (Dashti, 2019).

- **Flexible Design:**

Disaster-resilient houses are designed with flexibility in mind. This means incorporating features such as open floor plans and modular construction techniques that allow the building to adapt to changing conditions. Flexible design reduces the risk of structural failure during earthquakes and enables easier evacuation in the event of a disaster (Li, 2020).

- **Elevated Foundations:**

In flood-prone areas, houses are often built on elevated foundations to minimize the risk of water damage. Elevated structures can withstand rising water levels and prevent floodwaters from entering living spaces. Additionally, incorporating flood vents allows water to flow freely underneath the house, reducing hydrostatic pressure and minimizing structural damage (Kim, 2021).

- **Wind-Resistant Features:**

In regions susceptible to hurricanes or high winds, architectural design focuses on wind-resistant features. This includes reinforced roofing materials, impact-resistant windows, and aerodynamic shapes that minimize wind resistance. By reducing the

vulnerability to wind damage, these features help protect both the structure and its occupants during extreme weather events (Wang, 2019).

- **Fire-Resistant Materials:**

In areas prone to wildfires, designs prioritize the use of fire-resistant materials in construction. This includes non-combustible roofing materials, exterior cladding with high fire ratings, and fire-resistant landscaping practices. Creating a defensible space around the house, free from flammable vegetation, further reduces the risk of fire damage (Thompson, 2020).

- **Passive Design Strategies:**

Passive design strategies are integral to the architectural design of disaster-resilient houses. These strategies maximize natural ventilation, daylighting, and thermal comfort while minimizing reliance on mechanical systems. Features such as strategically placed windows for cross-ventilation and shading devices to mitigate solar heat gain not only enhance comfort but also reduce energy consumption and reliance on external resources during disasters (Chandra, 2021).

IMPACT OF DISASTER RESILIENT HOUSES OR BUILDING SUSTAINABILITY

The increasing frequency and severity of natural disasters have made disaster-resilient housing and sustainable building practices essential factors in urban planning and architecture. Natural disasters like hurricanes, floods, earthquakes, and wildfires have brought attention to how vulnerable traditional structures and infrastructure are, making a change to more sustainable and robust design principles necessary. Disaster-resistant housing and sustainable building practices have a wide range of effects, including social, technological, economic, and environmental ones. According to UNDRR (2021), one significant aspect of disaster-resilient houses is their ability to minimize environmental degradation and resource depletion. Sustainable building practices, such as using eco-friendly materials, incorporating energy-efficient designs, and implementing water conservation measures, contribute to reducing the carbon footprint of buildings. From an economic perspective, investing in disaster-resilient houses and building sustainability yields long-term cost savings and economic benefits. While the initial construction costs may be higher due to resilient design features and materials, the lifecycle costs are often lower. These structures require less maintenance, are more durable against natural hazards, and can even lower insurance premiums due to their reduced risk of damage. Additionally, resilient buildings can serve as community assets during disasters, providing shelter and support services, which can mitigate post-disaster recovery costs. Socially, disaster-resilient houses contribute to community well-being and safety. Incorporating features like accessible design for people with disabilities, emergency communication systems, and designated safe areas within buildings enhances overall preparedness and response capabilities. These measures not only protect lives but also foster a sense of security and resilience among residents, encouraging community cohesion and disaster resilience at the neighbourhood level.

Technological advancements play a pivotal role in enhancing the effectiveness of disaster-resilient houses and building sustainability. Innovations such as smart sensors, real-time monitoring systems, and predictive analytics enable early warning mechanisms for disasters, allowing for timely evacuation and risk mitigation (CIB

W108, 2019). Education and awareness are essential components of promoting disaster-resilient houses and building sustainability.

Collaboration among stakeholders is key to maximizing the impact of disaster-resilient houses and building sustainability. This includes partnerships between governments, private sectors, NGOs, academia, and local communities. By fostering interdisciplinary collaboration, sharing best practices, and leveraging collective expertise, stakeholders can co-create innovative solutions and strategies that enhance disaster resilience and sustainability across various scales. Research and development are fundamental to advancing the field of disaster-resilient houses and building sustainability (FEMA, 2022). Monitoring and evaluation mechanisms are critical for assessing the effectiveness and impact of disaster-resilient houses and building sustainability initiatives. Performance metrics, data analytics, and feedback loops enable stakeholders to measure resilience outcomes, identify areas for improvement, and make informed decisions for future projects. The impact of disaster-resilient houses and building sustainability extends across environmental, economic, social, and technological dimensions (U.S. Green Building Council, 2020). By prioritizing resilient design, sustainable practices, technological innovation, education, collaboration, research, and monitoring, stakeholders can enhance community resilience, protect lives and property, and promote a more sustainable built environment for current and future generations.

THE RESISTANCE OF DISASTER RESILIENT HOUSES TO ENVIRONMENTAL HAZARD

Disaster resistance refers to the ability to resist the onset and impact of a disaster and disaster resilience refers to the ability to absorb the impact of a disaster. Disaster-resilient architecture strives to construct buildings and structures that can withstand natural and artificial disasters and recover quickly (BIM Community, 2024). Creating disaster-resilient houses involves designing structures that can withstand various environmental hazards, including floods, earthquakes, hurricanes, wildfires, and more. The resistance of disaster-resilient houses to environmental hazards is crucial for protecting occupants and minimizing damage to property. Here is the resistance of disaster-resilient houses to environmental hazards:

- **Robust Construction Materials:**

Disaster-resilient homes are constructed using durable materials that can withstand the impact of various environmental hazards. For instance, in hurricane-prone areas, houses are often built with reinforced concrete, impact-resistant glass, and steel framing to endure high winds and flying debris. Similarly, in wildfire-prone regions, builders use fire-resistant materials such as concrete, brick, and metal roofing to reduce the risk of ignition.

- **Strategic Design and Layout:**

The layout and design of disaster-resilient homes are meticulously planned to minimise vulnerability to environmental hazards. This includes positioning the house away from floodplains, elevating it above potential flood levels, and orienting it to reduce exposure to prevailing winds or wildfire spread. Additionally, features like sloped roofs and storm shutters are incorporated to enhance structural integrity and protect against wind damage.

- **Resilient Infrastructure:**

Beyond the structure itself, disaster-resilient homes often incorporate resilient infrastructure features such as reinforced foundations, storm water management systems, and backup power sources. These elements not only enhance the home's ability to withstand environmental hazards but also ensure functionality during and after disasters, facilitating a quicker recovery process.

- **Advanced Technology Integration:**

The integration of advanced technology plays a significant role in enhancing the resilience of modern homes. From sensor-based monitoring systems that detect early signs of structural compromise to smart home devices that enable remote monitoring and control during emergencies, technology enables homeowners to proactively respond to threats and minimize damage.

- **Community Planning and Preparedness:**

Building resilience goes beyond individual homes; it requires community-wide efforts. Disaster-resilient housing initiatives often involve collaboration between homeowners, builders, local authorities, and community organizations to implement comprehensive planning and preparedness measures. This may include zoning regulations, building codes, and community education programmes aimed at enhancing overall resilience.

- **Sustainable and Eco-Friendly Practices:**

Many disaster-resilient homes embrace sustainable and eco-friendly practices, not only to reduce environmental impact but also to enhance resilience. Features such as green roofs, rainwater harvesting systems, and passive heating and cooling designs not only contribute to energy efficiency but also increase the home's ability to withstand and recover from disasters by reducing reliance on external resources.

HOW TO BUILD DISASTER RESILIENT HOUSE

Building a disaster-resilient house requires a comprehensive approach that encompasses site selection, innovative design, resilient construction materials, and community engagement. By following these steps and incorporating suitable features, homeowners can create houses that are better equipped to withstand and recover from natural disasters, ensuring the safety and well-being of occupants. Below is the systematic process for building a disaster-resilient house:

- **Site Selection and Analysis:**

Begin by selecting a suitable site for the construction of the house. Conduct a thorough analysis of the site to identify potential hazards such as flooding, earthquakes, hurricanes, or wildfires. Utilize geological surveys, flood maps, and local building codes to assess the risks associated with the chosen location (UNDRR, 2018).

- **Design for Resilience:**

Work with architects and engineers to design a house that prioritizes resilience against identified hazards. Incorporate features such as elevated foundations, reinforced concrete structures, and wind-resistant materials into the design. Ensure flexibility in the layout to allow for quick adaptation to changing conditions (Cutter, 2020).

- **Selection of Materials:**

Choose construction materials that are resilient to the specific hazards prevalent in the area. Opt for fire-resistant roofing materials, impact-resistant windows, and flood-resistant building materials. Utilize sustainable and eco-friendly materials wherever possible to enhance resilience and minimize environmental impact (IPCC, 2021).

- **Structural Reinforcement:**

Reinforce the structure of the house to withstand the forces exerted by natural disasters. Incorporate techniques such as seismic bracing, hurricane straps, and shear walls to enhance structural integrity. Ensure that the house meets or exceeds local building codes and standards for disaster resilience (FEMA, 2019).

- **Landscaping and Site Design:**

Implement landscaping and site design strategies that reduce the risk of damage during disasters. Create a defensible space around the house by maintaining a clear zone free from flammable vegetation. Utilize natural barriers such as berms or swales to mitigate flood risk and channel water away from the house (Brown, 2022).

- **Resilient Utilities:**

Install resilient utility systems that can withstand disruptions during disasters. Utilize underground utilities to reduce the risk of damage from high winds or flooding. Incorporate backup power systems such as solar panels or generators to ensure continuous electricity supply during outages (Chang, 2023).

- **Accessibility and Evacuation Planning:**

Design the house with accessibility in mind to ensure that all occupants, including those with mobility challenges, can safely evacuate during emergencies. Install wide doorways, ramps, and handrails to facilitate easy movement within the house. Develop clear evacuation routes and emergency plans for all occupants (CDC, 2020).

- **Community Engagement:**

Engage with the local community throughout the construction process to build resilience at the neighbourhood level. Collaborate with neighbours to share resources, develop emergency plans, and establish community shelters. Foster a sense of collective responsibility for disaster preparedness and response (UNDP, 2022).

- **Education and Training:**

Provide education and training to occupants on disaster preparedness and response measures. Conduct drills and simulations to practice evacuation procedures and familiarize occupants with emergency supplies and equipment. Empower residents to take proactive steps to protect themselves and their homes during disasters. (Paton, 2018).

CONCLUSION

The concept of disaster-resilient housing extends beyond the physical attributes of buildings to encompass broader principles of community resilience and adaptive capacity. The architectural design of disaster-resilient houses serves as a cornerstone of building sustainability against environmental hazards in Akwa Ibom State. By embracing principles of resilience, sustainability, and community engagement, architects can contribute to the creation of homes that not only withstand the

challenges posed by natural disasters but also promote the long-term well-being and prosperity of communities. Through collaborative action and commitment to resilient housing initiatives, Akwa Ibom State can pave the way for a safer, more sustainable future for generations to come.

RECOMMENDATION

- Government authorities in Akwa Ibom State should priorities the integration of disaster resilience criteria into building codes and regulations. This includes updating existing codes to incorporate provisions for flood-resistant construction, seismic design standards, and other resilience measures.
- Infrastructure improvements are essential for enhancing the resilience of housing against environmental hazards. Investments in flood management systems, drainage infrastructure, and coastal protection measures can help mitigate the impact of flooding and erosion in vulnerable areas.
- Building the capacity of architects, engineers, builders, and local communities is crucial for advancing disaster-resilient housing initiatives in Akwa Ibom State. Training programmes, workshops, and educational campaigns can provide stakeholders with the knowledge and skills needed to design, construct, and maintain resilient houses.

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