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EVOLVING ROLE OF THE ARCHITECT: DESIGNING FOR DISASTER RESILIENCE IN THE BUILT ENVIRONMENT AMIDST CLIMATE CHANGE

[1]Hassan Kumshwan Dagung [2]Dawurung Racheal Philemon [3]Davou Mark Yohanna [4]Dang Dahmawur Jim

[1,2,3,4] Department of Architecture, Plateau State University, Bokkos, Plateau State, Nigeria.
Corresponding Authors' Mail: Email: dagunghassan@gmail.com
ORCID: 0009-0003-3783-2652

ABSTRACT

Climate change has intensified the frequency and severity of floods, wildfires, heatwaves, storms, and other natural hazards, exposing the vulnerability of the built environment and highlighting the need to redefine the architect's professional responsibilities. This study examines the evolving role of architects in promoting disaster resilience through the integration of disaster risk reduction principles into architectural design and planning. The research adopted a qualitative methodology based on a critical review of contemporary literature and comparative analysis of seven international case studies representing diverse climatic regions and hazard contexts. The findings demonstrate that resilient architectural practice extends beyond aesthetics and functionality to include hazard-responsive planning, passive survivability, adaptive material selection, community participation, and systems thinking. The case studies further reveal that architects who integrate resilience strategies into the design process contribute significantly to reducing disaster risks while enhancing environmental sustainability and community adaptive capacity. The study recommends that architectural education, professional practice, and government policies mainstream disaster risk reduction and climate adaptation into building design standards, professional training, and development regulations. This paradigm shift will enable architects to transform the built environment from a vulnerable asset into a resilient system capable of protecting lives, livelihoods, and critical infrastructure under future climate uncertainties.

***Keywords**:* Architecture, Climate Change, Disaster Resilience, Built Environment, Disaster Risk Reduction, Climate Adaptation

1. INTRODUCTION

There is unequivocal evidence of a climate crisis. The Intergovernmental Panel on Climate Change (IPCC) reiterates that human activity has warmed the atmosphere, ocean, and land, causing widespread and rapid changes in weather and climate extremes (IPCC, 2022). Floods, wildfires, storms, and heatwaves have become more frequent and intense, with direct consequences for the built environment. Traditional architectural practice, often preoccupied with aesthetic innovation and cost efficiency, has historically produced buildings and urban areas that remain dangerously vulnerable to climate-related shocks (Till et al., 2020).

The devastating heat dome over British Columbia, the lengthening wildfire seasons in Australia and North America, and the catastrophic flooding seen in Pakistan in 2022 illustrate a serious flaw in the way habitats are designed (IPCC, 2022; Birkmann, Liwenga, Pandey, & Boyd, 2022). The architect's role must be fundamentally reevaluated in light of this reality. The profession must adopt a new ethical imperative centred on resilience; it can no longer be restricted to the domains of form and function alone.

This paper argues that twenty-first-century architects should take the lead in incorporating disaster readiness into the built environment. This requires a shift from a reactive approach, rebuilding after a disaster occurs, to a proactive one in which resilience is incorporated by design. In addition to advocating for community-centric designs that improve adaptive capacity, the architect must synthesise complex climatic data and support robust material and structural strategies. Drawing on seven contemporary case studies from around the world, this paper examines this expanded role through the lenses of systems thinking, passive survivability, material science, and urban planning.

2. LITERATURE REVIEW

2.1 From Sustainability to Resilience

Over the past few decades, the guiding philosophy of the architectural profession has undergone significant change. The concept of sustainability, which emphasised reducing environmental impact through resource conservation and energy efficiency, dominated the late twentieth and early twenty-first centuries (Moe, 2019). Sustainability alone, however, is an inadequate framework for the climate era. It frequently presumes a state of equilibrium, whereas the climate of today is characterised by dynamic, non-linear change.

The concept of resilience has thus emerged as a critical complement and, in some contexts, a successor to sustainability. Resilience in the built environment is defined as "the ability to prepare and plan for, absorb, recover from, and more successfully adapt to adverse events" (National Academies, 2019, p. 23). This definition aligns with the disaster management cycle, comprising mitigation, preparedness, response, and recovery, within which architects hold the greatest leverage during the first two phases (Lizarralde & Johnson, 2021).

Recent research points to a significant disconnect between the widely acknowledged need for resilience and its practical implementation. According to Till et al. (2020), professional incentives and architectural education continue to favour iconic, object-based structures over the development of adaptable, life-supporting systems. Furthermore, building regulations frequently lag years behind emerging climate research, rather than future-proofing cities, resulting in a regulatory environment that codifies historical vulnerabilities instead of anticipating future risk (Crichton, 2018). Drawing on international precedents, this study aims to address this gap by providing a precise, practical framework for the architect's expanded responsibility.

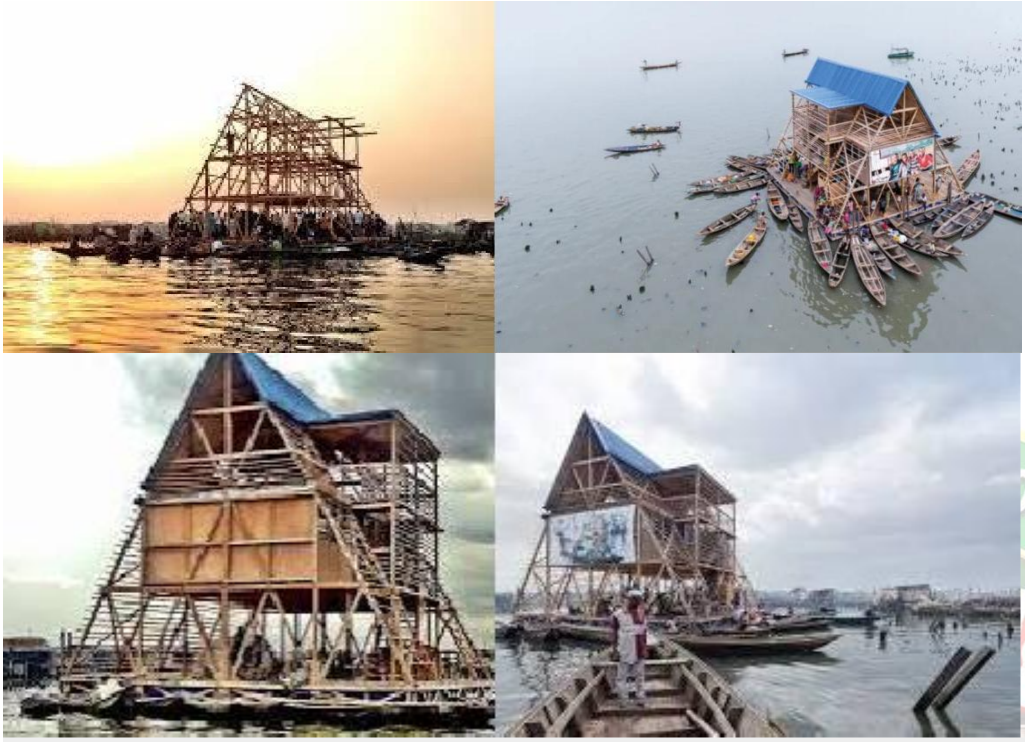
2.2 Global Case Studies in Resilient Architecture

The following seven case studies, drawn from each inhabited and uninhabited continent, illustrate how architects across diverse geographic and climatic contexts have responded to specific disaster risks through design. Each case is examined in terms of its resilience strategy, its integration with the surrounding community, and the expanded role assumed by the architect.

2.2.1 Africa: The Makoko Floating School, Lagos, Nigeria

Hazard: Sea-Level Rise and Coastal Flooding

NLÉ, the architecture and urbanism practice founded by Nigerian-born architect Kunlé Adeyemi, designed the original Makoko Floating School as a prototype building to serve the coastal community of Makoko, a settlement badly affected by flooding and rising sea levels (Olotuah, 2021).



Plates 1–4: The Makoko Floating School, constructed of timber on a buoyant plastic-barrel base
Source: NLÉ Works (2011). MFS I – Makoko Floating School, Lagos, Nigeria. https://nleworks.com/case/Makoko-floating-school/

As shown in plates 1-4 above, the Makoko Floating School demonstrates how buoyant architecture can successfully adapt to recurring coastal flooding through an innovative floating structural system.

Resilience Strategy: The building adjusts to the water rather than resisting it. Constructed on a buoyant base composed of recycled plastic barrels, the A-frame structure was designed to rise and fall with changing water levels, thereby reducing flood vulnerability(Adegun & Adedeji, 2021; Olotuah, 2021).

Community Integration: The building demonstrated multifunctional use, serving as both a school and a community gathering space. In a hot, humid region, its open, permeable design encouraged natural ventilation, exemplifying passive survivability (Adegun & Adedeji, 2021).

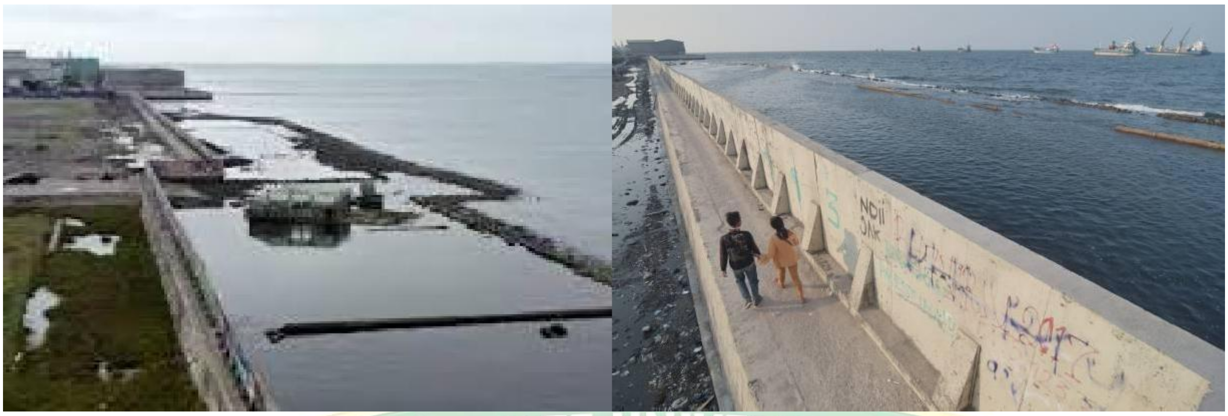
Architect's Role: Using local resources and labour, the architects collaborated with the Makoko community and applied systems thinking to develop an adaptable, culturally relevant solution that transformed an environmental hazard into a habitable response.

It is important to note that the original prototype, completed in 2013, was not without limitations: the structure was abandoned in March 2016 over safety concerns and subsequently collapsed during a storm in June 2016 (Olotuah, 2021). Subsequent iterations of the design, including the prefabricated MFS II shown at the 2016 Venice Architecture Biennale, addressed several of these structural shortcomings. This outcome underscores an important caveat for the architect's expanded role: prototype resilience strategies require continuous monitoring, maintenance, and iterative refinement, and cannot be assumed to remain effective indefinitely without institutional follow-through.

2.2.2 Asia: The Jakarta Emergency Embankment, Indonesia

Hazard: Land Subsidence and Tidal Flooding

Tidal flooding is being exacerbated by Northern Jakarta's alarming rate of subsidence. Large-scale sea walls form part of the government's response, but architectural interventions at the community level remain critical (Firman, 2020).



Plates 5–6: The Jakarta Emergency Embankment, Indonesia, addressing land subsidence and tidal flooding
Source: Mohd, Z. (2023). Giant wall of sinking city – Jakarta.

As illustrated in plates 5-6 above, the project integrates elevated infrastructure and flood-adaptive urban planning to reduce the impacts of tidal flooding and land subsidence.

Resilience Strategy: The Emergency Embankment project entails raising infrastructure across entire neighbourhoods. A new, elevated ground level is created by building houses on stilts and raising vital services and roadways onto embankments (Sagala et al., 2021).

Community Integration: Architects and planners must rebuild the entire urban fabric, not only individual buildings, as part of this extensive, planned adaptation. This includes the construction of new public spaces on the embankments and integrated water management systems (Sagala et al., 2021).

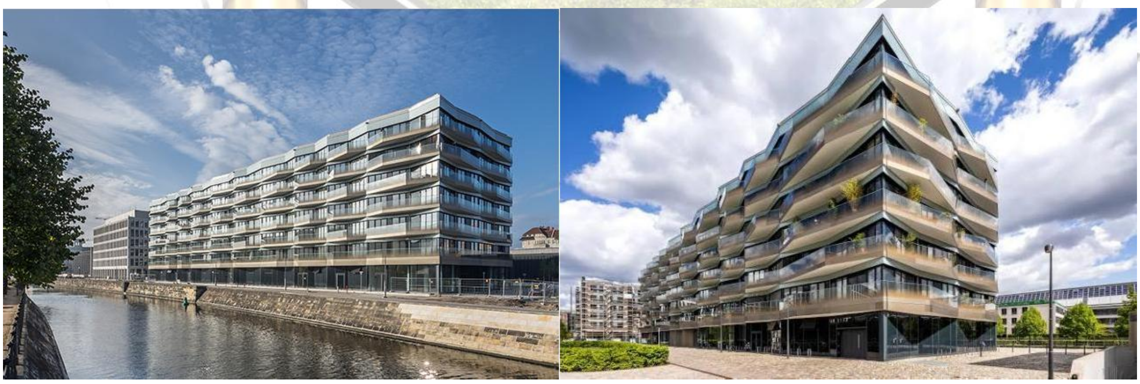
Architect's Role: In this context, the architect functions as an urban planner and community strategist, coordinating a managed retreat and large-scale adaptation while prioritising functional infrastructure and community cohesion throughout the redesign process.

2.2.3 Europe: The Hamburger Strasse Development, Berlin, Germany

Hazard: Urban Heat Island Effect and Flash Floods

In a densely populated European setting, this multi-storey residential complex establishes a benchmark for climate-resilient urban design (Schmidt, 2022).

As depicted in plates 7-8 below, green roofs, vegetated facades and permeable surfaces function as integrated climate adaptation measures within the development.



Plates 7–8: The Hamburger Strasse Development, Berlin, Germany, addressing the urban heat island effect and flash floods
Source: Alamy (2019). New construction, modern office building, upscale district, Berlin, Germany.

Resilience Strategy: A comprehensive green roof and façade system absorbs rainfall, reduces surface runoff, and uses evapotranspiration to cool the structure and its surroundings Plates 7–8.

Permeable pavement within the courtyard manages surface water, while the building's orientation and shading optimise passive cooling (Bowler et al., 2010).

Community Integration: The complex incorporates green areas and shaded community courtyards that provide thermal refuge during heatwaves, while neighbourhood resilience improving social resilience (Bowler et al., 2022).

Architect's Role: Functioning as a specialist in passive survivability and material science, the architect specified living systems, including green roofs, as essential architectural elements for managing water and microclimate.

2.2.4 North America: The Medford Fire Station 1, Oregon, USA

Hazard: Wildfire and Poor Air Quality

Located in a region increasingly prone to catastrophic wildfires, this fire station is designed to serve as a resilient operational base and potential community shelter (Walker, 2021).

Plates 9–11: The Medford Fire Station 1, Oregon, USA, addressing wildfire risk and poor air quality

Source: City of Medford, Oregon, Fire Department. www.medfordoregon.gov/Government/Department/Fire

As presented in Plates 9-11, the fire station combines fire-resistant construction with operational resilience to ensure uninterrupted emergency response during wildfire events.

Resilience Strategy: The building's exterior is composed of non-combustible concrete and metal. To preserve indoor air quality during smoke events, it incorporates an airtight envelope and a dedicated outside air system (DOAS) fitted with advanced filtration. Backup power and on-site water storage ensure operational autonomy (Gershwin et al., 2022).

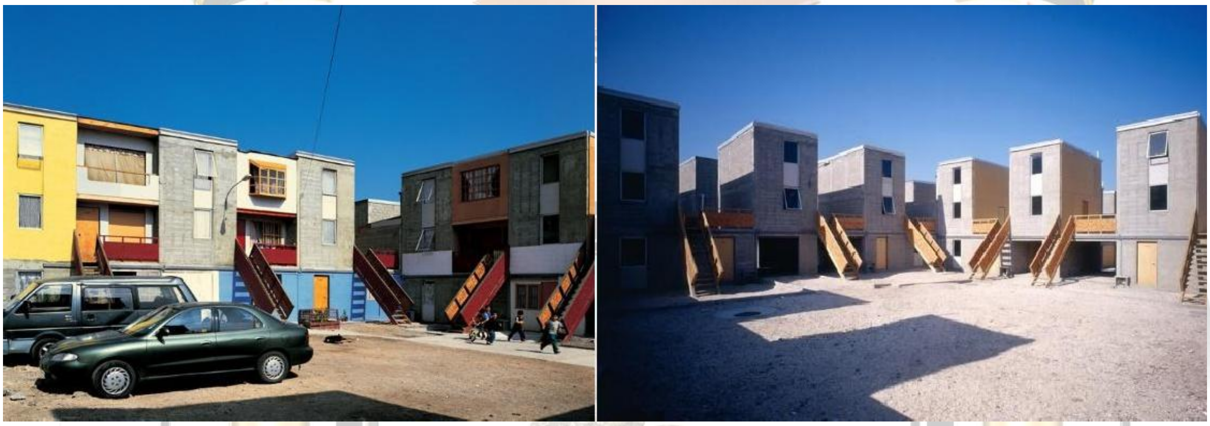
Community Integration: As a vital first-responder facility, the building's resilience directly affects the community's capacity to respond to and recover from disaster events. Its design also enables it to function as a public clean-air shelter during severe smoke event (Walker, 2021; Gershwin et al., 2022).

Architect's Role: By synthesising health and safety data, the architect produced a structure that protects both its occupants and its critical function from the combined hazards of smoke and fire.

2.2.5 South America: The Quinta Monroy Housing, Iquique, Chile

Hazard: Earthquakes

Designed by ELEMENTAL, this social housing project, located in a seismically active region, addresses both affordability and seismic resilience (Aravena, 2019). As shown in plates 12-13 below, the project combines earthquake-resistant construction with incremental housing development that allows future expansion without compromising structural safety.



Plates 12–13: The Quinta Monroy Housing, Iquique, Chile, designed and built to address earthquake risk
Source: Arch Daily (2008). Quinta Monroy / ELEMENTAL.

Resilience Strategy: The design adopts a half-house approach (Plates 12–13), in which residents gradually construct the remaining portion themselves while the government finances a robust, complete core structure. The building's overall structural integrity is maintained through the use of reinforced concrete that complies with stringent seismic requirements (Lepore & Pensa, 2021).

Community Integration: This strategy ensures that vulnerable populations live in seismically safe homes from the outset, while empowering residents and supporting community-led development.

Architect's Role: Acting as both material scientist and community advocate, the architect developed a flexible, collaborative approach that preserves life-saving structural robustness despite financial constraints.

2.2.6 Oceania: Te Kura Whare, Ngāi Tūhoe, New Zealand

Hazard: Severe Storms and Power Outages

This is the first Indigenous Living Building in Aotearoa New Zealand, designed for the Tūhoe iwi (tribe), who maintain a deep cultural connection to their environment (Mane-Wheoki, 2020). As illustrated in plates 14-16 below, the building demonstrates how renewable energy systems and passive environmental design contribute to resilience during severe storms and prolong power outages. As presented in Plates 17-19, the station's modular design and hydraulic ski system enable relocation in response to shifting Antarctic ice conditions.

Plates 14–16: Te Kura Whare, Ngāi Tūhoe, New Zealand, designed to address severe storms and power outages
Source: Radio New Zealand (2018). A people build a house and a house builds a people.

Resilience Strategy: The building produces more water and energy than it consumes, making it net-positive (Plates 14–16). It incorporates photovoltaic arrays with battery storage, on-site wastewater treatment, and rainwater collection. Its thermally substantial structure, built from local timber, provides effective passive temperature regulation (Fischer & Juras, 2023).

Community Integration: The building represents the Tūhoe value of environmental guardianship (kaitiakitanga) as a community centre. Its self-sufficiency allows it to continue functioning as a community hub both during prolonged storms and utility disruptions (Fischer & Juras, 2023).

Architect's Role: By integrating indigenous knowledge with contemporary technology, the architects created a structure that is both culturally relevant and achieves a high degree of resource independence and passive survivability.

2.2.7 Antarctica: The Halley VI Research Station

Hazard: Extreme Cold, Snow Accumulation, and Shifting Ice Shelves

The Halley VI, a British Antarctic Survey station, is a leading example of architecture designed for extreme and dynamic environments (Squire, 2020).

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Plates 17–19: The Halley VI Research Station, designed and built to address extreme cold, snow accumulation, and shifting ice shelves

Source: Hugh Broughton Architects. Halley VI British Antarctic Research Station.

Resilience Strategy: The station comprises several modular pods mounted on giant hydraulically driven skis (Plates 17–19). This design allows the entire station to be relocated inland when the Brunt Ice Shelf, on which it is situated, shifts and calves icebergs. The British Antarctic Survey successfully relocated the station 23 kilometres inland in 2017 in response to a developing ice chasm. Because wind passes beneath the elevated structures, the design also prevents snow accumulation from burying them (Fox, 2021).

Community Integration: The resilience of this self-contained scientific community is essential to the safety and continuity of Antarctic research. The modular design enables reconfiguration and ensures that the remaining pods continue to function even if one module is compromised.

Architect's Role: By creating a mobile, adaptable settlement that responds to the specific geophysical risks of the Antarctic continent, the architects, AECOM and Hugh Broughton Architects, demonstrated exceptional systems thinking and design innovation.

3. MATERIALS AND METHODS

This study adopted a qualitative research design based on a desk review of relevant literature and comparative case study analysis to examine the evolving role of architects in designing for disaster resilience amidst climate change. Data were obtained exclusively from secondary sources, including peer-reviewed journal articles, books, conference proceedings, institutional reports, policy documents, and publications from reputable international organisations. A purposive sampling technique was employed to select seven internationally recognised architectural projects that demonstrate innovative resilience strategies against diverse climate-induced hazards, including flooding, sea-level rise, wildfires, earthquakes, extreme weather, and energy disruptions.

The selection criteria included projects with documented evidence of disaster resilience, international recognition, availability of credible technical documentation, and relevance to architectural design and climate adaptation. Conversely, projects lacking sufficient documentation, empirical evidence, or direct relevance to disaster-resilient architectural practice were excluded from the study. Photographic illustrations and project documentation were incorporated to support the descriptive analysis and facilitate interpretation of the identified resilience strategies. The collected data were analysed using qualitative content analysis and thematic synthesis to identify recurring design principles, resilience strategies, and professional lessons emerging from the selected case studies. The findings were synthesised to establish the relationship between climate change, disaster resilience, and architectural practice, providing evidence-based recommendations for professional practice, architectural education, and policy formulation aimed at strengthening resilience-by-design within the built environment.

4. RESULTS AND DISCUSSION

The findings reveal that climate change has significantly redefined the role of architects from providers of functional and aesthetic buildings to key actors in disaster risk reduction and climate adaptation. The reviewed literature consistently demonstrates that resilient architecture is achieved through proactive planning, adaptive design, interdisciplinary collaboration, and context-specific responses to environmental hazards. Across the seven case studies, resilience was embedded through different but complementary strategies, including floating construction (Makoko Floating School), integrated flood management (Jakarta), green infrastructure (Berlin), wildfire-resistant construction (Medford Fire Station), incremental earthquake-resistant housing (Quinta Monroy), regenerative and energy-independent design (Te Kura Whare), and modular adaptive construction (Halley VI Research Station).

The comparative analysis indicates that successful resilient architecture extends beyond structural performance to include social, environmental, economic, and institutional dimensions. Projects that incorporated local environmental conditions, community participation, renewable energy systems, and flexible design approaches demonstrated greater long-term adaptability to climate-related risks. The photographic illustrations further reinforce these findings by demonstrating how resilience principles are translated into practical architectural solutions across different geographical and climatic contexts.

The findings also underscore the growing importance of resilience-by-design as a fundamental component of contemporary architectural practice. Rather than responding to disasters after their occurrence, the reviewed projects anticipate future risks through innovative planning, material selection, passive environmental strategies, and adaptable building systems. This paradigm shift aligns with global calls for climate-responsive development and supports the view that architects must increasingly integrate resilience considerations throughout the planning, design, construction, and management of the built environment. Consequently, the study affirms that disaster resilience should become an integral component of architectural education, professional practice, and public policy in order to enhance the sustainability and safety of future communities.

4.1 CHALLENGES AND BARRIERS TO IMPLEMENTATION

Despite the clear rationale for resilience-by-design, significant barriers continue to constrain its widespread adoption across the architectural profession.

Economic Constraints: Despite data indicating a benefit-cost ratio of approximately 4:1 for resilience investments over a building's lifecycle, clients and developers frequently resist the perceived higher upfront cost of robust design elements (World Bank, 2019).

Regulatory Lag: Changes to building codes occur slowly. A building that is compliant today may be unsafe tomorrow, as many national codes still fail to adequately account for future climate projections (Crichton, 2018).

Skills Gap: Many practising architects lack formal training in resilience principles or climate science, creating a need for extensive ongoing professional development (Till et al., 2020).

5. CONCLUSIONS

The evidence presented in this study demonstrates that resilient architecture is no longer an optional design philosophy but an essential response to the increasing frequency and intensity of climate-related disasters. The international case studies further reveal that effective resilience is achieved through context-sensitive planning, interdisciplinary collaboration, adaptive design strategies, and active community participation. Consequently, architects must embrace a proactive role in disaster risk reduction by integrating resilience considerations into every stage of the design process.

In conclusion, designing for disaster readiness is no longer a niche specialism but a fundamental and non-negotiable dimension of responsible architectural practice. As climate change continues to reshape the built environment, architects must lead the transition from reactive reconstruction to proactive resilience-by-design. By embracing this expanded professional responsibility, the architectural profession can significantly contribute to safeguarding lives, protecting infrastructure, strengthening community resilience, and promoting sustainable development for present and future generations.

6. CONTRIBUTIONS TO KNOWLEDGE

This study contributes to the growing discourse on climate-responsive architecture by synthesising contemporary evidence on the evolving role of architects in disaster resilience. Unlike previous studies that focus on individual hazards or isolated design strategies, it presents an integrated comparative analysis of seven international case studies, demonstrating how resilience-by-design can be applied across diverse climatic and geographical contexts. The study further contributes by highlighting the architectural profession's expanding responsibility in climate adaptation, disaster risk reduction, and sustainable development. The findings provide a practical knowledge base for architects, educators, researchers, and policymakers seeking to mainstream resilience principles into architectural practice, education, and policy.

7. RECOMMENDATIONS

To advance this vision, the architectural profession should strengthen its capacity for climate adaptation and disaster risk reduction by making continuing professional development (CPD) in these areas a requirement for professional accreditation, reflecting the interdisciplinary expertise demonstrated in projects such as Halley VI and the Medford Fire Station. Similarly, architecture schools should, without delay, integrate resilience theory, climate science, and passive survivability techniques into their core curricula, drawing on case studies such as Makoko Floating School and Te Kura Whare to promote context-sensitive and community-driven design approaches. Furthermore, governments should accelerate the reform of building codes towards performance-based, forward-looking standards, using probabilistic climate data to ensure that new buildings remain fit for purpose under future climatic conditions, as demonstrated by the regulatory-driven resilience initiatives implemented in Berlin and Jakarta.

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