

Disasters and the Built Environment

Research Roadmap



**International Council
for Research and Innovation
in Building and Construction**

Title	Disasters and the Built Environment
Subtitle	Research Roadmap Summary
Serial title	CIB Publication 410
Edition	1 st edition
Year	2016
Authors	Dr Lee Boshier, Dr Jason Von Meding, Dr Cassidy Johnson, Dr Fatemeh Farnaz Arefian, Dr Ksenia Chmutina, Dr Yan (Alice) Chang-Richards
Language	English
Key words	Disasters, Built Environment, Research, Agenda
ISBN	978-908-0302-2-04

Responsible CIB Commission: W120 – Disasters and the Built Environment

Publisher	CIB General Secretariat PO Box 516, 2600 AM Delft The Netherlands email: secretariat@cibworld.nl www.cibworld.nl
-----------	--

Forewords

Dr Wim Bakens – Secretary General CIB

We are all beginning to realize that making the built environment resilient against to be expected impacts from climate change and other threats will take society an enormous investment. It is not only about making the physical environment resilient. If a city is to be resilient its social, economic and institutional infrastructures need to be resilient too. If a city, or whatever type of built environment, has really ambitious resilience goals, the needed approach will be far reaching and of a challenging complexity. It requires the development and implementation of and experimentation with new concepts and technologies and research has a major role to play in this. With this research roadmap CIB hopes to show the international research community how it can be most effective in supporting society as a whole to become more resilient. We hope that this publication will help and in fact stimulate both national and international research funding agencies, research institutes and research dissemination organisations in Building and Construction to define the right priorities and to do this in a worldwide cooperation.

Dr Jerry Velasquez , Chief of Section, Advocacy and Outreach UN Office for Disaster Risk Reduction (UNISDR)

Rapid urban growth, presents challenges, including increased disaster vulnerability and exposure, as well as opportunities especially to local governments, as the closest level of government to citizens and their communities and responsible for many basic social services. For the first time globally, annual economic losses from disasters exceeded US\$100 billion for five consecutive years. During these last 10 years of record-breaking temperatures and rainfall, we have seen economic losses close to US\$1.4 trillion.

The growing need for global action to build resilience and reduce risks has not gone unnoticed. In 2015 a series of global frameworks were adopted starting with the Sendai Framework for Disaster Risk Reduction, the Sustainable Development Goals and the Paris Agreement on climate change. The importance of the involvement of the local level for effective disaster risk reduction, in particular urban resilience, has been recognized by the Sendai Framework and the SDGs. The cooperation between CIB and the United Nations Office for Disaster Risk Reduction (UNISDR) Campaign, “Making Cities Resilient: My City is getting ready!” have been useful in the development, and will be useful in the implementation and follow-up of these global agreements, in particular in reducing disaster risks and addressing disaster risk factors in the built environment.

Prepared by

- **Dr Lee Boshier** (Water, Engineering and Development Centre, Loughborough University, UK)
- **Dr Jason Von Meding** (School of Architecture and Built Environment, University of Newcastle, Australia)
- **Dr Cassidy Johnson** (DPU, University College London, UK)
- **Dr Fatemeh Farnaz Arefian** (IRDR/DPU, University College London, UK)
- **Dr Ksenia Chmutina** (School of Civil and Building Engineering, Loughborough University, UK)
- **Dr Yan (Alice) Chang-Richards** (Department of Civil and Environmental Engineering, The University of Auckland, New Zealand)

With peer assist from:

- Members of W120 and TG63
- Staff from UNISDR
- Secretary General Dr Wim Bakens

Contents page

Forewords	2
Contents	3
Towards a CIB-UNISDR Research Roadmap	4
Introduction to the Roadmap report	5
Conceptual Framework	6
The state of the art	10
Key Research Roadmap considerations	15
Implications for the W120 Research Roadmap	17
The Future Scenario	18
Development strategy	19
Future research contribution and agenda	20
References	22
Annex 1: Resilient Cities Webinars: Contributors and key findings	24
Annex 2: Report on the CIB W120 Public Forum	27
Annex 3: Acknowledgments, contributions and consultations	30
Annex 4: Author biographies	31

Towards a CIB-UNISDR Research Roadmap

W120 – ‘Disasters and the Built Environment’: Objectives and Scope (2014-2017)

In 2014 the CIB Programme Committee established a new Working Commission (W120) that would focus on issues related to ‘Disasters and the Built Environment’ and appointed Dr Lee Boshier (Loughborough University) and Dr Jason von Meding (University of Newcastle) as Joint Coordinators. W120 is a successor to TG63 that was established in 2010 under the coordination of Dr Richard Haigh (Salford University) and Dr Cassidy Johnson (University College London).

Objectives and Scope

Rapid growth of urban centres presents numerous challenges to humanity, many of which can be addressed through built environment solutions. In the face of more frequent and powerful hazards, the future of vulnerable and growing populations is increasingly perilous. Against this background, recognising both this vulnerability and the importance of protecting and enhancing life, the objectives of the Commission are:

- to explore optimum means of engaging multiple stakeholders in collaborative projects that address issues of disaster and development through built environment solutions
- to encourage strategic urban planning through development of an evidence base supporting built-in disaster risk reduction (DRR)
- to advocate for the deployment of the appropriate built environment professionals in support of DRR activities
- to develop tools / frameworks / models to support built environment organisations in complex environments in a variety of global contexts
- to support the embedding of disaster and development issues in the curriculum of built environment disciplines globally, encouraging the consideration of broader career paths, and
- to encourage built environment professional bodies (engineering, architecture etc.) to include a similar obligation in their educational base requirements.

Work Programme

The Commission's Work Program includes:

- stimulating and facilitating experts' discussion worldwide via social media
- triennial updating of a Research Roadmap
- best practices Webinar series
- participation with scientific sessions and workshops in international conferences and congresses, including the triennial CIB World Building Congress and the i-Rec conferences
- setting up and facilitating an international, Commission related Student Chapter on Disasters and the Built Environment

CIB Cooperation with UNISDR

CIB and the United Nations Office for Disaster Risk Reduction (UNISDR) Campaign, *“Making Cities Resilient: My City is getting ready!”* have set out a partnership agreement, outlining intentions to cooperate on information sharing and policy development within their respective domains. One initiative of this partnership has been a series of web-based seminars (webinars) held in May 2012 that was originally set up as part of the TG63 activities. More recently CIB W120 organised a workshop on ‘Reducing disaster risks in the built environment’ at the UNISDR’s World Conference on Disaster Risk Reduction (WCDDR) in Sendai, Japan. The development of this joint CIB – UNISDR research roadmap started in 2013 and is now being finalised outlining the future directions for research in substantive areas of joint interest between CIB and UNISDR.

As part of its commitment to the partnership with UNISDR, the CIB Secretariat has financially supported the coordination of the webinars, the development of this research roadmap and the organisation of a workshop at the Sendai conference in early 2015. The coordinators and members of W120, and before that TG63, have been instrumental in carrying out the actions of this partnership thus far, and working with officers from UNISDR, to coordinate the webinars and develop future initiatives. It is also intended that the initiatives outlined in this document will align with the World Bank's Global Facility for Disaster Reduction and Recovery's new "Building Regulation for Resilience" Program.¹

Introduction to the Roadmap report

The CIB Secretariat has developed a framework (see Figure 1) to illustrate how a CIB research roadmap should be designed.

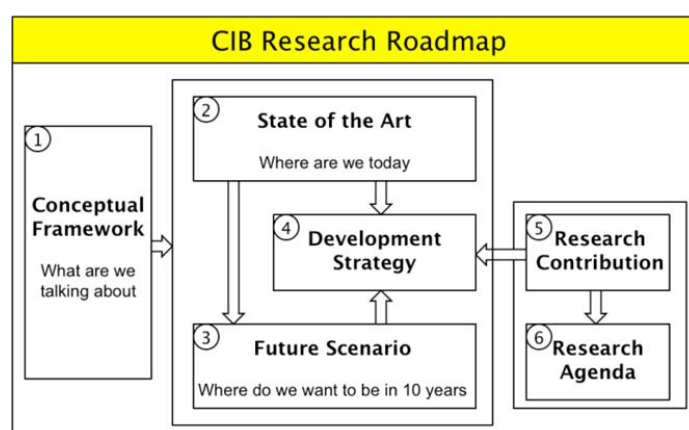


Figure 1: Outline of R&D Roadmap (Source: CIB Secretariat)

As indicated in Figure 1, the research roadmap addresses the following six themes:

1. **Conceptual framework:** What are we talking about? The conceptual framework may address questions like: What are the issues, how do those interrelate, what influences all of this, who are the stakeholders, what are the relevant areas of expertise, what are the characteristics of the most relevant systems, processes and technologies.
2. **State of the art:** Where are we today? The roadmap will describe the state of the art on technology, best practices, differences in parts of the world, perceived problems, challenges, needs for improvement, who are the world's leading centres of expertise etc.
3. **Future scenario:** The roadmap will unfold a vision on where we want to be in the future, e.g. in ten years' time including the stakeholders' opinions on required/envisaged future systems, processes and technologies, preferred future practices and skills etc.
4. **Development strategy:** What is needed in terms of knowledge, education, information, tools, concepts and applications to enable the respective systems, processes and technologies to develop from where we are today to where we want to be in the future?
5. **R&D Contribution:** How can research and development (R&D) contribute to such a development strategy, and what are the requirements for R&D to indeed contribute?
6. **R&D Agenda:** What is to be the agenda for research worldwide? What will be relevant areas of science and technology development, required sequences of development, priorities for research, international cooperation within the research community, cooperation between research and practice etc.

¹ World Bank (2016) <https://www.gfdrr.org/buildingregulation>

Methods for the development of the roadmap

The roadmap has been largely drawn from the series of the webinars that were conducted in May/June 2012. The webinars shared knowledge and expertise between CIB members, the United Nations Office for Disaster Risk Reduction (UNISDR), and cities that are involved in the UNISDR's 'Making Cities Resilient' Campaign. The target audience for the webinars were local governments, disaster risk reduction practitioners, planners and researchers.

The webinars were jointly organised by CIB and the UNISDR and these provided an important international and multi-disciplinary forum for discussing key research ideas and agendas related to disasters and the built environment. There were four webinars held over a one-week period on different topics, including: 1) Enabling risk reduction through urban planning, 2) Engaging multiple stakeholders in DRR for cities 3) People's needs and expectations in post-disaster reconstruction 4) Making Cities Resilient campaign local government self-assessment tool.²

The roadmap is also built on a number of relevant resources, including collective empirical inputs from a number of case studies, references that synthesise literature and dedicated expert meetings. Sources include:

- UNISDR's Global Assessment Reports from 2011, 2013 and 2015, in which the W120 coordinators were invited to contribute background papers on themes related to disasters and the built environment
- A broad range of research papers, working papers and references synthesising literature on theory and case studies
- CIB supported books and journals, including *Building Research and Information* and *International Journal of Disaster Resilience in the Built Environment*
- Information provided on the UNISDR and CIB official websites
- Discussions and feedback on key topics at the W120 workshop that was held at the 2015 UNISDR World Conference on Disaster Risk Reduction (WCDRR) in Sendai, Japan

Consultation process

An early draft of the roadmap was presented to CIB members, UNISDR and other interested stakeholders during consultation meetings held at the CIB 'World Building Congress' in Brisbane, Australia 5-9 May 2013, and at the i-Rec Reconstruction Conference in Switzerland, 26-May 2013.³ Some of the consultation noted that the roadmap was being drafted during a period of transition, with TG63 in the process of becoming W120 and key international frameworks such as the Hyogo Framework for Disaster Risk Reduction and the Millennium Development Goals being under review at the time. Therefore, further consultation of the Research Roadmap was put on hold until new international frameworks had been finalised in late 2015. Thus an updated draft of the Research Roadmap, with relevant acknowledgement of these new international frameworks, was then presented for consultation at the CIB 'World Building Congress' in Tampere, Finland in May 2016.

Conceptual Framework

Mainstreaming the disaster risk reduction strategies and measures that should be undertaken during the design, construction and maintenance of the built environment, with the aim of making the built environment more resilient to the impacts of natural hazards and human induced threats.

² Contributors to the resilient cities webinars and summary of the key findings are listed in Annex 1

³ The consultation meeting attendees and researchers who provided feedback are listed in Annex 3

The frequency of disastrous events has significantly increased during recent decades. Extreme weather events account for significant damage to cities, with annual direct losses now reaching an average of US\$250 billion to US\$300 billion each year (UNISDR 2015). However, the economic costs of disasters are only one part of the problem, with the impacts on human life being the most fundamental and distressing elements of these effects. Figures obtained from EM-DAT (2014) indicate that between 2000 and 2013, on average 226 million people per year (that is approximately 3% of the world's population) were affected by all types of disasters. During the same period, nearly 2 million people were killed, an average of 148, 894 people each year (EM-DAT 2014). While the frequency of natural hazards is increasing, urban environments are more vulnerable and at the risk of so called 'natural disasters' than rural environments. Simultaneously the fast trend of urbanisation, especially in low- and middle-income countries, is leading the globe towards becoming an increasingly urbanised world. It is cited that more than half of the world's population now live in a city, and, according to a United Nations projection, by 2050 two thirds of the world population will live in cities.

Great numbers of cities are located in, or adjacent to, disaster prone locations, exposing increasing numbers of people to natural hazards, *"the physical exposure itself does not explain nor automatically lead to increased risk. It needs vulnerability to generate levels of disaster risk"* (UNDP, 2004: 30-31). Cities in developing countries grow rapidly, placing increased strains on infrastructure and services, causing the formation of informal settlements in or around the cities. Poor conditions of existing houses and infrastructure and the inappropriate land-use planning are among the 'human induced' reasons why cities are becoming increasingly susceptible to natural hazards, especially in low- and middle-income countries (Ofori 2011).

The role of the built environment

As Hillebrandt (2000) and Han & Ofori (2001) assert, the built environment accounts for a significant proportion of every nation's savings. The building and construction sector is a major component of a country's physical assets and plays major contribution to nation's economic development (Bosher *et al.* 2007). Built environment is also the largest emitter of the greenhouse gas (GHG) emissions thus significantly contributing towards the causes of climate change. By the same token, however, the built environment is also extremely vulnerable to the effects of climate change and the impacts of disasters on the built environment can be so profound as to wipe out years of development and investment (Ofori 2011). Future (expected annual) losses are now estimated at US\$314 billion in the built environment alone (UNISDR, 2015).

The built environment is characterised by a number of different building practices, such as 1) speculative development of all kinds; 2) construction of commercial premises, i.e. services or production by businesses; 3) infrastructure development; 4) individual housing, either formal or informal (Johnson, 2013). These conditions apply to both pre-disaster scenarios (usual urban/rural development activities) and post-disaster scenarios (recovery and reconstruction activities).

The built environment is life's infrastructure it reflects who we are in the human ontological project, it protects and enhances or ethical and societal needs yet all the while it contributes to our vulnerabilities. The built environment professional's single most important function is protecting and enhancing life (civic ecology) whether it is in disaster resilient design and construction practices or in disaster recovery and reconstruction activities. In defining the role of the built environment and in maintaining and sustaining it the single pillar of protecting and enhancing life needs the supporting stays or foundations of: energy, water, food and human transportation infrastructure; environmental enhancement and biodiversity; health, safety, well-being. Humanitarian engineering and disaster response requires innovative built environment design for now and the future.

The built environment forms differing scales from single buildings to large-scale infrastructure and includes urban development activities that are undertaken by both the public and private sectors. The development of the built environment comprises simple building projects and/or flagship infrastructure mega projects; which are typically implemented incrementally (and too often independently of each other), shaping the built environment over a long-term period of time. The establishment, operation and maintenance of the built environment therefore engages a wide variety of professionals, including architects, planners, engineers, managers, and trades in various specialist fields in the stages of planning and design, construction and building, maintenance and management. Skillsets, tools and measures that underpin this development and the interactions of the many stakeholders include design codes and building regulations, technological systems and legislations, enforcement laws, industry practice and funds.

The term 'built environment professional' includes those primarily concerned with providing technical support services – consultation and briefing, design, planning, project management and implementation and technical investigations including monitoring and evaluation studies. They may be employed directly by a client or indirectly through a contractor. Built environment professionals may also be concerned with designing and implementing policy, standards and regulation of the built environment – essential factors in reducing the risks from hazards – or are exclusively or partly involved with training, professional education and research. The professions include engineers, architects, quantity surveyors, building surveyors, land surveyors, planners, administrators and land tenure specialists who are concerned with sectors such as housing and land issues that are particularly highlighted in any post disaster situation (Lloyd-Jones, 2009) but also should include the broad range of subcontractors or sole traders that can also play an important part in reducing disaster risks in our built environment. Thus it is increasingly being recognised that a wide range of risk reduction options can be mainstreamed into formal and informal construction decision making processes, so that Disaster Risk Reduction (DRR) can become part of the 'developmental DNA' (Bosher and Chmutina 2017).

Disaster risk reduction (DRR)

The need for reducing the socio-economic loss from natural hazards triggered an international consensus. Following the Hyogo Framework for Action 2005-2015, a Sendai Framework for Disaster Risk Reduction 2015-2030 (SFA), was introduced and negotiated during the 3rd United Nations World Conference on DRR in March 2015 in Japan. The new Framework is a more nuanced version of the existing HFA, with some overall guiding principles, a set of common standards, targets, a legally based instrument for disaster risk reduction, and a combination of these. Taking into account the experience gained through the implementation of the HFA, and largely maintaining its expected outcome and goal, the new Framework offers more focus on multi-stakeholder approaches at local, national, regional and global levels in the following four priority areas:

1. Understanding disaster risk;
2. Strengthening disaster risk governance to manage disaster risk;
3. Investing in disaster risk reduction for resilience;
4. Enhancing disaster preparedness for effective response, and to "Build Back Better" in recovery, rehabilitation and reconstruction.

The SFA points out the roles of various stakeholders, including the State as well as civil society (and the most vulnerable population groups), academia, private businesses, and media as well as international organisations. The framework also emphasises the role of the international cooperation and global partnership. It is notable that some of the principles espoused by the SFA are also reflected in some of the seventeen revised Sustainable Development Goals (SDGs), such as (9) Build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation,

(11) Make cities and human settlements inclusive, safe, resilient and sustainable, and (13) Take urgent action to combat climate change and its impacts.

Stakeholders

Given the wide spectrum of construction sector activities there are a wide range of building and construction stakeholders that need to be involved in DRR and their inputs need to be optimised (ideally in the pre-construction stages). Urban stakeholders at micro (household and individuals), meso (organisational, community) and macro (national, regional and policy) level all engage in similar areas of activity for DRR, including assessment and planning, physical and environmental protection, response capacity development. For example, it is sometimes said that earthquakes don't kill people – buildings do. Therefore, where those buildings are located, the way they are designed, built, and maintained, is critical to their ability to resist different types of natural hazard (Chief Executive of Disasters Emergency Committee cited in Lloyd-Jones, 2009).

Figure 2 shows there are several factors that can potentially influence the urban construction environment (Johnson *et al.* 2013). The motivations and interests of different actors, for example local governments and their regulations, insurance industry, built environment professionals, investors, insurance companies, and land owners all influence how and where investments in construction are made.

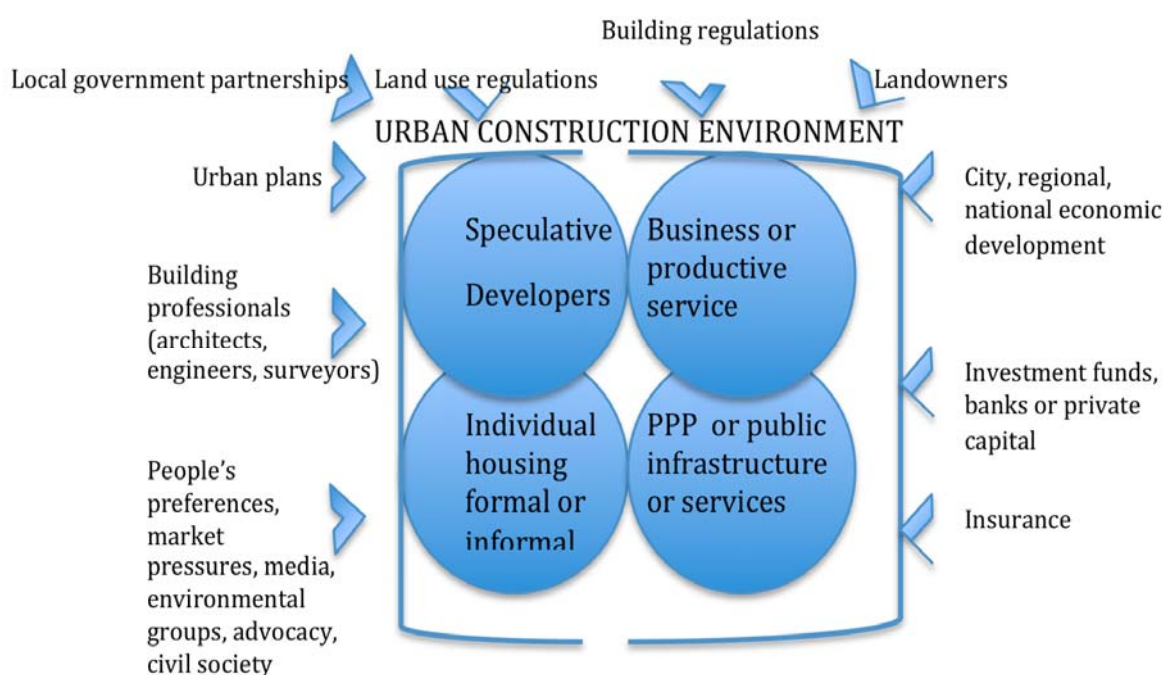


Figure 2: Factors potentially influencing the production of risks in the urban construction environment (Johnson *et al.* 2013; UNISDR 2013)

The private sector is one of the most influential stakeholders in the construction industry and consequently this sector's role needs to be further explored. Although it is generally recognised that the private sector has an important role to play in addressing the increasing socio-economic consequences of disasters, there has been relatively little effort to understand the potential for contributions by specific industries (World Economic Forum in collaboration with Arup, 2010). In partial response to this knowledge gap, the UN's *Global Assessment Report on Disaster Risk*

Reduction 2013' (UNISDR 2013) set out to explore the extent to which increasing disaster risks represent a growing problem for the economic and business community at different scales; in most economies, public investment represents only 15-30 % of total capital formation. How disaster risk is addressed in the other 70-85 % of capital investment is therefore critical. This is further emphasised in GAR 2015: *"The disaster risk management sector has had little success in mainstreaming its priorities and ensuring that other ministries or departments adopt policies, norms, standards and regulations to manage and reduce risk. Similarly, there has been little systematic engagement with the private sector in most countries, except through the lens of corporate social responsibility"* (p.121). Some of the key findings of the recent GARs (UNISDR 2013, 2015) will be drawn upon in later sections of this report.

Coordination between multiple stakeholders is necessary for reducing risks in the built environment in both pre- and post-disaster scenarios. Expanded stakeholders may be implicated, such as disaster management agencies, which must work together with built environment professionals. Depending on the type or scale of the construction project, DRR for the built environment may involve stakeholders from public agencies, private sector, academic/scientific institutes, civil society organisations, opinion leaders, and development and humanitarian organisations. For instance, Local Resilience Forums that have been adopted in the United Kingdom (UK) are a good example of how 'top down' initiatives can help to encourage local stakeholders to develop locally relevant solutions to local problem (Fisher et al. 2015).

DRR competencies

Whilst coordination of multiple stakeholders is important, this approach is unlikely to be effective if stakeholders don't know the basics of DRR and sustainability (see Chmutina et al. 2014). A key message is that civil engineers are not yet sufficiently recognised as being part of the disaster risk reduction processes; in addition, they do not have sufficient training and skills. These concerns were highlighted at a forum organised by CIB W120 at the UN's World Conference on Disaster Risk Reduction in Japan in March 2015 (see Appendix 2) and further summarised by Boshier et al. (2015). Disaster risk reduction issues increasingly need to be addressed explicitly by practitioners, professional institutions and educators serving the construction sector, as this will lead to ensuring that disaster risk reduction is not a niche skill but is instead widely accepted as an important competency, integral to their ethical code and at the core of socially responsible engineering and construction practices. Whilst some of hazards such as fire and earthquakes have been included in building regulations in many countries around the world, other prominent hazards (e.g. floods) and risk reduction measures that can address these are often treated as a 'bolt-on' solution. This typically happens due to the lack of consideration of such hazards in educational and on-the-job training of many construction professions.

DRR competencies requires that the built environment professional develops a full understanding of their ethical role in terms of designing critical solutions to highly sophisticated problems with the primary aim of preserving or improving human life; having and demonstrating innovation, creativity and a passion for compassion in the delivery of disaster resilient construction and recovery solutions.

The state of the art

Following advances in disaster studies in recent decades, it is now widely understood that so called 'natural disasters' are largely human induced disasters. Each so called 'natural' disaster is a manifestation of failures in previous development activities. Over 30 years ago, O'Keefe et al. (1976) recognised that the term 'natural disaster' was a misnomer, and questioned how 'natural' so called 'natural disasters' were. They highlighted that many disasters result from the combination of natural

hazards and social and human vulnerability. This important point was more recently reiterated in a United Nation's report (UNISDR 2007).

In recent years research and empirical reports/observations have highlighted the need for mainstreaming disaster risk reduction activities (structural and non-structural) into the design, planning formation, operation and maintenance of the built environment. It is increasingly being acknowledged that the responsibilities for achieving this vision lie across many disciplines and sectors but in particular it is argued that the construction sector should play a more proactive and central role in the attainment of 'built-in' resilience. Therefore DRR competencies among the construction section professionals (that are considered in their broadest sense) should be increased through education and professional development training.

As Benson and Twig (2007) mention linking disasters and development activities ultimately necessitates mainstreaming disaster risk reduction strategies and measures in all development activities. Also Boshier and Dainty (2011) suggest that there are seven guiding principles that should be considered for mainstreaming DRR activities (structural and non-structural)⁴ into the design, planning formation, operation and maintenance of the built environment:

1. Adopt a holistic perspective.
2. Develop and appropriately apply resilient technologies.
3. Engage a wide range of stakeholders (including local communities) in resilience efforts.
4. Utilise existing guidance and frameworks when appropriate.
5. Exploit opportunities to build-in resiliency measures post-disaster.
6. Integrate built environment and emergency management professionals into the disaster risk management process.
7. Mainstream 'resilience' into the built environment curricula.

Understanding how current advances in mainstreamed measures and strategies can become more integrated parts of developmental activities requires more attention; particularly towards not only identifying technological knowledge gaps but on why the existing knowledge is not used, and how the existing knowledge can be strategically employed and coordinated across professions. Therefore the way urban development programmes and their construction activities are defined, strategised and managed becomes especially important. For example, the complex structures, the multitude of processes and project defined mentalities that underpin the construction sector indicate that propagating DRR through an integrated planning/design/construction/decommissioning effort is a problematic notion (Boshier and Dainty 2011). Also in the post-disaster context the importance of organisational arrangements that link stakeholders together have been recently highlighted. For example Davidson (2009) emphasises that organising for reconstruction is a design problem since the organisation design should identify actors and their roles.

The cases presented by Johnson et al. (2013) outline three current practices of the construction sector that are increasing hazard risks (see Table 1). These are: building in hazard prone locations; projects built in a location that exacerbates risks in neighbouring areas; projects that do not implement risk reducing building designs or infrastructure (Johnson et al. 2013).

⁴ 'Structural', refers to the use of temporary or permanent physical measures such as the strengthening of buildings and infrastructure exposed to hazards (via engineering design and construction practices, etc.). 'Non-structural', includes non-physical measures such as directing new development away from known hazard locations through land-use plans and regulations, relocating existing developments to safer areas, education/training and maintaining protective features of the natural environment (such as sand dunes, forests and vegetated areas that can absorb and reduce hazard impacts).

Table 1: Risk-inducing construction practices (Johnson et al. 2013).

Risk-inducing construction practices
Building in hazard-prone locations • Building on flood plains • Building in coastal areas subject to storm surge • Building on seismic fault lines or areas prone to liquefaction • Building on steep slopes at risk of landslides • Building near to bushfire or forest fire areas
Construction in one area exacerbates risks in neighbouring areas • Coastal erosion in adjacent areas caused by engineering techniques used in the project • Infilling of wetlands, lagoons, swamps, mangroves increases flooding in other areas • Flood reducing infrastructure, i.e. pumping, embankments, causes greater flooding elsewhere • Use of non-porous surfaces increases run-off • Pumping out groundwater is causing subsidence and increasing earthquake risks
Building designs or construction methods that do not account for known risks. Lack of risk reducing infrastructure integrated into the project • In seismic areas, designs or construction methods that are not safe for earthquakes • In flood areas, buildings that are not raised, or having critical building infrastructure located in basements • Foundations that are not deeply set can cause buildings to move in floods • Inadequate site drainage

Regulations and policies that address how the built environment is designed, planned and operated are critical for DRR, as are the ways in which land is used and buildings and infrastructure are designed and operated influence exposure to hazards and threats. Once the investment in built assets in a risk-prone location has been made, it will remain there for a long period of time; in addition, once in place it is more expensive and less effective to correct and add new DRR measures than it would have been to avoid the risk creation in the first place (GAR 2011). It is therefore clear that building regulations and planning policies can be a primary prevention, mitigation and adaptation mechanism.

There are many examples of the existence of building codes (seismic codes for the building at the risk of earthquakes), and planning regulations (preventing building construction in flood plain areas). During the past 25 years building regulations and codes have been developed for virtually every type of construction; there is also an increasing number of informal guidance for construction sector. They are constantly revised and improved (e.g. Chile and New Zealand), and the evidence show that in those countries where building codes have been effectively applied, there is a dramatic improvement in performance of new construction (Krimgold 2011). The majority of the current building codes and regulations and land-use planning policies take into account various hazards and threats (e.g. floods storm and earthquakes). However whilst these policies and regulations have shifted towards addressing the root cause of vulnerabilities to disasters, they do not often do so explicitly and focus only on a single hazard or one part of the problem; therefore the existence of certain building codes and planning regulations do not necessarily lead to a positive outcome of disaster risk reduction. In many cases, the application of building codes and planning regulation in practice has been ignored, or there is a lack of the enforcing mechanisms to prevent such ignorance by contractors, developers

and/or people/clients. In addition, mandatory built environment policies are based on the historical trends and passed events thus neglecting future projections that are critical for the effective integration of DRR measures.

Case studies showed that planning regulations and building codes can be neglected as a result of prioritising other considerations (for example, the profit margin, the project time) by the private sector during public-private sector partnerships (UNISDR 2013). Planning regulations can also be ignored by people through the formation of informal settlements. Additionally, building and planning regulations themselves can impede DRR if they:

- Are not legally enforced (Chmutina and Boshier 2015);
- Make safe building or secure land tenure unaffordable or unobtainable by the poor;
- Enforce greater inequalities in access to land or housing;
- Lead to forced evictions or reduced tenure security of people in informal settlements;
- Do not account for the existing realities on the ground, i.e. construction of small dwellings/workspaces or use of alternative building materials because they are more affordable; Already existing densities in urban areas (Johnson et al. 2013)

Reconstruction

Reconstruction following a destructive natural hazard is the most apparent conjunction of disaster studies and the built environment professionalism. In a reconstruction scenario, the number of stakeholders and actors significantly increases. The reason is in addition to traditional stakeholders in urban development and construction projects other actors (e.g. NGOs) are also involved in reconstruction. Therefore, the typical reconstruction scene is multi-actor, multi-organisation, uncertain and complex (e.g. Coppola 2006; Davis 2006; Christopolos, cited in Pelling 2007).

Rebuilding infrastructure and buildings owned by public and private sectors requires engaging the built environment professionals. Professionals are already often employed by humanitarian agencies. However, this is normally in a specifically technical role, which may limit their ability in order to advise on wider operational matters where other built environment expertise might also be usefully employed. The need for exploring the role of the built environment professionals and contributions from construction industry has been highlighted (for example, Haigh et al. 2006; Lloyd-Jones 2009; Ofori, 2008).

Despite the profound complexity in reconstruction, researchers (Osion and Gawronski cited in Wisner et al., 2004) agree that there are still potentials for improvements towards mainstreamed DRR (also see Christopolos et al. 2006). Reconstruction therefore can provide a starting point for positive DRR inputs required to attain improved urban resilience. Davis (2006) declares reconstruction is a physical opportunity supported by a collective mind set for introducing changes in structural and non-structural risk reduction elements that need to be mainstreamed into the central flow of government policies and planning, and disaster recovery may provide the catalyst for such changes. Recent approaches to disaster-development studies emphasise the links between relief, rehabilitation and development. Within this widely accepted approach post-disaster reconstruction (especially housing reconstruction programmes) is a facilitative process for multidimensional recovery, for example psychological and economic recovery (Davis 2006).

However, there are gaps in knowledge in relation to institutional arrangements, organising and managing reconstruction activities towards the delivery of such expectations in highly complex post-disaster contexts (Davis 2006). Whereas Davidson (2009) also concludes that various organisations

are involved and practical decisions have to be made in a context of competing interests. According to the World Bank (2008), the levels of complexity in urban housing reconstruction programs are generally higher than rural housing reconstruction. Thus, in reconstruction there is an ethical and moral obligation to recognise the needs of victims and survivors, their attachment to place (*topophilia*), their love of life and their sense of belonging (*biophilia*).

Recent Global DRR initiatives

Following the Hyogo Framework 'Priorities for Action' in 2011, the UNISDR initiated the 'Making Cities Resilient' Campaign, for the target audience of local governments and produced Local Government Self-Assessment Tool (LGSAT). The campaign espouses a ten-point checklist covering the essential building blocks for disaster risk reduction, developed in line with the Five Priorities of the Hyogo Framework for Action and followed up in the Sendai Framework for Disaster Risk Reduction. One of the aims of the campaign is to encourage 'urban managers' (mainly public but also including the private sector) to find and employ appropriate strategies and tools for reducing disaster risk in their cities. The essentials are listed thus:

- **Essential 1:** Put in place **organisation and coordination** to understand and reduce disaster risk, based on participation of citizen groups and civil society. Build local alliances. Ensure that all departments understand their role to disaster risk reduction and preparedness.
- **Essential 2:** **Assign a budget** for disaster risk reduction and provide incentives for homeowners, low-income families, communities, businesses and public sector to invest in reducing the risks they face.
- **Essential 3:** Maintain up-to-date **data on hazards and vulnerabilities**, prepare risk assessments and use these as the basis for urban development plans and decisions. Ensure that this information and the plans for your city's resilience are readily available to the public and fully discussed with them.
- **Essential 4:** Invest in and **maintain critical infrastructure** that reduces risk, such as flood drainage, adjusted where needed to cope with climate change.
- **Essential 5:** Assess the **safety of all schools and health facilities** and upgrade these as necessary.
- **Essential 6:** Apply and enforce realistic, **risk compliant building regulations** and land use planning principles. Identify safe land for low-income citizens and develop upgrading of informal settlements, wherever feasible.
- **Essential 7:** Ensure **education programmes and training** on disaster risk reduction are in place in schools and local communities.
- **Essential 8:** **Protect ecosystems and natural buffers** to mitigate floods, storm surges and other hazards to which your city may be vulnerable. Adapt to climate change by building on good risk reduction practices.
- **Essential 9:** Install **early warning systems and emergency management capacities** in your city and hold regular public preparedness drills.
- **Essential 10:** After any disaster, ensure that the **needs of the survivors are placed at the centre of reconstruction** with support for them and their community organizations to design and help implement responses, including rebuilding homes and livelihoods.

Figure 3 shows the worldwide distribution of the 3,310 cities that, at the time of writing, have registered to participate in the campaign; this includes over 40 role model cities. Participation in this campaign is voluntary, and it is based on self-reporting of the activities and actions in this regard.



Figure 3: The cities joined the UNISDR Making Cities Resilient Campaign (UNISDR 2016)

Key Research Roadmap considerations

Formation of the built environment, especially at city scale, is a complex system, influenced by technological, economic, social, cultural, administrative factors and trends. The application of DRR in the formation and maintenance of the built environment adds another dimension to all other forces; it overlaps all other dimensions in one way or another.

During one of the CIB-UNISDR Resilient Cities Webinars in 2012 local government managers shared their experiences on how the LGSAT was being used in their cities (a summary of the key findings from the Webinars can be found in Annex 1). The ensuing discussions on the achievements and challenges highlighted that risk reduction is still primarily identified by many stakeholders as 'preparedness' and 'response' to disasters/emergencies. Apparently the more proactive/preventative aspects of DRR were not so prominent in the consciousness of these important stakeholders. While the vision on disaster risk reduction is shared, its reflections in programmes and projects also should be integral and harmonised. Ways of translating theory into practice must be explored, and any change in approach must be deepened and extended with other stakeholders. It is clear that ways of translating theory into practice must be explored. The following issues, challenges and areas for improvement were identified several times during the Webinars and discussed at the Sendai Conference on Disaster Risk Reduction:

- **Participation by all stakeholders is needed** - International risk reduction policies are targeting urban authorities, i.e. mayors and elected officials, but these people are only temporarily in power. What is needed is a settled and sustainable culture of risk reduction targeted to a greater spectrum of actors than only local authorities. All stakeholders, particularly professionals involved in the building and construction industry and local communities, are the durable carriers of DRR culture and policy.
- **Lack of DRR competencies among construction professionals** - An open dialogue with the professional institutions about the feasibility of including disaster risk reduction as a professional

competency through core undergraduate training, on-the-job practical training and/or continued professional development courses is needed in order to mainstream incorporation of DRR – relevant skills.⁵

- **Lack of aligned and coordinated approaches** - Strategic approaches are needed to address overall risk and vulnerability instead of making laws reacting to the latest disasters. There are different planning contexts in which risks are tackled: reconstruction planning, emergency planning, mitigation planning (which is the main concern in regards to the reduction of risks and disaster losses), and resilience planning (organisation and achievement of sustainable social development). The context therefore varies from urban planning to organisation planning so it is important that the strategic approaches incorporate expertise in relation to 'disaster risk planning'.
- **DRR is currently too often managed and operationalised by the wrong types of professionals** - Despite some theoretical advances it is too often the case that the stakeholders responsible for (rather reactive) disaster relief stages (i.e. providing tents and blankets) are in charge of the broader DRR strategy, too often resulting in a rather reactive application of DRR (i.e. planning to respond rather than planning to prevent). Spatial planning is not being considered at the early stages in emergency planning in an aftermath despite the effects of emergency planning on spatial planning and built environment formation during reconstruction.
- **The existing urban development system is not capable of fostering DRR strategies** - The urban planning system, (which differs in different contexts) may or may not be capable of fostering DRR. For example, land use planning is identified as reductionist, a palliative, and an outdated way of thinking; being based on the need to organise where different functions should happen in the urban environment. Nonetheless in contemporary circumstances there is a need to put limits on growth, for technology, and to monitor complex socio-economic systems and comprehensive analysis of risk sectors. We have the ability to do this but prohibitive zoning and limiting densities are difficult to supervise and must be integrated with other powers, taxation, rent control, insurance, transfer of development rights and other supports and incentives. Mitigation planning is not described in legal systems and there tends to be no regulatory procedures in place for how this should be carried out. Inadequate legislative statutes, property values, lack of disaster expertise in the practice of land-use/spatial planning are additional constraints.
- **Lack of available hazard information, especially information that is available in the public domain** - Hazard information is a major instrument if monitoring market behaviour, demand, and thus physical development. Risk information has a taming effect on markets - people will choose to live in safer locations. City level hazard data could contribute much to increasing the effectiveness of DRR. Evidence and data (on economic, social and environmental costs of disasters and have knowledge about disaster hot-spots) are important to inform decision-making for planning and land use. From the Webinars it was clear that there are many pockets of good practice. However, we (as academics and practitioners) need to be much better at sharing this good practice and also in understanding the extent to which such practice is (or is not) transferable from one context to another.
- **Absence of mechanisms to encourage DRR** - There is a need for competitive system of aligned funds to incentivise DRR and encourage a culture of risk avoidance. The insurance sector should/could have a larger role to play in this aspect.

⁵ Here it is worth noting that Quake Core established by the New Zealand government between University of Auckland and University of Canterbury is working towards this goal (to integrate DRR and resilience skills and knowledge in tertiary education). More information can be found here <http://www.quakecore.nz/>

- **Lack of national leadership (national government was important as opposed to sub-levels of government) and support** - Central authorities sometimes show adverse attitudes towards supporting local governments, and sometimes intrude, intervene and over audit. In many cases, the legislative statutes are inadequate and it has been suggested that regional level approaches are needed, e.g. planning for entire floodplain management, to support local DRR). National strategy and legislative forces are crucial and must be aligned with other relevant documents and planning instruments.
- **The existing challenges in cities, e.g. preservation of cultural heritage, provision of affordable housing and informal settlements** - The impacts of any DRR consideration must be re-examined against other criteria and DRR itself, in order to prevent re-producing vulnerability in other forms. For example, people in informal settlements are being evicted or resettled because they are at high risk for natural hazards, but evictions can increase people's vulnerability (lack of livelihoods, social network). There are alternative approaches to top-down state led mass housing. Alternative approaches must be explored through consultation with the affected/beneficiary communities and in a way that sustains the essential infrastructure that supports and nurtures human life.

The following concerns are also identified by Johnson et al. (2013):

- As many past studies have shown, regulations about building and planning are an integral part of disaster reduction practices. However the case studies investigated as part of the development of this roadmap reveal that regulations on their own are not sufficient to reduce risks in construction projects (particularly in the private sector). Technocratic planning processes tend to prevail, and more dynamic planning processes are required that allow interaction between the multiple actors shaping the built environment.
- The cases also show how in building projects, integrating hazard risk early on in the project process can increase the awareness about risk and incentivise risk reduction practices in building design. This can even make construction firms more competitive in construction tenders.

Implications for the W120 Research Roadmap

The wide spectrum of the roles of construction sector in the built environment formation was broadly explored in previous sections, and the areas that require further attention and knowledge development for integrated DRR in construction industry was identified. In order to achieve workable outcomes, this roadmap requires a focus that is able to contribute to other well known areas in disaster risk reduction. The focus of this roadmap can summarised in the following broad areas:

- Institutional, managerial and legislative mechanisms: Institutional arrangements, managerial aspects and legislative mechanisms define frameworks for construction industry activities. Therefore they have a crucial, influential role on integrating measures and strategies for mainstreamed DRR in construction industry. The Sendai Framework highlighted the role of governments at national and local levels for reducing disaster risks through setting legislative mechanisms, such as land-use plans and building codes.
- The role of private sector: According to a GAR13 Concept Paper, around 85% of all investments worldwide are made by the private sector, including large companies, small and medium enterprises and individual investors. Much of this investment goes into construction projects. The private sector therefore has been identified as playing an important role both in the creation of disaster risks in the built environment as well having a major potential to contribute to a safer built environment. GAR2015 emphasises that the private sector,

government and civil society have to work together in order to ensure sustainable and resilient future.

- Engagement of built environment professionals: Built environment related professionals (architects, engineers, urban planners/designers, and urban managers) also are among the stakeholders who are well-placed to contribute to risk reduction. However, it was highlighted in the Webinars that it is not just a case of understanding which stakeholders need to be involved, there is also a need to understand when and how they should be involved in DRR related decision making. It is also important to note that decision making needs to include the ability to reason out the ethical challenges and consequences of any decisions made. GAR 2015 supports this argument and additionally points out that emergency management is not good enough to address all the issues DRR – as a part of Disaster Risk Management – are theoretically responsible for, and therefore the input of construction professionals is needed. This, however, can only be achieved if DRR becomes a part of their professional competencies.

To sum up, disaster studies have highlighted the important interrelationships between disasters and development, and thus have moved towards addressing disaster risks through the development activities that can (sometimes inadvertently) exacerbate disaster risks within the built environment. However, the question is how and when the existing and extensive systems for design, formation and maintenance of the built environment, and the disaster management system can communicate and work with each other in order to reduce disaster risks for the future, and to create/maintain a more resilient built environment.

Construction and disaster risk management professions need to work and communicate with each other to overcome the existing legal, institutional, and professional constraints. In addition, there is a need for a culture of disaster risk reduction that is 'mainstreamed' across a greater spectrum of actors and particularly construction professionals and practitioners (i.e. architects, planners, engineers, construction/facilities managers, materials suppliers etc.).

The Future Scenario

In the future scenario an improved built environment in the field of DRR and built in resilience is envisioned. Boshier (2014) points out that built-in resilience *"is not merely about the creation of physical assets in an appropriate way and in suitable locations, it is equally important to increase the capacity of the social, institutional, environmental and economic support mechanisms in order to keep the built environment operational and adaptable. Hence, built-in resilience is a quality of a built environment's capability (in physical, institutional, environmental, economic and social terms) to keep adapting to existing and emergent threats"* (p. 241). Considering the focus areas of this roadmap the characteristics of a more resilient built environment are as the following:

- Disaster risk reduction and built in resilience is always one of the strategic objectives in building and construction engineering projects and programmes; this will be across all scales and stages in the process of the built environment design, implementation and maintenance. The weight of this objective will be in balance with (i.e. in proportion to) other essential objectives (e.g. profit margin in private sector projects and preserving cultural heritage in urban development planning). This objective will apply to both pre-disaster and post-disaster scenarios.
- All stakeholders, including built environment related professionals (architects, engineers, urban planners/designers, and urban managers) will participate in DRR. For example, the

Webinar and the Sendai discussions outcomes showed that at city development level urban planning and design can foster risk reduction strategies and tools because a) planners are equipped to deal with future scenarios, complex systems, efficient means of monitoring future development; b) assessment of risk in cities requires an understanding of complex socio-economic systems; c) risk reduction requires various forms of expertise, for which planners are equipped to bring these together. Such urban planning aims to reduce future risks in cities (e.g. safe land for development, safe construction, affordability for the poor) and to manage existing risks (e.g. informal settlements, unsafe buildings and infrastructure).

- Stakeholders' participation in urban/rural development programmes and construction projects (in both pre- and post- disaster contexts) are consistently coordinated towards DRR. Their participation and inputs will be timely and strategically aligned and harmonised.
- Information on hazards and good practices of DRR will be shared and available (in appropriate formats) to all relevant stakeholders, especially engineers, architects, urban planners/designers and urban managers.
- There will be construction technologies and frameworks in place that can be used to reduce risks to the identified risks and threats for specific contexts. These frameworks and technologies contribute to introducing new regulations and codes in construction industry. Suitable incentives and commercial demand for these technologies mean that they will be affordable and private sector/public sector organisations (including SMEs) are familiar with these frameworks.
- There will be rules, regulations and reinforcement mechanisms/legislations in place to ensure that practical application of strategies and measures for built-in DRR and resilience are applied in appropriately.
- DRR is the concern of all stakeholders, including the local communities. The momentum for improving DRR measures and strategies is maintained due to 'top down' supported incentives and 'bottom up' generated demand; accordingly such measures and strategies are constantly evolving.
- Urban/rural development programmes and construction projects in normal situations and post-disaster programmes include expertise on disaster risk management and examine the impacts of the development on future disaster risks.

Development strategy

In order to address the identified challenges and approaching envisioned future scenario outlined in the previous section, a combination of strategies will need to be adopted, namely:

- Raising DRR awareness amongst all stakeholders.
- Educating built environment related professionals so that they know about the notion of DRR in relation to their specific area of specialism. This can be achieved through Continued Professional Development (CPD) type courses but also, ideally, incorporated into the professional training (i.e. at undergraduate/apprentice) level of construction professionals. Institutions that provide civil engineering education will take the lead in educating students about their roles in disaster risk reduction. This will be supported by key professional institutions that have a global influence such as the Institution of Civil Engineers (ICE), Royal Institute Of British Architects (RIBA), Royal Institution of Chartered Surveyors(RICS),

American Society of Civil Engineers (ASCE), Royal Town Planning Institute (RTPI) and their national and regional equivalents.

- Exploring and introducing incentives for DRR targeting different groups of stakeholders. For example, the cases in the background paper also show how in building projects, integrating hazard risk early on in the project process can increase the awareness about risk and incentivise risk reduction practices in building design (Johnson et al. 2013). This can even make construction firms more competitive in construction tenders (UNISDR 2013).
- Encouraging the use of strategic multidisciplinary approaches for people in charge of DRR in a way where as much emphasis is placed on the proactive preventative measures associated with hazard mitigation.
- Changing incapable/unsophisticated planning systems with ones that incorporate DRR expertise and concepts.
- Providing progressive data banks on hazards and good practices in different contexts, available to all stakeholders.

Future research contribution and agenda

In light of the previous discussions and outcomes of the Webinars and the Sendai workshop, a number of future research areas need to be pursued in order to help develop and implement the strategies and approaches required to attain the envisioned 'more resilient' future, namely:

- Explore the way disaster studies and each specific built environment related disciplines communicate and work with each other. This should include inputs from disaster studies in construction and reconstruction activities, as well as the inputs from construction industry in post-disaster reconstruction in terms of employing the right types of professions in various scenarios.
- Develop innovative new technologies and/or improve the existing technologies for reducing specific disaster risks and enhance safe construction in building and construction industry.
- Develop (and if possible adopt relevant existing) multidisciplinary frameworks for the application of mainstreamed DRR and resilient in the process of planning and design, implementing and construction, management and maintenance of the built environment in both pre-disaster and post-disaster situations.
- Develop multidisciplinary frameworks for understanding priorities in cities/communities, the role of stakeholders/actors that can potentially play in reducing disaster risk and, subsequently in reducing community vulnerability, ways of efficient and effective co-operation among different stakeholders/actors in both pre-disaster and post-disaster contexts.
- Compile progressive interactive data banks on a range of natural hazards and an open access database of good practices for DRR in different contexts (i.e. different hazards/threats, urban contexts, pre-/post-disaster, types of construction professionals).

The on-going and future role of CIB

The research challenges outlined above align well with the principles and approaches taken within CIB and for the priority themes. It is also clear that some of the specialist task groups and working commissions already draw upon the literature of other domains in tackling the matters core to their members (e.g., TG79 'Building Regulations and Control in the Face of Climate Change', W107 'Construction in Developing Countries' and W108 'Climate Change and the Built Environment' and W114 'Earthquake Engineering and Buildings').

Focussing on the key research requirements there are a large number of CIB task groups and working commissions that align (some more naturally than others) with these future areas of investigation. The most likely co-contributors to each of the areas (listed in alphabetic order) are identified below:

CIB Task Groups

TG59 – People in Construction
TG72 – Public Private Partnership
TG76 – Recognising Innovation in Construction
TG79 – Building Regulations and Control in the Face of Climate Change
TG81 - Global Construction Data
TG86 - Building Healthy Cities
TG87 - Urban Resilience Benchmarking and Metrics
TG88 - Smart Cities
TG90 - Information Integration in Construction
TG91 - Infrastructure

CIB Working Commissions

W014 – Fire Safety
W018 – Timber Structures
W023 – Wall Structures
W055 – Construction Industry Economics
W065 – Organisation and Management of Construction
W069 – Residential Studies
W070 – Facilities Management and Maintenance
W078 – Information Technology for Construction
W080 – Prediction of Service Life of Building Materials and Components
W086 – Building Pathology
W089 – Education in the Built Environment
W096 – Architectural Management
W098 – Intelligent and Responsive Buildings
W101 – Spatial Planning and Infrastructure Development
W102 – Information and Knowledge Management in Building
W107 – Construction in Developing Countries
W108 – Climate Change and the Built Environment
W110 – Informal Settlements and Affordable Housing
W112 – Culture in Construction
W114 – Earthquake Engineering and Buildings
W116 – Smart and Sustainable Built Environment
W117 – Performance Measurement in Construction
W118 – Clients and Users in Construction
W119 - Customised Industrial Construction

References

- Benson, C. and Twigg, J., (2007). *Tools for mainstreaming disaster risk reduction: guidance notes for development organisations*. Provention Consortium, Geneva
- Bosher, L.S. (ed.) (2008) *Hazards and the Built Environment: Attaining Built-in Resilience*. Taylor and Francis, London.
- Bosher, L (2014) 'Built-in resilience through disaster risk reduction: Operational issues', *Building Research and Information*, vol. 42, no. 2, pp.240-254
- Bosher L.S. and Chmutina K., (2017), *Disaster Risk Reduction for the Built Environment: An introduction*, Wiley, London
- Bosher L.S. and Dainty A.R.J., (2011) 'Disaster risk reduction and 'built-in' resilience: Towards overarching principles for construction practice', *Disasters: The Journal of Disaster Studies, Policy and Management*, Vol.35, No1, pp. 1-18
- Bosher L.S., Dainty A.R.J., Carrillo P.M., Glass J., and Price A.D.F., (2007) 'Integrating disaster risk management into construction: A UK perspective', *Building Research & Information*, Vol.35, No.2, pp.163-177
- Bosher, L., Johnson, C. and von Meding, J. (2015). Reducing disaster risk in cities: moving towards a new set of skills. *Proceedings of the Institution of Civil Engineers – Civil Engineering*, vol. vol. 168, no. 3, p. 99.
- Chang-Richards, Y., Seville, E., Wilkinson, S., Kachali, H., & Stevenson, J. (2014). 'Addressing inter-sectoral linkages and interdependencies: A study of the past disaster events'. Input Paper Prepared for the Global Assessment Report on Disaster Risk Reduction 2015, UNISDR
- Chmutina, K. and Bosher, L., 2015. Risk Reduction or Risk Production: The social influences upon the implementation of DRR into construction project in Barbados. *International Journal of Disaster Risk Reduction*, 13, pp.10-19.
- Chmutina K, Ganor T and Bosher L (2014) Role of urban design and planning in disaster risk reduction. *Proceedings of the Institution of Civil Engineers – Urban Design and Planning* Vol.167, no. 3, pp.125–135.
- Christopolos, I., ALNAP, Glemminge Development Research, (2006). 'The elusive window of opportunity' for risk reduction in Post-disaster recovery'. ProVention Consortium, Geneva
- Coppola, D.P., (2006). *Introduction to International Disaster Management*, 1st ed. Butterworth-Heinemann.
- Davidson, C., (2009). 'Multi-actor arrangements and project management', in: Lizarralde, G., Johnson, C., Davidson, C. (Eds.), (2009), *Rebuilding after Disasters : from Emergency to Sustainability*. Spon Press, London; New York.
- Davis, I., (2006). *Learning from Disaster Recovery; Guidance for Decision Makers*. International Recovery Platform (IRP)
- EM-DAT (2014). *Annual Disaster Statistical Review 2013*. The International Disaster Database.
- Fisher, J, Chmutina, K, Bosher, L (2015) [Urban Resilience and Sustainability: The Role of a Local Resilience Forum in England](#). In Masys, A (ed) *Disaster Management: Enabling Resilience*, Springer International Publishing, pp.91-107, ISBN: 978-3-319-08818-1. Full text: <http://www.springer.com/gb/>. DOI: [10.1007/978-3-319-08819-8](https://doi.org/10.1007/978-3-319-08819-8).
- Haigh, R., Amaratunga, D., Kerimanginaye, K., (2006). 'An Exploration of the Construction Industry's Role in Disaster Preparedness, Response and Recovery', in: *Proceedings of The Annual Research Conference of the Royal Institution of Chartered Surveyors*. University College London, London.

- Han, S.S. and G. Ofori (2001) 'Construction industry in China's regional economy'. *Construction Management and Economics*. 19(2). pp. 189–205
- Hillebrandt, P.M. (2000) *Economic Theory and the Construction Industry*. (Third edition.) Macmillan, Basingstoke.
- Johnson C., Boshier L., Adekalan I., Jabeen H., Kataria S., Wijitbusaba A. and Zerjav B., Arefian, F. (2013), 'Private sector investment decisions in building and construction: increasing, managing and transferring risks'. *Working paper for the Global Assessment Report 2013 on Disaster Risk Reduction*, UNISDR, Geneva, Switzerland
- Krimgold, F. 2011. Disaster risk reduction and the evolution of physical development regulation. *Environmental Hazards*, 10 (1), 53-58.
- Lloyd-Jones, T., (2009). *The built environment professions in disaster risk reduction and response : A guide for humanitarian agencies*. MLC Press.
- O'Keefe, P., K. Westgate and B. Wisner (1976) 'Taking the naturalness out of natural disasters'. *Nature*. 260. pp. 566–567
- Ofori, G., (2011), *Contemporary Issues in Construction in Developing Countries*, CIB, Rotterdam
- Ofori, G., (2008). 'Construction in developing nations. Towards increased resilience to disasters', in: Boshier, Lee (Ed.), *Hazards and the Built Environment: Attaining Built-in Resilience*. Routledge, London, pp. 39–60.
- Pelling, M., (2007). 'Learning from others: the scope and challenges for participatory disaster risk assessment'. *Disasters*, 31, 373–385.
- Stevenson, J., Giovinazzi, S., Seville, E., Brown, C., Chang-Richards, Y., & Wilkinson, S. (2015). 'Chapter 6 From Disaster to Opportunity: Reviving Urban Function after the Canterbury Earthquakes'. In P. Fillion, M. Skidmore, & G. Sands (Eds.), *Cities at Risk: Planning for and Recovering from Natural and Human Disasters*. Surrey: Ashgate Publishing Ltd
- UNISDR (2011), *Global Assessment Report on Disaster Risk Reduction*, UNISDR, Geneva
- UNISDR (2013), *Global Assessment Report on Disaster Risk Reduction*, UNISDR, Geneva
- UNISDR (2015), *Global Assessment report on Disaster Risk Reduction*, UNISDR, Geneva
- UNISDR (2007) *Disaster Risk Reduction: 2007 Global Review*. Consultation edition. UNISDR, Geneva.
- United Nations Development Programme, (2004). *Reducing disaster risk: A challenge for development.*, New York: United Nations Development Programme Bureau for Crisis Prevention and Recovery. Available at: <http://www.undp.org/cpr/disred/rdr.htm> [Accessed December 23, 2010].
- Wilkinson, S., Chang-Richards, Y., & Sapeciay, Z. (2014). Investment in the construction sector to reduce disaster risks. Input Paper Prepared for the Global Assessment Report on Disaster Risk Reduction 2015, UNISDR.
- Wisner B., Blaikie P.M., Cannon T. and Davis I., (2004) *At Risk: Natural Hazards, People's Vulnerability and Disasters*, London, Routledge
- World Bank, (2008). *Housing Reconstruction in Urban and Rural Areas*, World Bank
- World Bank, (2008). *Housing Reconstruction in Urban and Rural Areas*, World Bank Good Practice Notes.
- World Economic Forum in collaboration with Arup, (2010). *Engineering and Construction Disaster Resource Partnership*. World Economic Forum, Geneva.

Annex 1: Resilient Cities Webinars: Contributors and key findings

May - June 2012

Contributors

WEBINAR 1: Enabling risk reduction through urban planning

- Dr Cassidy Johnson, University College London, UK - Planning regulations and its impacts on DRR in the formal and in informal city: reflections from five urban case studies
- Ms Susan Houston, New Zealand Planning Institute, New Zealand - Preliminary results of a survey on resilience planning across the Commonwealth
- Professor Murat Balamir, Middle East Technical University, Turkey - The challenges of coupling land use planning and disaster risk
- Dr Fatma El Mallah, League of Arab States on Climate Change, Egypt - Building the resilience of Arab cities: the challenges and the opportunities

WEBINAR 2: Engaging multiple stakeholders in DRR for cities

- Dr Lee Boshier, Loughborough University, England - Making cities resilient - A top down multi-stakeholder approach from the United Kingdom
- Dr Marla Petal, Save the Children, Australia - Disaster-resilient construction: involving decision-makers from the bottom-up
- Mr Daniel Homsey, City Of San Francisco, USA - The Empowered Communities Program - Building Stronger Neighborhoods, One Decision at a Time
- Professor Rohit Jigyasu, Research Center for Disaster Mitigation of Urban Cultural Heritage, Ritsumeikan University, Japan - Reducing risks to Urban Cultural Heritage through engagement of multiple stakeholder

WEBINAR 3: Necesidades y expectativas de los habitantes en el proceso de reconstrucción (In Spanish)

- Profesor Gonzalo Lizarralde, Université de Montréal, Canada - Estrategias y alternativas basadas en las libertades individuales de los habitantes
- Professor Alfonso Solano, Pontificia Universidad Javeriana, Colombia - Regresando al habitat Original, Cupica, Choco, Colombia
- Mr Jaime Soto, Swiss Association Territoires Solidaires - Desde el Valle del Itata en Chile, aprendiendo a re-construirnos y construir resiliencia
- Mr Luis Hernandez, Santa Tecla, El Salvador - Santa Tecla, El Salvador: un modelo participativo de la reconstrucción, transformando el desarrollo local
-

WEBINAR 4: Local Government Self-Assessment Tool

- Ms Andrea Valsagna, Municipality of Santa Fe - Argentina - Principal Disaster Risks in Santa Fe City
- Dr Ana Liz Flores, Municipality of Chacao - Venezuela - Citizen Culture for Risk Management
- Mr. Greg Pillay, Cape Town - South Africa - Local Government Self-Assessment Tool

All these webinars can be viewed online at the following web link

<http://www.cibworld.nl/site/recordings-van-de-webinars/resilient-cities.html>

Webinars – Key findings

1. Enabling risk reduction through urban planning

- Better information (or communication methods) about risk is needed for planners and others working in the planning and construction professions
- There is a need to better understand the information and technical needs of urban planners for doing integrated planning
- Work on informal settlements – understanding what the alternative approaches to resettlement are
- Development of prioritisation methods for DRR investment, which risks should be attended to first?
- Hazard information availability to monitor land markets
- Development of effective tools of control for mitigation planning (taxation, rent control, Transfer of development rights)
- To what extent is there private interest in mitigation funding?
- Comprehensive regeneration vs individual retrofitting of new building, especially approaches on this in Istanbul.
- Assessment of risk at the city-level
- Simple building codes for informal settlements
- How will climate change impact on buildings, building codes
- Need for better information about the social, economic and environmental costs of disasters
- Need for more information about hazard risk

2. Engaging multiple stakeholders in DRR for cities

- Traditional knowledge in urban planning, management and construction that contributes towards disaster resilience needs to be documented and adapted to present needs and concerns for urban development.
- Informally trained builders/artisans need to be included in DRR-related training and awareness-raising. How can this best be operationalized?
- It is important to document and then share best practices (and arguably the not so good ones) that demonstrate how cultural heritage concerns have been addressed in urban disaster risk reduction initiatives and vice-versa.
- We need to better understand how 'resilience' and 'sustainability/green' dialogues (and practices) can be better aligned/balanced/integrated and consider what the implications of these agendas are on the future of the built environment.
- To protect children's rights to safety and education we need research on new technologies and the implementation of policies to ensure that every new school is a safe school and that development investments in education are being safeguarded.
- To ensure sound assessment and planning for education sector safety we need participatory action research to find best ways to integrate national and local hazard assessment with crowd-sourced data on school structural/environmental safety and school disaster management within education sector management information systems.

3. People's needs and expectations in post-disaster reconstruction

The priorities to respond to the needs and expectations of the affected population during post-disaster reconstruction projects were highlighted as the following:

- To integrate the affected residents (individually and collectively) in the decision-making process during all the project phases (planning, financing, design, procurement, construction, adaptations, etc.), assuming a sustainable and participatory process that does not exclusively depend on technical and political decisions. What role can the construction sector play in this?
- To decentralize the reconstruction process, facilitating additional participation from the civil society and from affected families in active decision-making within their own individual projects of housing, economic production, industry, infrastructure, etc.
- To prioritize owner-driven strategies and strategies of incremental housing in which individual families make decisions according to their own needs, expectations, priorities, resources, capacities, etc.
- To develop public policy that can work as a framework for active decision-making from affected families regarding their own individual solutions at the household level (projects of housing, economic production, industry, infrastructure, etc.)
- To adopt a wide view of housing in which the reconstruction process is not restraint to the construction of housing units but to the development of an appropriate built environment in which public infrastructure, community services and income generation at the household level play a fundamental role.
- To enhance leadership at the municipal level with emphasis in long term development and concerted action.
- To involve universities and research groups in the reconstruction process.

4. Ten Essentials for Making Cities Resilient Local Government Self Assessment Tool

- Risk reduction still by many stakeholders and actors is identified as preparedness and response to disaster emergencies.
- While the vision of disaster risk reduction is shared its reflection in programmes and projects also should be integral and better harmonised.
- Ways of translating theory into practice must be explored

Annex 2: Report on the CIB W120 Public Forum at the UN's World Conference on Disaster Risk Reduction

Introduction

Recent disasters such as earthquakes in Nepal and Haiti, floods in the UK and storms in the USA have yet again brought to prominence the vulnerability of our ever urbanised world to the impacts of natural hazards. In response to this the UN's recent 'Global Assessment Report' has acknowledged that Disaster Risk Reduction (DRR) activities need to move away from approaches constrained within disciplinary siloes dominated by emergency management and civil protection practitioners (UN 2015). An even broader range of important stakeholders will therefore need to take on greater responsibility for DRR activities, and in doing so they need to be supported by suitable levels of training and practical support. Central to this more holistic approach to DRR are key stakeholders (whether they are currently aware of it or not) that are responsible for how the built environment is planned, designed, (re)built, operated and maintained.

Disaster risk reduction: "The concept and practice of reducing disaster risks through systematic efforts to analyse and manage the causal factors of disasters, including through reduced exposure to hazards, lessened vulnerability of people and property, wise management of land and the environment, and improved preparedness for adverse events" (UNISDR 2007)

This report provides an overview of the public forum that was organised by CIB's Working Commission W120 on 'Disasters and the Built Environment' at the UNISDR's World Conference on Disaster Risk Reduction (WCDRR) in Sendai, Japan. The speakers at the forum presented an overview of the key issues influencing the production of disaster risk in the built environment. Five international experts provided an overview of some relevant research activities being undertaken across the world and this work and other related work was then openly discussed with the aim of better understanding how we can better integrate DRR principles and activities into the practices of built environment professionals.

Background to the conference and public forum

Over 6,500 participants attended the WCDRR, including 25 Heads of State and Government and 100 ministerial-level delegates, UN agencies and international organizations, and civil society and business representatives. As a result of the conference, representatives from 187 countries have adopted the '*Sendai Framework for Disaster Risk Reduction 2015-2030*'⁶ making it the first major agreement of the post-2015 development agenda. The Framework, which was adopted following a marathon round of negotiations, includes seven targets and four priorities for action.

It is thus a credit to CIB (one of the smallest but longer established organisations represented at the conference) that as an entity it was eligible to register for this conference and provide a global platform for W120 to contribute towards this important event. At the start of the forum, the work of CIB and W120 was briefly presented to the audience of approximately 25 people.

The problem field

A brief session was provided by the W120 coordinators, Dr Jason Von Meding and Dr Lee Boshier, that helped to set the scene within ongoing discussions about the extent to which urban disaster risk is being produced through, amongst a myriad of issues, a legacy of poor (ill-informed) decision-making by multiple stakeholders and the lack of engagement with the private sector. It was argued

⁶ www.wcdrr.org/uploads/Sendai_Framework_for_Disaster_Risk_Reduction_2015-2030.pdf

that many such issues arise due to DRR capability and competency deficits that exist within built environment disciplines. In some cases, this dilemma manifests as social/environmental/political insensitivity rather than lack of technical expertise. Thus the importance of research-led education cannot be underestimated in closing this gap.

Ongoing research and practice

A one hour session was then convened, that drew upon a broad range of ongoing research and experiences from a number of well know experts (photographs of the workshop are provided in the Appendix). The key messages from these engaging talks are now summarised:

1. **Dr Fred Krimgold** (Virginia Polytechnic Institute and State University, USA) – *‘Strengthening building and land use regulatory implementation for DRR’*
Fred highlighted that issues related to how urban risk is produced are not necessarily about technical problems but more about the complex governance issues experienced in many low and middle income nations. For instance problems were what Fred referred to as the nuts and bolts of the regulatory system that result in disconnections between the code and ‘reality’. These are driven by three major impediments, namely poverty, ignorance and corruption. This is further complicated when considering the legacy of inappropriate (unregulated) development in many cities and exacerbated by the additional costs of retrofit solutions.
2. **Dr Yung-Fang Chen** (Coventry University, UK) – *‘Evaluation of reconstruction projects in Taiwan after typhoon Morakot’*
Using an example from Taiwan, Yung-Fang provided a sad but important lesson about the pitfalls of poorly planned and ill-conceived post-disaster reconstruction projects, particularly when relocating affected communities. This case study provided insight into the stark realities of what happens when there is a lack of proper community consultation and when the needs of indigenous communities are overlooked.
3. **Prof Rohit Jigyasu** (Ritsumeikan University, Japan) – *‘Protecting our built heritage’*
Rohit explained that there is an urgent need for more dynamic approaches to vulnerability and risk assessments if the world’s fragile built heritage is going to be appropriately protected from disaster risks. Rohit provided numerous examples of how the loss of traditional skills and lack of suitable maintenance are increasing the vulnerability of precious heritage sites. Therefore local capacity needs to be supported so that improved monitoring and maintenance approaches can be undertaken. Linked to this, Rohit concluded that improved dialogue is required that balances human safety over heritage values.
4. **Dr Lee Boshier** (Loughborough University, UK) – *‘Multi-hazard approaches to designing safer urban spaces’*
Lee provided a brief overview of the outputs from the European Commission funded ‘Designing safer urban spaces (DESURBS)’ research project that has developed an Integrated Security & Resilience Framework, designed to encourage built environment professionals to proactively consider DRR in their development projects.
5. **Dr Jason Von Meding** (University of Newcastle, Australia) – *‘Modelling competency for project success in post-disaster reconstruction’*
Jason discussed the development of a competence-based tool with the capacity to model the success of humanitarian staff in different disaster scenarios. Based on data from fieldwork in South-East Asia, the system is underpinned by a framework that links post-disaster project barriers, individual competencies and strategic decision-making. The tool is in beta testing and is set to build organisational capacity to respond appropriately in the most complex project environments.

Expert discussion

To wrap up the forum, a lively open discussion was initiated between all the attendees with the overall aim of considering ***‘How to improve inputs of built environment professionals into DRR’***. Some of the key comments that emerged from the discussion were:

- We need to do a better job at **transferring existing knowledge** – many of the problems being encountered are not about knowledge/information not existing (i.e. on how to build low-cost earthquake proof housing), it is primarily about the knowledge not being applied (due to poor knowledge transfer, poor training as well as local corruption or poor regulation).
- **Research funding needs to be distributed in a more interdisciplinary manner** so that the ‘softer’ sciences can work alongside the ‘harder’ sciences and that non-structural approaches to DRR are given as much credence as more technical structure ‘solutions’.
- There is arguably a need to do a better job at educating built environment professionals about their roles in DRR. It was suggested that W120 could play a leading role in advocacy work with the key professional institutions such as the ICE, RIBA, CIOB, RICS, RTPI and IStructE. If so, it may be possible to encourage these globally influential institutions to include **DRR as a professional competency** (though core undergraduate training, on-the-job practical/informal training and/or Continued Professional Development courses).

Summary

Overall this was a very rewarding public forum that raised some very important points (summarised above) which were also raised at other sessions at the WCDRR. There is clearly increasing acknowledgement that there are a range of DRR related issues that need to be more explicitly addressed by the construction sector, the practitioners within the sector, the governmental and professional institutions that oversee and govern the sector as well as the learned institutions that train and educate the practitioners. While much of this work is beyond the capabilities of CIB, there is clearly much scope for CIB and the members of W120 to positively contribute towards addressing these issues over the next few years. Sadly, the recent Nepalese earthquake disaster is a harsh reminder that much more needs to be done globally to reduce urban disaster risks.

For more information about the contents of this report, or if you wish to help us to move forwards with some of these issues, then please contact:

Dr Lee Boshier (Loughborough University, UK) L.Boshier@Lboro.ac.uk

Dr Jason Von Meding (University of Newcastle, Australia) Jason.VonMeding@newcastle.edu.au

Annex 3: Acknowledgments, contributions and consultations

The authors of this report are very grateful to the following colleagues that provided insightful feedback on drafts of the Research Roadmap report.

Adrian Bennett – Ministry of Business Innovation and Employment, New Zealand

Ciaran McAleenan – Ulster University, Northern Ireland

Esther Obonyo – University of Florida, USA

Frank Schultzmman – Karlsruhe University, Germany

Frederick Krimgold - Virginia Tech, USA

George Tucker - University of Cape Town, South Africa

Giuseppe Forino - University of Newcastle, Australia

Gonzalo Lizarralde, University of Montreal, Canada

Helen Giggins - University of Newcastle, Australia

John Duncan – Branz, New Zealand

John Onyango – University of Miami, USA

Le Chen – QUT, New Zealand

Leila Irajifar – Griffith University, Australia

Linda Kestle - UNITEC, New Zealand

Luqma Oyewobi – University of Cape Town, South Africa

Maeva Sabre – Centre Scientifique et Technique du Batiment, France

Mahen Mahendran – QUT, New Zealand

Morten Gjerde – Victoria University of Wellington, New Zealand

Peter Thorby - Ministry of Business Innovation and Employment, New Zealand

Robert Weatherup - Ulster University, Northern Ireland

Suzanne Wilkinson – University of Auckland, New Zealand

Thomas Moullier – The World Bank, USA

Annex 4: Author biographies

Dr Lee Bosher - Lee is a coordinator of CIB W120 (and was previously coordinator of Task Group 63) 'Disasters and the Built Environment'. He is a Senior Lecturer in the Water, Engineering and Development Centre at Loughborough University, England. He has a background in disaster risk management and his research and teaching includes disaster risk reduction and the multi-disciplinary integration of proactive hazard mitigation strategies into the decision-making processes of key stakeholders, particularly stakeholders from the construction industry. Lee is editor of the book '*Hazards and the Built Environment: Attaining Built-in Resilience*' (Routledge) and the co-author (with Ksenia Chmutina) of a new textbook, '*Disaster Risk Reduction for the Built Environment: An introduction*' (Wiley).

Dr Jason Von Meding – Jason is a coordinator of CIB W120. Jason's expertise is in disaster resilience, organisational behaviour, community adaptation, systems theory and international construction. He collaborates with a range of industrial and humanitarian partners on multidisciplinary research projects. He is Head of Discipline of Construction Management at University of Newcastle, Australia.

Dr Cassidy Johnson - Cassidy was a coordinator of CIB Task Group 63, 'Disasters and the Built Environment'. She is Senior Lecturer at the Bartlett Development Planning Unit, Faculty of the Built Environment of University College London. She has a background in urban studies and minimum cost housing, with a focus on low and middle-income countries. Her interests are concerned with how communities and governments can prepare urban areas to be resilient to and respond to disasters, and the implications of forced evictions in cities. She has done research on post-disaster temporary housing - particularly looking at disaster recovery in Turkey and on urban rehabilitation and Roman communities in Istanbul. She has also worked with Natural Resources Canada on the use of solar energy in cities. Cassidy is a founding member of Information and Research for Reconstruction Network (i-Rec).

Dr Fatemeh Farnaz Arefian - Farnaz has 20 years of experience in private sector management for large-scale urban developments, urban design and smaller scale architecture projects. She was a participant observer: as a consultancy practice manager for architectural service provision needed for housing reconstruction for 2,100 families, and also the street scale urban design project in post disaster reconstruction programme in Bam, Iran. She has a background in management, urban design and architecture. In her PhD research at the Bartlett Development Planning Unit, University College London, Farnaz investigates organisation design and management for post disaster reconstruction programmes which are participatory and aim to contribute to the future disaster risk reduction.

Dr Ksenia Chmutina - Ksenia is a Lecturer in Sustainable and Resilient Urbanism based within the School of Civil and Building Engineering at Loughborough University since 2011. Ksenia has a background in sustainability and her research includes synergies of resilience and sustainability in the built environment and resilience of small developing island states. Other research interests are related to stakeholders' engagement in multi-hazard disaster risk reduction activities, policy environment for the DRR, DRR competencies among construction professionals as well as energy efficiency, decentralised energy and energy policy.

Dr Yan (Alice) Chang-Richards - Yan (Alice) is a Lecturer in the Centre for Disaster Resilience, Recovery and Reconstruction at the University of Auckland. She has a background in civil engineering and disaster risk reduction. Her current research and teaching portfolio includes decision making in the construction industry and disaster resilience in the built environment. Alice has extensive post-disaster field experience and knowledge in Indonesia, China, Australia, New Zealand, Japan and the USA. She also worked as a research consultant for the Asia Pacific Economic Cooperation (APEC) Secretariat in 2013, for the Building Research Association of New Zealand (BRANZ) in 2015 and served as a consulting engineer working for Care International, Canada in its Post-Tsunami Housing Reconstruction Programme, Banda Aceh, in 2008.



CIB General Secretariat

PO Box 516

2600 AM Delft

The Netherlands

E-mail: secretariat@cibworld.nl

www.cibworld.nl

CIB Publication 410 / ISBN 978-90-8030-220-4