

## Article

# Design and Disaster Resilience: Toward a Role for Design in Disaster Mitigation and Recovery

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**Abstract:** This paper examines how the discourses and practices of design can be applied to both mitigate the damaging impacts of (un-)natural disasters and guide resilient post-disaster recovery. Integrated with systems analysis, design can provide both an innovative window for understanding the complexities of disaster-risk reduction and recovery, as well as a conceptual bridge to new ways of building socio-economic and physical resilience in disaster-affected communities. However, the skills of key systems and design thinkers, such as architects, urban planners, and landscape architects, are seldom employed, despite their demonstrated capacity to work with disaster-prone or -impacted communities to develop integrated spatial responses to guide both disaster-risk reduction and long-term rebuilding after a disaster. Indeed, there has been little focused investigation of the potential contributions of design per se in developing strategies for disaster-risk reduction and recovery. Similarly, there has been little attention in design education to complementing the creative problem-solving skills of the designer with the contextual and systemic understandings of disaster management and disaster-resilient design. This paper addresses these omissions in both disaster management and design education through a review of research on design contributions to disaster issues and provides a case study of the curriculum and pedagogical approaches appropriate to build capacity for enhancing this contribution.



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**Keywords:** disaster mitigation; disaster-risk reduction; disaster recovery; design; architecture; design thinking

## 1. Introduction

This paper examines how the discourses and practices of design can be applied to both mitigate the damaging impacts of (un-)natural disasters before they occur and guide effective post-disaster recovery. From annual cyclones in the tropics and sub-tropics, to earthquakes, floods, heat stress, and wildfires, the world is experiencing an increasing number of disasters, which have caused damage in excess of USD 5200 billion since 1980, and USD 150 billion in 2019 alone (Munich Re 2020) [1]. The intensity and cascading nature of disasters have doubled the number of people displaced in the past two decades: a rate of greater than one person per second, every day, every year. The 1900 disasters reported in 2019 displaced 24.9 million people from their homes, globally. This figure is the highest recorded since 2012 and three times the number of displacements caused by conflict and violence (IDMC 2020a) [2]. Flooding, alone, is predicted to cause 50 million displacements a year by 2100 if climate change is not addressed (IDMC 2020b) [3].

However, the scale of these losses is not the only or, indeed, the major problem. Thus, Cadman (2020) [4] argues, *the key issue is determining what needs to be done to make communities and their homes and infrastructure more resilient*. However, government and community agencies often struggle to implement effective strategies to prevent or mitigate the impacts before such disasters occur and to plan for long-term recovery afterwards (Bojic, Baas, and Wolf 2019) [5]. The central challenge these agencies face is the development

of policies and practices for reducing the vulnerabilities that prevent communities from becoming more disaster-resistant (Geis 2000) [6] or ‘resilient’ (Aldunce et al., 2014 [7], Alexander 2013 [8]).

Increasingly, scholars are identifying whole-of-system risks related to the design of the built environment—including unsafe settlement patterns and the inappropriate design of buildings in disaster-prone areas—as key causes of the vulnerabilities that need to be addressed (Fisher 2013) [9]. These studies include, for example, inquiries into wildfire damage (e.g., Gonzalez-Mathiesen and March 2018) [10] and the impacts of flooding and cyclones (e.g., Smith and Low Choy 2014) [11]. Similarly, a review of reconstruction projects after the 2004 Boxing Day tsunami in Sri Lanka found that poor urban design was responsible for many villages being rebuilt in unsafe locations and lacking in basic infrastructure for water, sewerage, and electricity (Ahmed and Charlesworth 2015) [12].

While many such housing and infrastructure challenges are critically related to design issues, design also provides both an innovative window for understanding the complexities of disaster-risk reduction and recovery, as well as a conceptual bridge to new ways of building socio-economic and physical resilience in disaster-affected communities (Keenan 2018) [13]. Predominant approaches to complex disaster events tend to focus on individual elements of regional or urban systems, such as constructing fire breaks or flood levees (Lee, 2020) [14]. As such, they are often not well-suited to mitigating the original system vulnerabilities that can turn extreme weather events into major disasters. This is because the complexity of such systemic problems requires approaches to resolution that recognize systemic connections (in which the solutions to today’s problems may become tomorrow’s new problem) and the consideration of creative and diverse alternatives. This is the realm of design thinking because it helps tackle complex and uncertain challenges which are commonly seen as ‘wicked problems’. In the increasingly complex and uncertain world of disaster-risk management, design thinking avoids linear thinking and, instead, looks to two iterative processes: (i) identifying and formulating the problems by understanding systemic relationships, and then (ii) developing and testing alternative solutions. The first is an analytic sequence in which the designer investigates all the social, cultural, environmental, political, and economic elements and interconnections within related systems. This is a key task as a poorly formulated problem will not lead to a lasting solution. The second involves sequences of exploring, identifying, and testing several possible approaches to specify best-possible resolutions for the problem. (The design thinking process in relation to wicked problems has been elaborated in a wide range of publications since Buchanan (1992) [15]. See, for example, (Johnson 2016 [16])).

However, the skills of key systems and design thinkers (such as architects, urban planners and designers, and landscape architects) are seldom employed in disaster mitigation and recovery despite their demonstrated capacity to work with communities and to develop integrated spatial responses to guide both disaster-risk reduction and long-term rebuilding after a disaster (Charlesworth 2014) [17]. Indeed, despite the growing body of research on *urban planning* in relation to risk and climate-change adaptation (e.g., Elliot-Ortega 2010 [18], Fisher 2013 [9], Shaw, Rahman, Surjan, and Parvin 2016 [19] American Society of Landscape Architects 2020 [20]), there has been little focused investigation of the potential contributions of *design* in developing strategies for disaster-risk reduction and recovery with and for impacted communities. Similarly, there has been little attention in design education to complementing creative problem-solving skills of the designer with the contextual and systemic understandings of disaster management or disaster-resilient design. Thus, it is understandable that design expertise is not often applied in recovery and reconstruction as the number of architects equipped to respond in such situations is still very low.

This paper seeks to address this critical gap in both knowledge and practice by focusing on two questions:

- (i) What can be learnt from examples of design-based responses to disaster mitigation and recovery?

- (ii) How can the skills needed to integrate design into disaster-risk management be developed?

A theoretical foundation for answering these questions is provided in the next section. Then, the paper turns to the first question in a section that explores several examples of design-based responses to disaster. This section is based upon a cross-case analysis of case studies of ‘humanitarian architecture’ conducted by Charlesworth (2014) [17]. A key finding from the cross-case analysis was the lack of attention to providing design strategies for disaster and conflict scenarios in the professional education of the architects involved. Thus, the final section of the paper investigates ways in which these skills could be included in future design education through a brief review of current postgraduate courses in design and disaster-risk management and, through exploring a case study of a design studio in Vietnam, illustrates the nature of the pedagogical principles involved.

## 2. Why Design?

Despite the growth of disaster studies as a field of research, especially in relation to the built environment (Sanderson, Kayden, and Leis 2016) [21], the disaster-management field is characterized by at least three weaknesses: (i) conceptual papers about the meaning and use of concepts with a lack of attention to operational issues; (ii) discrete case studies of disaster events and projects with little potential for meaningful generalizations; and (iii) single-sector and single-discipline studies that pay little attention to interdisciplinary processes, such as design, which can integrate across sectors and disciplines, and which are the key to addressing ‘wicked problems’. A key consequence of these weaknesses is the lack of a systematic and analytical body of work that bridges the conceptual and operational gap between *knowing the causes and impacts of vulnerability and developing solutions* that ensure landscapes and settlement infrastructure are resilient and better capable of safeguarding communities vulnerable to disasters. Addressing this weakness helps answer a call from Alexander (2016) [22] for ‘a major revision in the body of disaster theory’ so that ‘policies and practical solutions’ can be derived from a conceptual road-map ‘that clarifies complex realities and enables disasters to be managed and abated’ (p. 2). The processes of design through systems analysis and design thinking offer a pathway to this new approach to theory and practice in disaster mitigation and recovery.

In relation to the built environment, design specifically refers to a problem-solving process based upon cross-disciplinary systems thinking, spatial innovation, and creativity. Design involves iterative sequences of observation to understand and empathize with the needs of people through their participation and collaboration, the rapid prototyping and testing of alternative socio-spatial designs (Boer et al., 2013) [23], design development, and full project implementation and evaluation. These are among the core skills of architects and other built environment and landscape designers. The development of such capabilities involves an on-going, iterative process of creating and reforming two- and three-dimensional space based on an understanding of the interdependence of human aspirations, the natural environment, and the social, political, and cultural systems in which the designs are constructed. Thus, design is ‘both a mindset and a methodology’ (Vandenbroeck 2012, p. 33) [24]. This integrative nature of design can help redress some of the challenges in successful disaster mitigation and recovery.

In what follows, ‘design’ and ‘design thinking’ are used with practical architectural and spatial applications in mind, encompassing the more transferable aspects of these terms in other disciplines, but which are particularly applicable to some of the great challenges in disaster mitigation and recovery. One of the greatest physical, financial, and social infrastructure losses after (un-)natural disasters is housing, which is a critical element in disaster mitigation and long-term community recovery. A home provides not only shelter from the elements, but also essential family stability, dignity, and security, especially after a disaster. However, there is a discrepancy between, on the one hand, the people-centered nature of architectural design (and ‘housing as a process’ as per Davis 1978, [25] 2015), and the product-delivery culture that characterizes many disaster-recovery programs. The result for housing is often a ‘one size fits all’ approach (Daly and Feener 2016) [26], inspired

perhaps by a search for universal solutions for reasons of speed and economy. However, in this universal approach to rebuilding housing, insufficient attention is often paid to the aspirations of the people most affected and the infrastructure they specifically need, including the use of local housing technologies and site vulnerabilities. Tran (2018), for example, provides an illuminating analysis of the ways in which the “universalist” approach contributed to the failure of a disaster-resistant housing project in Vietnam. Architects’ expertise in people-centered housing and settlement design is essential; yet, as Brett Moore (Chief, Shelter Division, UNHCR) [27] noted after Typhoon Yolanda in the Philippines: ‘Despite the enormity of the disaster, it is almost impossible to get trained architects or planners for the complex task ahead of rebuilding the shelters and settlements’ (in Charlesworth 2014). [17] Nonetheless, approaches that use design to address the complex challenges of disaster mitigation and recovery are emerging through the intersection of research and field practice. Examples of such design-led responses, and an analysis of the lessons that may be learnt from them, are provided in the next section.

### 3. Disaster-Resilient Design

The frequent lack of systems thinking and design thinking in traditional risk-assessment and -reduction strategies was critiqued in the previous section. Nevertheless, they remain essential measures in disaster management. Essential, yes, but not sufficient, for as Geis (2000) [6] argued, ‘truly safe’ buildings and infrastructure are not possible ‘without also having a safe overall community and region in which to build’. He went on to argue that ‘[T]he only real way to minimize the growing human and property losses from earthquakes, cyclones, and severe flooding is rooted first and foremost in how we design and build our communities in the first place in . . . hazard-prone areas’ (p. 152). In integrating systems analysis and design thinking, Geis proposed the following elements as critical to what he termed ‘disaster resistant design’:

- An analysis of the overall capacity, functioning, and relationships of the various components and systems that support communities, business, and industry
- Integrating new development projects within the limits of natural systems
- The planning and design of development and redevelopment patterns
- The design and patterns of open space
- The design of neighborhood and commercial districts
- Individual and building group design, including location, configuration, and coherence with building code and climate-change imperatives
- The location, design, and service capacity of community facilities and public infrastructure
- Design to facilitate emergency management functions, including egress and access, the location, safety, and capacity of emergency shelters used and staging areas
- Utilizing maintenance and rehabilitation management as important tools for climate-change mitigation and adaptation (p. 157).

Similar sets of principles or frameworks have been proposed in the two decades since Geis proposed his list (e.g., Fisher 2013 [9], American Society of Landscape Architects 2020 [20], Lee 2020 [14]). Mostly, these have been couched in terms of disaster-resilient design, which has been defined as ‘the intentional design of buildings, landscapes, communities, and regions in order to respond to natural and manmade [sic] disasters and disturbances—as well as long-term changes resulting from climate change—including sea level rise, increased frequency of heat waves, and regional drought’ (Wilson 2014) [28]. As the founder of the Resilient Design Institute, Wilson has also provided sets of principles and strategies for resilient design (see Resilient Design Institute, nd [29]).

These broad principles and strategies for resilient design were explored in a series of interviews with 15 architects working in disaster mitigation and recovery, and the analysis of their projects (Charlesworth 2014) [17] as well as in an analysis of the design principles behind exemplar design projects after disasters in Australia, Bangladesh, Haiti, Sri Lanka, the USA, and Vietnam (Charlesworth and Ahmed 2015) [12]. In addition, several core

themes about design for disaster resilience, which transcend the practicalities of design and architecture, also emerged from this research. Evans (2015) [30] noted five of these as follows:

1. Architects have practical mind- and skill-sets which are of significant value in disaster mitigation and recovery, including the interdisciplinary understanding of science, engineering, technology, and materials; a spatial perspective on systems and patterns; creative problem-solving; planning, organizing, scheduling, and managing of—and working with—economic, social, emergency, legal, and governmental constraints.
2. The spatial awareness, aesthetic, and design skills that good architects bring to projects, the ability to create beauty—and perhaps in the most unlikely environments—do add real value to psychologically distressed and demoralized individuals and communities. This may not be a high priority in the immediate aftermath of a disaster, when the overwhelming need is simply to provide emergency shelter for thousands, perhaps hundreds of thousands, of displaced people. However, it is certainly very relevant in the transitional and permanent stages of rebuilding and resettlement.
3. The poor, marginalized, and the distressed deserve the benefits of good architecture equally, if not more so, than the privileged few who can afford the aesthetic and functional benefits of commercial design practices. As Shigeru Ban said in his acceptance speech for the Pritzker Prize in 2014, *'Architects are not building temporary housing because we are too busy building for the privileged people . . . I'm not saying I'm against building monuments, but I'm thinking we can work more for the public'*.
4. There are no universal, one-size-fits-all solutions in resilient design. The most successful schemes, in terms of both their affordability and their benefits, are those built around intensive, sustained consultation with local people; the use, as far as humanly possible, of local materials and construction systems; and the employment of local people—often in situations where there is no other employment available—in the construction process.
5. Design education has not served the field of disaster-resilient design well. None of the 15 architects interviewed by Charlesworth (2014) [17] had encountered the concepts and practices of public-interest design (Adendroth and Bell 2019) [31], humanitarian architecture (Zuckerman Jacobson and Ban 2014) [32], or any related fields. Indeed, they often lamented that the kind of professional attitudes and ambitions that were encouraged during their training mitigated against a view of architecture as a community service akin to public health or human rights law in medical and legal education. Instead, they came to the field of design and disasters as the result of personal and family values and career aspirations to expand their sometimes-limited disciplinary backgrounds.

These five themes speak not only to the opportunities available to expand the scope and impact of architecture and other built environment professionals, creating a wider 'spatial agency' (Awan, Schneider and Till 2011) [33] for designers. They also provide a case for the reform of architectural and design education. As Till (2020) [34] noted, increasing the social engagement values and skills of designers requires a review of the aims, content focus, and culture of much architectural education, which, he argues:

. . . inevitably edits down the social context of any project: rushed site visits, often abstract briefs with no clear user or client to engage with, and compressed timescales all mitigate against development of the skills required for socially engaged architecture. In addition, the standardized diet of juries, long nights, and isolation from other disciplines further consolidates the de-socialization of architecture students as they are admitted into the rituals of the tribe. A move towards a more socially engaged practice therefore needs a distinct shift in the processes, projects, and ethos of architectural education.

The next section reviews ways in which designers are increasingly being educated to work in disaster-resilient design, and includes a case study of a sample studio that illustrates the pedagogical principles appropriate to this.

#### 4. Learning for Disaster-Resilient Design

The relative lack of attention to disaster management in design education has been noted for well over a decade. Writing in 2004, one commentator noted that this reflected the general neglect of design responses to national and global issues in the curricula of most architectural and design education programs (Bristol 2004) [35]. Papers by Griffith (2004) [36] Lloyd-Jones (2006) [37] and Lloyd-Jones et al. (2009) [38] Owen and Dumashie (2007), [39] Cage et al. (2009) [40] Wang (2010) [41] and Thurairajah et al. (2011) [42] confirmed this neglect and, along with Bristol, offered a range of content and skill objectives for integration into design education, specifically, and also into professional education in the wider built-environment disciplines. However, by 2016, Acar and Yalcinkaya (2016) [43] still noted that the body of literature on integrating disaster-management perspectives into the architecture curriculum remained ‘relatively scarce’ (p. 4), in that ‘the number of undergraduate and post-graduate programs which integrate disaster-management perspectives into their curriculum as a long-term proactive strategy to build resilience is very low’ (p. 1). Even in 2018, it was being lamented that the ‘expansive pedagogic practices’ envisioned for design education ‘remain the exception rather than the norm’, with many common practices, especially in architectural education, criticized for mitigating ‘against development of the skills required for socially engaged architecture’ (Till 2018, p. xxix) [44].

The situation at the master’s degree level seems to be more amenable to innovation. For example, The Graduate School of Design at Harvard University is a key partner in the Harvard Humanitarian Initiative and has a master’s degree specialization in Risk and Resilience. Two universities in Australia have established master’s degrees in disaster-risk management within Schools of Architecture whilst universities in many countries have individual courses on architecture for climate-change adaptation and disaster resilience within their postgraduate degrees. In Europe, a small but growing group of university schools of design and architecture has been meeting since 2016 to explore and share developments and practices in specialist master’s degrees on design for disaster and displacement. The objectives of these symposia included: building teaching and research collaborations; cross-enrolment of students in courses and field studies across the universities; and knowledge exchange with leading international delivery agencies, such as IFRC, UNHCR, and UN-Habitat. Participating universities include: Aalto and Hanken in Finland; UCL, Oxford Brookes, and Westminster in the UK; ETH in Switzerland; UIC in Spain; Paris-Belleville in France; KU Leuven in Belgium; University of Naples, Milan Polytechnic, and University of Venice in Italy; and RMIT from Australia. Each of the universities has written case studies of their master’s programs and the pedagogical principles underpinning the curriculum, including reviews of particular design-education activities and studies. For example, KU Leuven provided cases studies of skill development in landscape urbanism to address flood problems in the Yangtse River Delta in China and the Guayas River Delta in Ecuador, while Westminster and RMIT reported on field studies on design responses for climate adaptation in Vietnam. (Reports of the case studies and discussions from the 2018 and 2019 meetings may be found under the heading ‘International Symposia’ at <https://harbureau.org/#publications>).

Drawing upon their experiences of teaching disaster-resilient design, this group has identified several recurring conceptual, ethical, and operational themes, including:

- The importance of critical reflection on design for disasters and displacement as the ‘new normal’
- The desirability (or otherwise) of a competency framework for curriculum development in the field of design for disaster mitigation and recovery
- The practice of designing for a much wider range of clients than in commercial architecture, many of which are marginalized and may have few resources
- The ethical and political dimensions of design as a break with traditional ‘modernist’ practice in the profession
- The importance of teaching ethics in design education

- The challenge of teaching the values and skills underlying socially engaged co-design practices
- The value of integrating teaching and learning with research—co-produced, evidence-based practice
- Pedagogical challenges such as integrating conceptual knowledge of key issues through field-based studies and simulations.
- Integrating systems thinking and design thinking as pedagogical and professional tools.
- The value of developing transferable, 21st-century skills and predispositions suitable for employability in the disaster and humanitarian fields, especially for working with vulnerable people living under hardship.

### 5. Climate Change, Design, and Development Study, Hôi An, Vietnam

Many of these issues can be illustrated through a case study of an international design studio conducted in Vietnam, which was presented at the European network's 2019 symposium. Convened by RMIT University, the studio was part of a semester-long course called 'Climate Change, Design and Development', which is a module in a degree called the Master of Disaster, Design and Development (MoDDD). The degree provides an early-to mid-career qualification for people wishing to transition their careers into the disaster-management field and, to cater for this, are taught through a blended learning format (online and face-to-face). The underlying philosophy throughout all courses is systemic design (an integration of systems and design thinking), which is used as a process for understanding issues and addressing problems in the complex and dynamic field of disaster-risk management. This means that the program is interdisciplinary and involves courses and students not just from architecture and planning but also engineering, communications, social science, project management, development studies, and environmental management. There is a strong emphasis on the promotion of research and operational skills for future employment through regular and intensive interaction with industry professionals through weekly webinars, field studios, intensive workshops, internships, and a capstone industry research project that students undertake as their final course. (Details of the degree program may be found at [www.masterdisasterdesigndevelopment.com](http://www.masterdisasterdesigndevelopment.com)).

The learning objectives of the 'Climate Change, Design and Development' studio in Vietnam included developing skills for:

- Synthesizing knowledge from a variety of scientific and community-based sources on climate change, and the links between climate change and disasters
- Evaluating key strategies of climate-change adaptation and disaster-risk reduction, and their differences and convergences
- Interpreting and analyzing the implications of climate change and disasters for the built environment, in parts of the Asia-Pacific region, from diverse perspectives and sectoral linkages
- Working effectively with others in a field-based situation and demonstrating social, intercultural, and environmental awareness
- Communicating using diverse formats and strategies to engage with a range of stakeholders.

There were two parts to the course. Part 1 explored key concepts and trends in climate change and strategies for adaptation through a set of online materials, webinars, and workshop assignments. Part 2 was a design study on the design of adaptation strategies for the historic town of Hôi An and its environs. This brief case study focuses on the design study. A cross-disciplinary group of ten architects, landscape architects, urban designers, planners, and built-environment professionals, as well as people with backgrounds in journalism and international development, participated. The study built upon the online studies in Part 1 and involved the sequence of activities in Table 1: (i) Site familiarization; (ii) Consultations and workshops with key local experts and stakeholders; (iii) Field investigations and data analysis; (iv) Design and planning exercises; and (v) Presentation and reporting.

**Table 1.** The sequence of learning activities and associated learning principles in the case study of learning to design for disaster resilience.

Phases in the Study	Learning Activities	Pedagogical Principles
1. Site familiarization	<ul style="list-style-type: none"> <li>An annotated mapping and photographic exercise focusing on the biophysical landscape, the centrality of the river and flood plain to economic activities, and architecture and culture heritage</li> <li>Statistical analysis of demographic and economic change in Hội An and surrounds</li> </ul>	<ul style="list-style-type: none"> <li>Field immersion</li> <li>Intercultural communication</li> <li>Stakeholder meetings</li> <li>Systems analysis</li> <li>Focus on socio-ecological relationships and drivers of change</li> </ul>
2. Consultations and workshops with key local experts and stakeholders	<ul style="list-style-type: none"> <li>Climate-change science and impacts in Vietnam</li> <li>Flood-risk scenarios for Hội An region</li> <li>Resilience Index research in Vietnam and Hội An</li> <li>World Heritage values in Hội An and climate-change threats to, and impacts on, heritage values</li> </ul>	<ul style="list-style-type: none"> <li>Stakeholder meetings</li> <li>Respect for scientific, social-science, and cultural knowledge and evidence</li> <li>Synthesis of knowledge forms</li> <li>Identifying design implications</li> </ul>
3. Field investigations and data analysis	<ul style="list-style-type: none"> <li>Situational Analysis</li> <li>Coastal and wetland vulnerability analysis</li> <li>Typhoon-resistant housing</li> <li>Gender issues in climate-change adaptation</li> </ul>	<ul style="list-style-type: none"> <li>Vulnerability analysis and mapping</li> <li>Recognition of traditional knowledges and flood adaptations</li> <li>Design and precedent analysis</li> <li>Gender sensitivity and design</li> <li>Stakeholder consultation</li> </ul>
4. Design and planning	<ul style="list-style-type: none"> <li>Flood- and typhoon-resistant house designs</li> <li>Landscape adaptations to flooding and coastal erosion</li> <li>Design of an Adaptation Pathways Plan</li> </ul>	<ul style="list-style-type: none"> <li>Linking systems thinking and design thinking through systemic design processes</li> <li>Development of design provocations</li> <li>Stakeholder consultation and revision</li> <li>Adaptation Pathways Planning</li> </ul>
5. Presentation and reporting	<ul style="list-style-type: none"> <li>Presentation preparation</li> <li>Presentation to key stakeholders encountered in various activities</li> <li>Report writing</li> </ul>	<ul style="list-style-type: none"> <li>Oral and written communication</li> <li>Stakeholder consultation</li> <li>Report writing and design</li> <li>Podcast production</li> </ul>



Figure 1 is a collage of images that illustrate this process. The primary objective of the study was to develop a number of design recommendations in Hội An to help build local capacity to adapt the built environment for climate resilience. Given the increasing pressures of tourism and sea-level rise on the town, planning ahead to mitigate such risks is critical for the future of the environmental, political, and cultural landscape of this central Vietnamese town.



1.

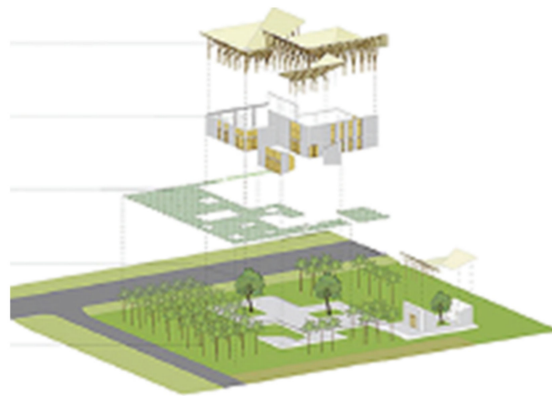


2.

Figure 1. Cont.



3.



4.



5.

**Figure 1.** Images of the learning activities in the Hôi An case study. **1.** Site familiarization: Group cycle trip to identify infrastructure vulnerabilities along the road from Hôi An to the coast. **2.** Workshop by local experts: Heritage in Hôi An. **3.** ((a) left) Field investigation: The use of wetlands to protect against storm surges during typhoons. ((b) right) Data Analysis: Vulnerability map-ping. **4.** Design: Planned green spaces around the city aim to slow down urbanization and limit further increases in building density, making way for more water runoff. **5.** Reporting: Interviewing householder for a podcast.

Climate-resilient designs for Hôi An were developed along a transect from the Historic “Old Town” towards the coast and estuary. Figure 2 depicts some of the design-based recommendations that were developed for these two precincts. They illustrate the application of findings from the systems analysis that occurred in Phases 1–3. These included the continued use of two-story construction such as in the traditional adaptation techniques of

shop-houses in the “Old Town”, where light furnishings and retail stock from the ground floor can be raised to the second floor during flood periods. They also included the design of mangrove planting to provide a resilient nature-based solution to increased coastal erosion, and building typhoon-resistant houses on the urban fringe on stilts, rather than concrete slabs, as both flood and typhoon protection, and to ensure that the expansion of housing into the peri-urban padi-fields does not increase runoff by reducing the permeability of the soil to rain and flood water.

A summary of the report was presented to a workshop attended by twenty Hoi An City and Quảng Nam Province officers and community representatives. These stakeholders recognized the value of the report but were also able to identify ways in which the study could be improved in the future. This included working even more closely with key stakeholder groups and focusing on adaptation needs in additional parts of the region. In addition, they offered to provide support to study additional issues in future design studies, e.g., quantitative data on mangrove-restoration schemes and construction density policies, building regulations, economic vs. human losses from flooding in Hoi An, and social vulnerability. This advice is being integrated into future design studios for the course.

## Old-Town Interventions

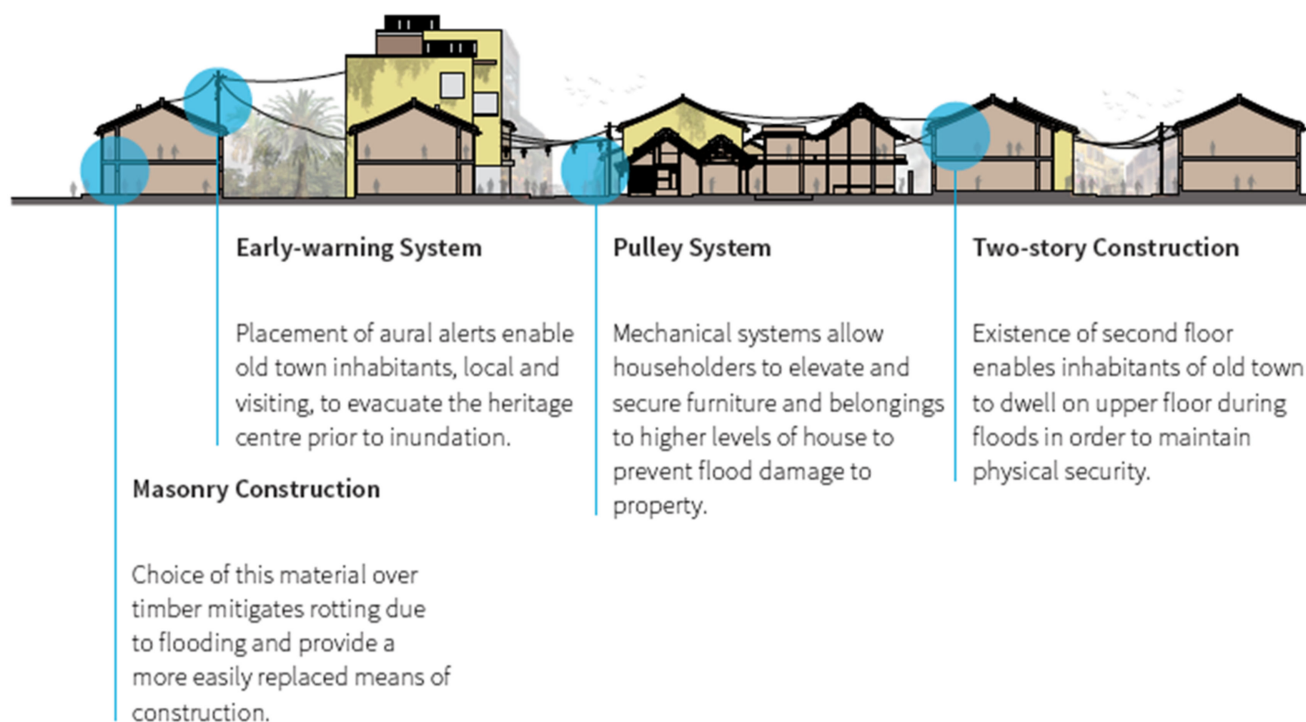
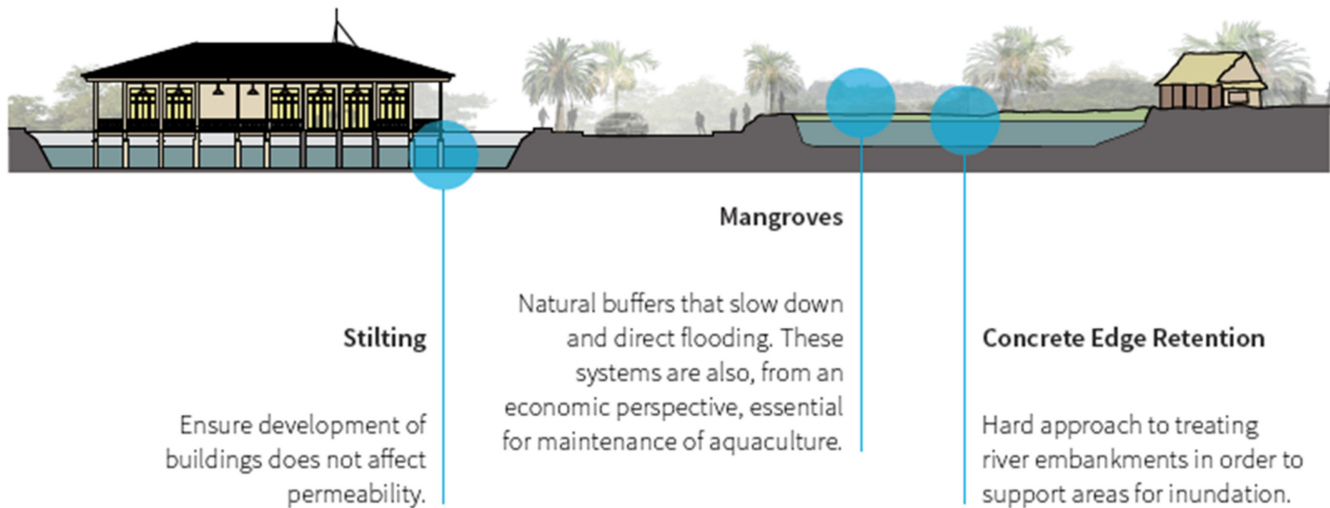


Figure 2. Cont.

## Estuary Interventions



**Figure 2.** Recommended designs for climate-change adaptation in two precincts of Hoi An.

Perhaps, the test of the efficacy of this study and the learning for disaster-resilient design that it sought to develop is to be seen in the vocational destinations of the students. Of the ten who undertook the 'Climate Change, Design and Development' course, four are now employed by development and disaster-based NGOs: Hannah by WADNA (Women and Development Network of Australia), Jaspreet by GAD Pod (Gender and Disaster Pod), Heidi by Live and Learn (from where she coordinated the COVID-19 communications program for the Australian government in the South Pacific), and Bjorn (a consultant for Oxfam on the design of blockchain for cash payments post-disaster, and now innovation Manager with the Humanitarian Innovation Fund). Nikhila is an Innovation Fellow in a School of Architecture in Australia; Carolina and Victoria are continuing postgraduate studies in international development; and Junyang, Alex, and Yingjie have returned to practice in landscape architecture with an increased commitment to disaster resilience in design.

## 6. Conclusions

This paper has sought to provide answers to the two questions posed in the introduction: (i) What can be learnt from examples of design-based responses to disaster mitigation and recovery? (ii) How can the skills needed to integrate design into disaster-risk management be developed? In doing so, it explored issues and lessons from design-based responses to disaster mitigation and recovery to develop a rationale for increasing the use of design strategies in addressing some of the 'wickedness' in disaster-risk management. It also provided principles and an example of how the skills needed to integrate design into disaster-resilience projects can be developed in future curricula in undergraduate and post-graduate design education and, thus, increase the interest and capabilities of design professionals in contributing to disaster-risk management.

In investigating the role of design in mitigating the damaging impacts of disasters and conflict, the paper has explained how design can be used as a strategic tool in developing interdisciplinary and innovative solutions to the often intractable, but ever-increasing, risks of (un-)natural disasters, sea-level rise, and human displacement. With unprecedented numbers of people globally rendered homeless by disasters, it is important to understand

how previously under-utilized disciplines, such as architecture, can contribute to building disaster resilience. Other key learnings from the paper include:

- International, government, and community agencies are struggling to implement effective strategies for disaster-risk reduction and for planning long-term recovery after disasters. The central challenge these agencies face is the development of policies and practices for reducing the vulnerabilities that prevent communities from becoming more disaster-resilient. Design can be seen as a critical bridge in planning for disaster mitigation and recovery.
- There is a practice–theory gap between the community-led processes needed for long-term recovery and the product-delivery culture that characterizes many shelter and settlement programs. The result is often a ‘one size fits all’ approach to housing, with insufficient attention paid to the aspirations of the people most affected and the infrastructure needed.
- The skills of experienced system and design thinkers, such as architects, urban planners, and landscape architects), are seldom employed in the disaster-risk-management field, despite their demonstrated capacity to work with communities and to develop integrated spatial responses to guide both disaster-risk reduction and long-term rebuilding after a disaster. Developing design solutions at housing and settlement scales, e.g., preparing house designs and community master plans, is the core competency of architecture. However, this expertise has been neglected and the number of built-environment professionals such as architects equipped to respond in such situations is still very low.
- While there is an innate conservatism in most design degrees in terms of dealing with critical social challenges and crises, specialized masters degrees incorporating disaster-resilient design are emerging, and are training the next generation of disaster, humanitarian, and development professionals.
- The paper has outlined the contributions of design as a disciplinary and operational tool to deal with many of the social, environmental, and economic crises now being faced. However, a reorientation of design education is needed so that it addresses core disaster-risk-management concepts, such as vulnerability, urban resilience, climate-change adaptation, risk-based design, and scenario and community planning. Otherwise, it will not achieve its potential value in enhancing disaster resilience.

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