



IMPROVED RISK EVALUATION AND IMPLEMENTATION OF RESILIENCE CONCEPTS
TO CRITICAL INFRASTRUCTURE

International Survey

Editor:

L. MELKUNAITE (DBI)

Contributors (in alphabetic order)

M. ALHEIB (INERIS)
G. BAKER (SPFR)
G. CADETE (INOV)
E. CARREIRA (INOV)
K. ERIKSSON (SP)
C. GASPAR (INOV)
P. GATTINESI (JRC)
F. GUAY (DBI)
D. HONFI (SP)
I. IOANNOU
J. KINSCHER (INERIS)
D. LANGE (SP)
L. PETERSEN (EMSC)
P.J. REILLY (UNIVERSITY OF SHEFFIELD)
B. RØD (UiT)
R. SALMON (INERIS)
R. STEVENSON (UNIVERSITY OF SHEFFIELD)
M. THEOCHARIDOU (JRC)
A. UTKIN (INOV)

Deliverable Number: D1.1

Date of delivery: May 31, 2016

Month of delivery: M12



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 653390

Coordinator:	David Lange at SP Sveriges Tekniska Forskningsinstitut (SP Technical Research Institute of Sweden)

Table of Contents

1.	Executive Summary	3
2.	Nomenclature	3
3.	Introduction	4
4.	Concept of Resilience	5
4.1.	Bounce Back versus Adaptation	8
4.1.1.	Engineering Resilience	8
4.1.2.	Ecological Resilience	10
4.1.3.	Social-Ecological Resilience	10
4.1.4.	Discussion	15
4.2.	Disaster Resilience	17
4.3.	Resilience and Vulnerability	21
5.	Community Resilience	22
5.1.	Technical Dimension of Resilience	28
5.1.1.	4R's Model and Resilience Triangle	28
5.1.2.	Indicators	30
5.2.	Organisational Dimension of Resilience	30
5.2.1.	Business Continuity Management	32
5.2.2.	Tenets of Organisational Resilience	33
5.2.3.	Indicators	34
5.2.4.	Standards	36
5.3.	Social/Societal Dimension of Resilience	37
5.3.1.	Social Capital	40
5.3.2.	Social Networks	41
5.3.3.	Social Memory	41
5.3.4.	Knowledge and Culture	42
5.3.5.	Shared Responsibility and Social Media	43
5.4.	Economic Dimension of Resilience	47
5.4.1.	Levels of Economic Resilience	48
5.4.2.	Indicators	49
5.5.	Ecological Dimension of Resilience	49
5.5.1.	Loss of Ecological Resilience	51
5.5.2.	Adaptive Governance	52
6.	Critical Infrastructure Resilience	54
6.1.	CI System Resilience	55
6.2.	CIR and other resilience concepts	60
6.3.	Risk Management	66
6.4.	Standards	67
7.	Case Studies	68
7.1.	Methodology and Overview	68
7.2.	Resilience Definitions and Implementation	70
7.3.	Resilience Assessment Tools and Models	81
8.	Conclusions	86
	Appendix 1	87

International Survey

Appendix 2	90
Appendix 3	96
Appendix 4	122
Appendix 5	141
Appendix 6	194
Appendix 7	222
Appendix 8	289
Appendix 9	317

1. Executive Summary

In recent years, the concept of resilience started to dominate strategic, operational as well as political domains of modern societies. Living in highly interconnected environment, where layers of infrastructures, people and economic interests interact creating both opportunities and vulnerabilities, different countries around the world turned towards resilience practices to reduce vulnerability of their critical infrastructures and societies. However, how can one implement resilience concepts without a comprehensive understanding of the concept itself? Focusing on the concept and practice of critical infrastructure resilience, this report provides a comprehensive overview of the existing scientific literature regarding the concept of resilience in general. It discusses the development of the concept of resilience and its application in societal, economic, ecological, organisational and critical infrastructure domains. The report provides an extensive discussion on the definition of resilience concepts, as well as information on scientific endeavours to implement and measure concepts of resilience.

The report also contains detailed information on the definitions and implementation of the concepts of resilience in different continents, namely Europe, Africa, Asia, Oceania, North America and South America. Focusing on the concept of critical infrastructure resilience, it provides an overview of the existing official concepts of resilience, implementation tools, and general practices aimed at increasing organisational, societal, economic and technical resilience in different countries.

To collect all the information, the IMPROVER consortium performed an extensive literature review on the use of resilience concepts. We also held a workshop with the associate partners, and conducted a set of personal interviews with critical infrastructure operators and resilience experts around the Europe. While conducting a number of case studies in different continents, we analysed existing region and state-level documents, and reports.

2. Nomenclature

4Rs model	Robustness, redundancy, resourcefulness, and rapidity
ABS	Access to Basic Services
AC	Adaptive Capacity
AG	Adaptive governance
AGIR	Global Alliance for Resilience
AST	Assets
BAU	Business as Usual
BC	Business continuity
BCM	Business continuity management
CAS	Complex adaptive system
CCIRC	Canadian Cyber Incident Response Centre
CI	Critical infrastructure
CIPMA	Critical Infrastructure Protection Modelling and Analysis
CIR	Critical infrastructure resilience
CMI	Consequences Measurement Index
DRM	Disaster risk management
DROP	The disaster resilience of place
DRR	Disaster risk reduction
EoRI	The Economics of Resilient Infrastructure
ES	Ecosystem services

International Survey

EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FEMA	Federal Emergency Agency
FPT	Federal/Provincial/Territorial
GIS	Geographic Information System
IFA	Income and Food Access
IGAD	Inter-governmental Authority on Development
KPI	Key Performance Indicators
LATE	Local authority trading enterprise
LEDDRA	Land and Ecosystem Degradation and Desertification: Assessing the Fit of Responses
LEP	Local Enterprise Partnerships
LS	Life Safety
MAUT	Multi-attribute utility theory
NIAC	U.S. National Infrastructure Advisory Council
NPAS	The National Public Alerting System
OER	Office of Economic Resilience
PDCA	Plan-Do-Check-Act
PIO	Public Information Officer
PMI	Protective Measures Index
RBI	Risk-based inspection
RI	Resilience Index
RIMA	Resilience Index Measurement and Analysis
RMI	Resilience Measurement Index
ROI	Return on investment
ROR	Relative Overall Resilience
ScoRDS	Scottish Resilience Development Service
SES	Social-ecological system
SSN	Social Safety Nets
TOSE	Technical, organisational, social, and economic
UK	United Kingdom
UNISDR	United Nations Office for Disaster Risk Reduction
US	United States

3. Introduction

Between 2005 and 2014 1,7 billion people were affected and \$1,4 trillion were lost due to disasters¹. As disasters are becoming more complex in their nature, exposure of people and assets has increased faster than vulnerability has decreased². Today resilience is perceived as central aspect of societies in reducing risks of disasters. However, over the last 10-year frame disasters have continued to cause

¹ UNISDR, The Economic and Human Impact of Disasters in the last 10 years. Available at: <http://www.unisdr.org/we/inform/disaster-statistics>. Accessed: 8 June 2015.

² UNISDR, Disaster Risk Reduction (DRR). Available at: <http://www.unisdr.org/who-we-are/what-is-drr>. Accessed: 8 June 2015.

immense social and economic losses³. Fukushima Daiichi nuclear disaster, hurricane Katrina, the Black Saturday bushfires in Australia are just a few recent years disasters that brought immense consequences to societies and states. Therefore, the remaining questions are what societies lack in order to be more resilient and reduce social and economic losses caused by different disasters, as well as how do we apply and measure resilience in critical infrastructure, societal, organisational, and economic contexts.

This report is divided into two parts: the first part discusses the concept and implementation of resilience based on the information collected from scientific literature, personal interviews with critical infrastructure operators and resilience experts, as well as group discussions with associate partners during the workshop in Copenhagen. The second part provides detailed information on implementation of the resilience concepts in different continents around the world. Due to the large amount of information that was collected while researching the concept of resilience in different countries, the main report provides its summary and consists of two tables. Table 7.1 provides an overview of the information on resilience definitions and implementation, and Table 7.2 discusses resilience assessment tools and models that are or could be used in the context of critical infrastructure. **Detailed** and **comprehensive** information on the topics is provided in the **Appendices 3-9**.

Appendix 3: C. Pursiainen (UiT), B. Rød (UiT), P. Gattinesi (JRC). *Resilience Concepts in EU/EEA*.

Appendix 4: I. Ioannou (UCL). *Resilience Concepts in Africa*.

Appendix 5: L. Melkunaite (DBI), J. Kinscher, M. AL Heib, R. Salmon (INERIS). *Resilience Concepts in Asia*.

Appendix 6: G. Baker (SPFR). *Resilience Concepts in Canada*.

Appendix 7: L. Petersen (EMSC), K. Eriksson, D. Honfi, D. Lange (SP). *Resilience Concepts in Oceania*.

Appendix 8: A. Utkin, C. Gaspar, R. Carreira, G. Cadete (INOV). *Resilience Concepts in South America*.

Appendix 9: P.J. Reilly, R. Stevenson (University of Sheffield), L. Melkunaite (DBI). *Resilience Concepts in the United States of America*.

The following chapter will be divided into three sections discussing evolution of the concept of resilience, resilience in hazard research, and its relationship with the concept of vulnerability. Chapter on community resilience will provide a comprehensive overview of technical, organisational, social/societal, economic, and ecological resilience. Chapter 6 discusses the application of resilience concepts in the context of critical infrastructure. Chapter 7 provides a discussion on implementation of resilience concepts in different continents around the world. The report is finalised with conclusions.

4. Concept of Resilience

Although resilience has become a very popular concept used in different fields, such as ecology, psychology, economy, political science etc., it is still rather equivocal and lacks common theoretical and empirical understanding. Research community is still very much focused on disagreements as to the very definition of resilience, whether resilience is an outcome or a process, what type of resilience should be addressed (economic systems, infrastructure systems, ecological systems, or community systems), and which policy realm (emergency management, climate change, counterterrorism, environmental restoration) it should target⁴. The confusion is first of all brought by the fact that

³ UNISDR, Economic losses from disasters set new record in 2012. Available at: <http://www.unisdr.org/archive/31685>. Accessed: 8 June 2015.

⁴ Cutter, S. L., Burton, C. G., & Emrich, C. T. (2010). Disaster Resilience Indicators for Benchmarking Baseline Conditions. *Journal of Homeland Security and Emergency Management*, 7(1). <http://doi.org/10.2202/1547-7355.1732>.

International Survey

resilience has been defined in many different disciplines and possesses different attributes depending on the field it is used in. Therefore, it could be argued that the phenomenon of resilience cannot be fully understood by analysing it in the frame of only one discipline or in several disciplines separately. One should rather take into account different contributions by different disciplines that resilience concept was developed and is still developing in.

The analysis of the concept of resilience should begin by stating, that there has been quite a bit of confusion with regards to the emergence of the concept. Many resilience researchers argue that the concept emerged in the discipline of ecology and was brought there by Holling⁵ (see e.g. Batabyal 1998⁶; Brand & Jax 2007⁷; Gallopín 2006⁸; Pisano 2012⁹; Rodriguez-Nikl 2015¹⁰; Turner 2010¹¹, etc.). For example, Folke argues that the resilience perspective emerged from ecology in early 1960s and 1970s through studies of interacting populations like predators and prey and their functional responses in relation to ecological stability theory¹². Berkes notes that resilience was originally developed as an ecological concept, which later became popular in other disciplines¹³. Batabyal makes similar observation stating that originating in the field of ecology, the concept of resilience has been applied and studied primarily in the context of ecosystems¹⁴. Gallopín also gives all the credit of the emergence of the concept of resilience to Holling¹⁵. However, the concept of resilience has much longer history than indicated in the afore-discussed literature.

The word “resilience” is derived from the Latin “resilire” and “resilio”, meaning to spring or bounce back¹⁶. These terms are found in the writings of Seneca the Elder, Pliny the Elder, Ovid, Cicero and Livy¹⁷. The first modern attempt to use the term was in mechanics, when William J. M. Rankine (1820 - 1872) employed the concept to describe the strength and ductility of steel beams. At its basic modern interpretation, the term was often applied in relation to an entity or system’s ability to return to a normal state, or functioning shortly after some disturbance¹⁷.

The disciplines of psychology and psychiatry were the first attempts to use the concept of resilience in an academic context. From the 1950s research in these fields was aimed at understanding how oppressive social environments might influence the development of children and adults¹⁸. The American psychiatrist Norman Garmazy was one of the first scholars to use the concept of resilience

⁵ Holling, C. S. (1973). Resilience and Stability of Ecological Systems. *Annual Review of Ecology and Systematics*, 4, 1–23.

⁶ Batabyal, A. A. (1998). The concept of resilience: retrospect and prospect. *Environment and Development Economics*, 0(02), 221–262.

⁷ Brand, F. S., & Jax, K. (2007). Focusing the meaning(s) of resilience: Resilience as a descriptive concept and a boundary object. *Ecology and Society*, 12(1). <http://doi.org/23>.

⁸ Gallopín, G. C. (2006). Linkages between vulnerability, resilience, and adaptive capacity. *Global Environmental Change*, 16(3), 293–303. <http://doi.org/10.1016/j.gloenvcha.2006.02.004>.

⁹ Pisano, U. (2012). Resilience and Sustainable Development: Theory of resilience, systems thinking and adaptive governance. *ESDN Quarterly Report N26*, (September), 51.

¹⁰ Rodriguez-Nikl, T. (2015). Linking disaster resilience and sustainability. *Civil Engineering and Environmental Systems*, 32(1-2), 157–169. <http://doi.org/10.1080/10286608.2015.1025386>.

¹¹ Turner, B. L. (2010). Vulnerability and resilience: Coalescing or paralleling approaches for sustainability science? *Global Environmental Change*, 20(4), 570–576. <http://doi.org/10.1016/j.gloenvcha.2010.07.003>.

¹² Folke, C. (2006). Resilience: The emergence of a perspective for social-ecological systems analyses. *Global Environmental Change*, 16(3), 253–267. <http://doi.org/10.1016/j.gloenvcha.2006.04.002>.

¹³ Berkes, F. (2007). Understanding uncertainty and reducing vulnerability: Lessons from resilience thinking. *Natural Hazards*, 41(2), 283–295. <http://doi.org/10.1007/s11069-006-9036-7>. P. 286.

¹⁴ Batabyal, A. A. (1998). The concept of resilience: retrospect and prospect. *Environment and Development Economics*, 0(02), 221–262. P. 235.

¹⁵ Gallopín, G. C. (2006). Linkages between vulnerability, resilience, and adaptive capacity. *Global Environmental Change*, 16(3), 293–303. <http://doi.org/10.1016/j.gloenvcha.2006.02.004>. P. 298.

¹⁶ Manyena, S. B., O’Brien, G., O’Keefe, P., & Rose, J. (2011). Disaster resilience: a bounce back or bounce forward ability? *Local Environment*, 16(5), 417–424. <http://doi.org/10.1080/13549839.2011.583049>.

¹⁷ Alexander, D. E. (2013). Resilience and disaster risk reduction: An etymological journey. *Natural Hazards and Earth System Sciences*. <http://doi.org/10.5194/nhess-13-2707-2013>. P. 2708.

¹⁸ Waller, M. A. (2001). Resilience in ecosystemic context: Evolution of the context. *American Journal of Orthopsychiatry*, 71(3), 290–297.

in the developmental psychopathology of children¹⁷. The pioneers in the study of resilience were mainly interested in risks and negative effects of adverse life events on children, such as, for example, divorce, abuse, war, etc.¹⁹. Children who emerged in these situations stronger and with new capacities to adapt were considered to be resilient²⁰.

As early as 1970s, in his well-known paper *Resilience and Stability of Ecological Systems*, Holling shifted the whole resilience debate towards dynamic approach to it⁵. He emphasized system's ability to respond to disturbances by adapting and changing this way becoming better able to cope with shocks and disturbances, and stressed the importance of dynamic equilibrium, including that which can exist in several different state spaces. He contrasted the concept of resilience with the concept of stability, arguing that stability is the ability of the system to return to equilibrium after a temporary disturbance⁵. On the other hand, a highly resilient system may be quite unstable, in that it may undergo significant fluctuation. The concept of resilience entered social sciences (human ecology) in 1990s, where it is used to describe the behavioural response of communities, institutions and economies²¹.

In his monograph *Vulnerability, Resilience and the Collapse of Society*, Timmerman defined resilience as the building of buffering capacity into society to make it resistant to disaster disturbances²². He was one of the first authors who discussed resilience of society in the context of climate change and linked the concept to vulnerability (see Section 4.3 on the relationship between the concepts of vulnerability and resilience). Timmerman acknowledged that resilience is becoming an ultimate term, sanctioned and sanctioning in times of crisis. The concept of resilience entered disaster risk management (DRM), disaster risk reduction (DRR) and climate change debate after the adoption of Hyogo Framework in 2005 (for further discussion see Section 4.2)²³. With the adoption of the protocol, resilience gained new leverage and became a core concept when talking about man-made and natural disasters. A common definition of resilience used in DRR is the one proposed by the United Nations Office for Disaster Risk Reduction (UNISDR) defining the phenomenon as “the ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions. The resilience of a community in respect to potential hazard events is determined by the degree to which the community has the necessary resources and is capable of organizing itself both prior to and during times of need.”²⁴ A resilient community is ideally supposed to be the safest possible disaster-prone community with the ability to overcome the damages brought by disasters either by maintaining their pre-disaster social fabric or by accepting marginal or larger change in order to survive²⁵.

¹⁹ Manyena, B. S. (2006). The concept of resilience revisited. *Disasters*, 30(4), 433–450.

²⁰ Johnson, J. L., & Wiechelt, S. A. (2004). Introduction to the special issue on resilience. *Substance Use & Misuse*, 39(5), 657–670. <http://doi.org/10.1081/JA-120034010>.

²¹ Klein, R. J. T., Nicholls, R. J., & Thomalla, F. (2003). Resilience to natural hazards: How useful is this concept? *Environmental Hazards*, 5(1-2), 35–45. <http://doi.org/10.1016/j.hazards.2004.02.001>.

²² Timmerman, P. (1981). Vulnerability, Resilience and the Collapse of Society: A Review of Models and Possible Climatic Applications. *Environmental Monograph*, 1, 1–45. <http://doi.org/10.1002/joc.3370010412>.

²³ United Nations. (2005). International Strategy for Disaster Reduction Hyogo Framework for Action 2005-2015: Building the Resilience of Nations. *World Conference on Disaster Reduction (A/CONF.206/6)*. Available at: <http://www.unisdr.org/we/inform/publications/1037>. Accessed: 23 April 2016.

²⁴ UNISDR, Terminology, Available at: <http://www.unisdr.org/we/inform/terminology>. Accessed: 23 April 2016.

²⁵ Gaillard, J.-C. (2007). Resilience of traditional societies in facing natural hazards. *Disaster Prevention and Management*, 16(4), 522–544. <http://doi.org/10.1108/09653560710817011>.

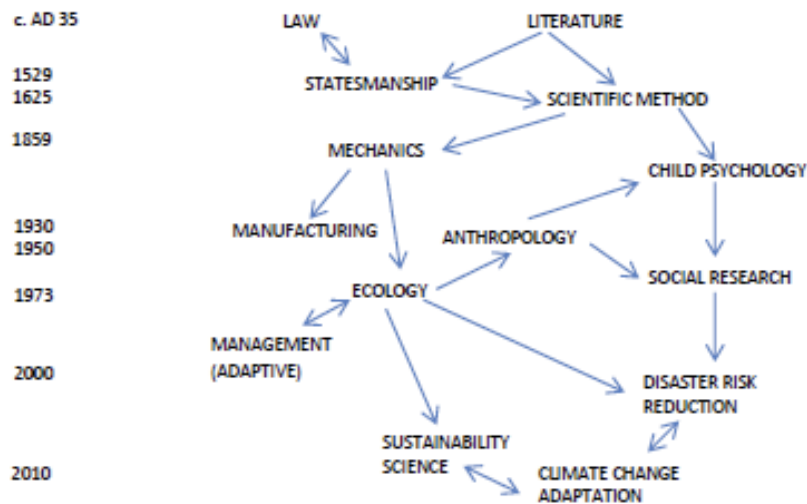


Figure 4.1 Schematic diagram of the evolution of the term of resilience.²⁶

The debate on the man-made and natural disaster resilience has been growing since the 2005 World Conference on Disaster Reduction held in Kobe, Hyogo, Japan. Although the terms such as ‘resilient community’, ‘resilience building’, and ‘resilience of critical infrastructure’ are widely used, there is still a need to address the ontological questions that continue to blur the concept of resilience. It is evident that there are differences in understanding and implementing resilience concepts between academia and practice²⁷. The following sections of the chapter aim to deconstruct the concept of resilience by analysing different elements of it this way contributing to the existing attempts to better understand it.

4.1. Bounce Back versus Adaptation

In the existing literature, resilience has been defined in two broad ways: as a desired outcome or as a process oriented towards a desired outcome. Resilience is described either as an entity’s ability to return quickly after a shock to its pre-defined state (bounce back), or as a process of change and adaptation. The latter suggests that the system is changed as a result of a shock, providing the same service or filling the same operational niche as before the disturbance, but through an adaptive response to the disturbance²⁸. In this case, system’s resilience is built on its ability to alter non-essential attributes to adapt in order to survive¹⁹.

4.1.1. Engineering Resilience

When applied in mechanics, engineering, mathematics, and similar disciplines, the concept of resilience focuses on system’s behaviour near a stable equilibrium and the rate at which a system returns to steady state following a disturbance¹². The general term for this type of resilience that could be found in the literature is “engineering resilience”²⁹. For example, Pimm defines resilience as a

²⁶ Alexander, D. E. (2013). Resilience and disaster risk reduction: An etymological journey. *Natural Hazards and Earth System Sciences*. <http://doi.org/10.5194/nhess-13-2707-2013>. P. 2714.

²⁷ Dahlberg, R., Johannessen-Henry, C. T., Raju, E., & Tulsiani, S. (2015). Resilience in disaster research: three versions. *Civil Engineering and Environmental Systems*, 32(1-2), 44–54. <http://doi.org/10.1080/10286608.2015.1025064>.

²⁸ Giroux, J., & Prior, T. (2012). Expressions of Resilience: From “Bounce Back” to Adaptation. *3RG REPORT Factsheet*. Zurich, Switzerland. Available at: <http://www.isn.ethz.ch/Digital-Library/Publications/Detail/?lang=en&id=170633>. Accessed: 20 August 2015.

²⁹ Holling, C. S. (1996). Engineering resilience versus ecological resilience. In P. Schulze (eds.). *Engineering Within Ecological Constraints*. National Academy Press, Washington DC.

process where one measures “how fast a variable that has been displaced from equilibrium returns to it”³⁰. According to the author, resilience can be estimated by a return time, namely, the amount of time taken for the displacement to decay to some specified fraction of its initial value (ibid.). For Wildavsky³¹, resilience is an outcome, stressing the capacity of the system to cope with unanticipated dangers after they have become manifest, learning to bounce back. Thus engineering resilience essentially focuses on maintaining efficiency of function²⁹. Haimes defines resilience as the ability of the system to withstand a major disruption within an acceptable degradation of parameters and to recover at acceptable time, costs and risks³². Engineering resilience focuses on system’s ability to resist a change and disturbance in order to conserve what it has¹². Therefore, the faster the system returns to equilibrium, the more resilient it is²⁹. The engineering interpretation of the concept exists up to date in many facets of ecology, especially in the early research within the field³³. However, such perception of the phenomena emphasizes reactive stance towards resilience and is rather limited³⁴, and cannot be considered as *the* measure of resilience. According to Walker et al., because of the possibility of multiple stable states, when considering the extent to which a system can be changed, return time does not measure all of the ways in which a system may fail to retain essential functions³⁵. For all the aforementioned reasons, engineering resilience is more applicable for objects that are capable of returning or regaining their original shape after bending, compression or other deformation³⁶ and can be perceived as one aspect of “ecological resilience”³⁵.

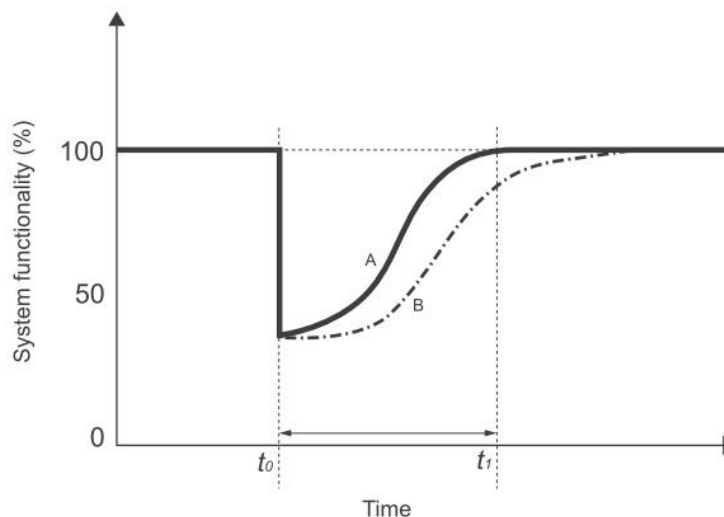


Figure 4.2 A conceptual representation of engineering resilience.³⁷

³⁰ Pimm, S. L. (1991). *The Balance of Nature? Issues in the Species and Communities*. University of Chicago Press, Chicago.

³¹ Wildavsky, A. (1991). *Searching for Safety*. Transaction, New Brunswick, NJ.

³² Haimes, Y. Y. (2009). On the definition of resilience in systems. *Risk Analysis*, 29(4), 498–501. <http://doi.org/10.1111/j.1539-6924.2009.01216.x>.

³³ McManus, J. W., & Polsenberg, J. F. (2004). Coral-algal phase shifts on coral reefs: Ecological and environmental aspects. *Progress in Oceanography*, 60(2-4), 263–279. <http://doi.org/10.1016/j.pocean.2004.02.014>.

³⁴ Blockley, D. (2015). Finding resilience through practical wisdom. *Civil Engineering and Environmental Systems*, 32(1-2), 18–30. <http://doi.org/10.1080/10286608.2015.1022725>.

³⁵ Walker, B., Holling, C. S., Carpenter, S. R., & Kinzig, A. (2004). Resilience, adaptability and transformability in social-ecological systems. *Ecology and Society*, 9(2). <http://doi.org/5>.

³⁶ Manyena, B. S. (2009). *Disaster Resilience in Development and Humanitarian Interventions*. University of Northumbria. Retrieved from <http://nrl.northumbria.ac.uk/661/>.

³⁷ Wang, C., & Blackmore, J. (2009). Resilience Concepts for Water Resource Systems. *Journal of Water Resources Planning and Management*, 135(6), 528–536.

4.1.2. Ecological Resilience

In his paper *Resilience and stability of ecological systems*, Holling proved that single equilibrium oriented resilience cannot be applied to ecological systems where the existence of more than one equilibrium is possible⁵. The author illustrated the existence of multiple stability domains or multiple basins of attraction in natural systems and showed how they relate to ecological processes, random events and heterogeneity of temporal and spatial scales⁵. It was recognized that disturbance events and special heterogeneity cause each recovery trajectory of the system to be unique and difficult or impossible to predict. The term of “ecological resilience” emerged in the literature. In this case the measurement of resilience is the magnitude of disturbance that can be absorbed before a system changes the variables and processes that control its behaviour³⁸. This view of resilience presumes a stationary stability landscape – stationary underlying forces that shape events. It is a view of multiple stable states in ecosystems, economies, and societies that are adaptive³⁹.

The concept of ecological resilience further advanced due to the development and its application in the context of complex adaptive systems (CASs), social-ecological systems (SESs), and “panarchy” more recently. Theories of complex systems portray system as process-dependent organic systems with feedbacks among multiple scales that allow them to self-organise⁴⁰. Theories of CAS study how complicated structures and patterns of interaction can arise from disorder through simple but powerful rules that guide change⁴¹. Arthur et al. identified six characteristics of complex adaptive economic systems: dispersed interaction; the absence of a global controller; cross-cutting hierarchical organisation; continual adaptation, perpetual novelty; and far-from-equilibrium dynamics⁴². Levin further describes CAS as having three main components, namely, sustained diversity and individuality of components; localized interactions among those components; and an autonomous process that selects from among those components, based on the results of local interactions, a subset for replication or enhancement⁴¹. Therefore, complex non-linear dynamics and adaptive capacity enable CAS to re-arrange their internal structure spontaneously in response to some external shock⁴³. This adaptive notion of resilience challenges the whole idea of equilibrium and instead asserts that the seemingly stable states of nature or society can suddenly change and become something radically new and different⁴⁴. In the literature, the dynamics of socio-ecological systems is described using the framework of adaptive cycle.

4.1.3. Social-Ecological Resilience

Holling and Gunderson suggested that most of CAS follow a four phase cycle: rapid growth (or exploitation, **r phase**) characterized by readily available resources, the accumulation of structure, and high resilience; periods of growing stasis and rigidity (conservation, **K phase**) in which net growth slows and the system becomes increasingly interconnected, less flexible, and more vulnerable to external disturbances; periods of readjustments and collapse (the release, **omega (Ω) phase**); reorganisation and renewal (the **alpha (α) phase**)³⁹.

³⁸ Holling, C. S. (1996). Engineering resilience versus ecological resilience. In P. Schulze (eds.). *Engineering Within Ecological Constraints*. National Academy Press, Washington DC. P. 33.

³⁹ Gunderson, H. L., & Holling, C. S. (2002). *Panarchy: Understanding Transformations in Human and Natural Systems. A Synopsis of the Seminal Work From Islands Press*, Washington DC.

⁴⁰ Folke, C. (2006). Resilience: The emergence of a perspective for social-ecological systems analyses. *Global Environmental Change*, 16(3), 253–267. <http://doi.org/10.1016/j.gloenvcha.2006.04.002>. P. 257.

⁴¹ Levin, S. A. (1998). Ecosystems and the Biosphere as Complex Adaptive Systems. *Ecosystems*, (1), 431–436. <http://doi.org/10.1007/s100219900037>. P. 432.

⁴² Arthur, W.B., Durlauf, S. N., & Lane, D. (1997). *The Economy as an Evolving Complex system II*. Addison-Wesley, Reading, MA.

⁴³ Martin, R., & Sunley, P. (2007). Complexity thinking and evolutionary economic geography. *Journal of Economic Geography*, 7(5), 573–601. <http://doi.org/10.1093/jeg/lbm019>.

⁴⁴ Bristow, G., & Healy, A. (2014). Building Resilient Regions: Complex Adaptive Systems and the Role of Policy Intervention. *Raumforschung Und Raumordnung*, 1–10. <http://doi.org/10.1007/s13147-014-0280-0>.

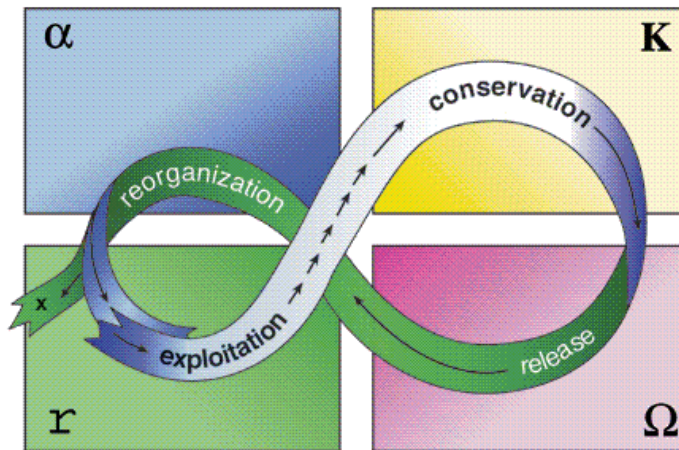


Figure 4.3 Adaptive cycle.⁴⁵

The rapid growth phase merging into a conservation phase comprises a slow, cumulative forward loop of the cycle, during which the dynamics of the system can be predicted. Early in the cycle the system is engaged in a period of rapid growth as species or other actors colonize recently disturbed areas⁴⁶. The system's components are weakly interconnected and its internal state is weakly regulated. As the conservation phase continues, resources within the system become increasingly locked up and connections between system's actors increase. As system's components become more strongly interconnected, its internal state becomes more strongly regulated and eventually system loses flexibility and responsiveness to external shocks³⁵. The growth rate slows as connectedness increases to the point of rigidity and resilience declines³⁵. Increasing dependence on existing structures and processes renders the system vulnerable to any internal or external disturbance that can release tightly knit capital, be it knowledge, inventions, biomass, etc. The transition from conservation phase to the release phase can occur rather very quickly. The longer the conservation phase persists the smaller external shock is needed to end it. A disturbance that exceeds the system's resilience breaks apart its web of reinforcing interactions⁴⁷. The system collapses but the destruction has a creative element as tightly bound social, natural, and economic capital is released and becomes a source for reorganisation and renewal¹². The phase of reorganisation enables innovation and new opportunities.

Accordingly, the omega and alpha phases form a so-called unpredictable "back loop" in the adaptive cycle. The alpha phase leads into a subsequent r phase, which may be a repetition of the previous r phase or be significantly different³⁵. The back loop is particularly interesting, because while disturbances are inevitable in dynamic systems, their impacts are not⁴⁸. Any of three possible outcomes can occur: first of all, the system can reorganize and remain within the same structural regime with no notable changes in structure or function, effectively remaining in the K phase until the next disturbance (resilience); secondly, it can shift to a different state within the same regime, characterized by shifts in certain feedback processes on in the scale at which processes operate

⁴⁵ Sustainable Scale Project. Available at: <http://www.sustainablescale.org/ConceptualFramework/UnderstandingScale/MeasuringScale/Panarchy.aspx>. Accessed: 20 May 2016.

⁴⁶ Gunderson, H. L., & Holling, C. S. (2002). *Panarchy: Understanding Transformations in Human and Natural Systems. A Synopsis of the Seminal Work From Islands Press, Washington DC*. P. 6.

⁴⁷ Pisano, U. (2012). Resilience and Sustainable Development: Theory of resilience, systems thinking and adaptive governance. *ESDN Quarterly Report N26*, (September), 51.

⁴⁸ Davidson, D. J. (2010). The Applicability of the Concept of Resilience to Social Systems: Some Sources of Optimism and Nagging Doubts. *Society & Natural Resources*, 23(12), 1135–1149. <http://doi.org/10.1080/08941921003652940>.

International Survey

(adaptation/adaptive resilience⁴⁹); thirdly, the system can transform to a new regime altogether (transformation)⁴⁸ (see the discussion on the concepts of adaptation and transformation below). The adaptive cycle involves changes in three variables: resilience; potential in the form of accumulated resources in biomass or in physical, human and social capital; and connectedness, meaning the tightness of coupling among the controlling variables that determine the system's ability to modulate external variability⁵⁰. In the r phase resilience is high, however, potential and connectedness are low; in K phase resilience decreases but two other variables increase. In omega phase potential crashes, and finally in alpha phase resilience and potential grow, connectedness falls, unpredictability peaks (ibid.). Therefore, the central idea of adaptive cycle is the view that disturbance is inevitable part of the development of the system. In a resilient ecosystem these four phases of the cycle will repeat themselves again and again⁵¹.

Walker et al. further contributed to the theoretical basis of SESs resilience by explaining it in terms of stability landscape and basins of attraction. Here SESs are assumed to move between several basins of attraction, defined as a region in a state space (state of variables that constitute the system) in which the system tends to remain. Resilience here is assumed to have three crucial aspects: latitude, which is defined as the maximum amount a system can be changed before losing its ability to recover (before crossing a threshold which, if breached, makes recovery difficult or impossible); resistance, meaning the ease or difficulty of changing the system; and precariousness or how close current state of the system is to a limit or threshold (see Figure 4.4 and Figure 4.5)³⁵. The fourth aspect of panarchy was introduced into the theory of resilience when the concept was brought into the field by Gunderson and Holling³⁹.

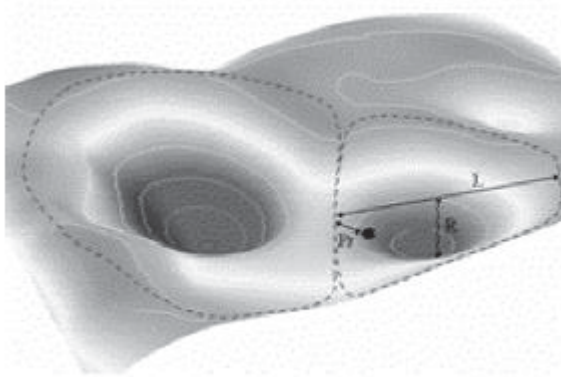


Figure 4.4 Three-dimensional stability landscape with two basins of attraction showing, in one basin, the current position of the system and three aspects of resilience, L = latitude, R = resistance, Pr = precariousness.³⁵

⁴⁹ See Cutter et al. (2008) for representation of the disaster resilience of place (DROP) model and discussion on adaptive resilience.

⁵⁰ Gotts, N. M. (2007). Resilience, panarchy, and world-systems analysis. *Ecology and Society*, 12(1). <http://doi.org/24>.

⁵¹ Berkes, F., Colding, J., & Folke, C. (2003). Navigating Social-Ecological Systems: Building Resilience for Complexity and Change. Cambridge University Press, Cambridge, UK. P. 17.

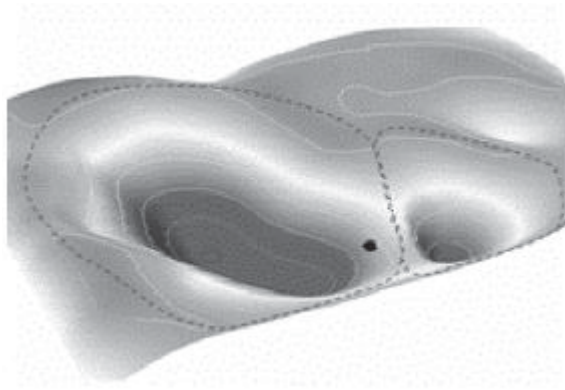


Figure 4.5 Changes in the stability landscape have resulted in a contraction of the basin the system was in and an expansion of another basin. System has changed basins without changing itself.³⁵

4.1.3.1. Panarchy

The concept of “panarchy” was developed by Gunderson and Holling in their famous book *Panarchy: Understanding Transformations in Human and Natural Systems*³⁹. Panarchy can be seen as a nested set of adaptive cycles operating at discrete ranges of scale (See Figure 4.6)⁵². The larger and slower cycles generally constrain the smaller and faster ones and maintain system integrity. The connection named “revolt” and “remember” are examples of the interplay across scales that are of significance in the process of building resilience¹². “Revolt” connections indicate how collapse of the omega phase (Ω) in one cycle triggers disturbance one level up. “Remember” is a cross-scale connection important in times of change, renewal and reorganisation³⁹. Here, alpha phase (α) of one cycle is organized by K phase of a higher cycle. Memory is perceived as accumulated experience and history of the system, and it provides context for renewal, innovation and self-organisation following disturbance. In panarchy, each level operates at its own pace, embedded in slower, larger levels but invigorated by smaller and faster cycles⁵³. Thus the fourth attribute of resilience, called panarchy, is about how longitude, resistance and precariousness (three attributes of resilience already discussed before) are influenced by the states and dynamics of the (sub)systems at scales above and below the scale of interest³⁵.

⁵² Allen, C. R., Angeler, D. G., Garmestani, A. S., Gunderson, L. H., & Holling, C. S. (2014). Panarchy: Theory and Application. *Ecosystems*, 17(4), 578–589. <http://doi.org/10.1007/s10021-013-9744-2>.

⁵³ Folke, C. (2006). Resilience: The emergence of a perspective for social-ecological systems analyses. *Global Environmental Change*, 16(3), 253–267. <http://doi.org/10.1016/j.gloenvcha.2006.04.002>. P. 259.

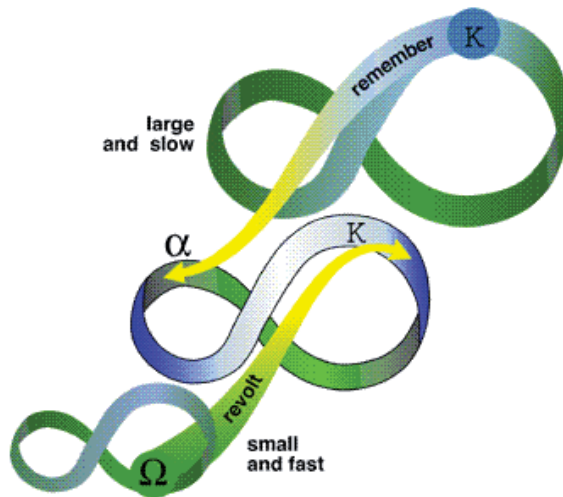


Figure 4.6 Panarchy, a heuristic model of linked multi-scale adaptive cycles.⁵⁴

The above introduced concepts of basins of attraction and stability landscape as well as panarchy, allows explaining the concept of resilience in the context of SESs more comprehensively. The central idea that the development of CAS theories and panarchy brought to the concept of resilience is the acknowledgement that disturbance can bring opportunities of recombination of evolved structures and processes, as well as renewal of the system and new trajectories. Therefore, in this case resilience provides the ability of the system to adapt and enables its further development through learning⁵⁵. Different authors began to define resilience as the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks – or in other words, stay in the same basin of attraction⁵⁶. The more resilient is a system, the larger disturbance it can absorb without shifting into an alternate regime. As the networked system has little control over its own complexity, its ability to self-organize becomes the necessity for the system to function⁵⁷. The dynamics after some disturbance depend on the capacity of CAS to self-organize, and the self-organizing process draws on temporal and spatial scales above and below the system in focus¹². Thus, in this view, resilience incorporates not only system's robustness and capacity to persist, but also the idea of adaptation, learning and self-organisation. In similar manner Manyena et al. suggested to view resilience as a “bounce forward” instead of “bounce back” phenomenon¹⁶. According to Manyena, resilience should be seen as a process which has a futuristic dimension due to the fact that adaptation occurs in the post disturbance phase as a strategy to mitigate future disturbances³⁶.

Although CASs are generally characterized by self-organisation without system-level intent control, humans are unique in having the capacity for foresight and deliberate action, and thus the principle of self-organisation in complex SESs is rather different from that in physical and ecological systems⁵⁸. Therefore, the concept of adaptability is important for understanding resilience in the SESs. A

⁵⁴ Sustainable Scale Project. Available at: <http://www.sustainablescale.org/ConceptualFramework/UnderstandingScale/MeasuringScale/Panarchy.aspx>. Accessed: 20 May 2016.

⁵⁵ Smit, B., & Wandel, J. (2006). Adaptation, adaptive capacity and vulnerability. *Global Environmental Change*, 16(3), 282–292. <http://doi.org/10.1016/j.gloenvcha.2006.03.008>.

⁵⁶ Walker, B., Gunderson, L., Kinzig, A., Folke, C., Carpenter, S., & Schultz, L. (2006). A handful of heuristics and some propositions for understanding resilience in social-ecological systems. *Ecology and Society*, 11(1). [http://doi.org/10.1890/1059-0935\(2006\)11\[1\]<A HANDFUL OF HEURISTICS AND SOME PROPOSITIONS FOR UNDERSTANDING RESILIENCE IN SOCIAL-ECOLOGICAL SYSTEMS>2.0.CO;2](http://doi.org/10.1890/1059-0935(2006)11[1]<A HANDFUL OF HEURISTICS AND SOME PROPOSITIONS FOR UNDERSTANDING RESILIENCE IN SOCIAL-ECOLOGICAL SYSTEMS>2.0.CO;2).

⁵⁷ Kaufmann, M. (2013). Emergent self-organisation in emergencies: resilience rationales in interconnected societies. *Resilience*, 53–68. <http://doi.org/10.1080/21693293.2013.765742>.

⁵⁸ Westley, F., Carpenter, S. R., Brock, A.W., Holling, C. S., & Gunderson, L. (2002). Why systems of people and nature are not just social and ecological systems. In L.H. Gunderson and C.S. Holling (eds.). *Panarchy: Understanding Transformations in Human and Natural Systems*. Islands Press, Washington DC.

vulnerable SES has lost resilience and losing resilience implies loss of *adaptability*¹². In a resilience network adaptability does not only imply adaptive capacity to respond within the social domain, but also to respond to and shape ecosystem dynamics and change in an informer manner⁵⁹. According to Walker et al., in resilience adaptability is perceived as the collective capacity of the human actors in the system to manage and build resilience through collective action³⁵. According to the theory of resilience, adaptability can take three forms: make desirable basins of attraction wider and/or deeper; create new desirable basins, or eliminate undesirable ones; or change the current structure of the system so as to move either deeper into a desirable basin, or closer to the edge of an undesirable one (ibid.). Adaptability is primarily determined by the absolute and relative amounts of social, human, natural, manufactured, and financial capital, as well as by the system of institutions and governance⁵⁶. However, high adaptability can unintentionally lead to the loss of resilience. This could happen in three ways: increasing adaptability in one place might lead to a loss of adaptability and resilience in another place, or over some larger area; increasing adaptability to some specific or regular shocks may adapt or optimize the system to this class of shock or regime of shocks, this way decreasing its general resilience to unknown shocks (for further discussion and examples see Walker et al. 2006⁵⁶).

There also might be situations when societies or groups find themselves trapped in an undesirable basin that is becoming wide and deep and the movement to a new basin or sufficient configuration of the existing basin becomes extremely difficult³⁵. At some point, it may be necessary to configure an entirely new stability landscape, defined by new state variables, or the old state variables supplemented by new ones. This capacity to create such a new stability landscape is called *transformability*³⁵. The changes introduced by the process of transformability cascade through and may transform the whole panarchy with all its constituent adaptive cycles³⁵. The notion of transformability, then, addresses a system's capacity to transform the stability landscape and to create new system pathways when social, economic, and ecological structures make the existing system unstable (Davidson 2010⁴⁸; Walker et al. 2004³⁵). Naturally, the tension will exist between maintaining resilience of a desired current configuration of the system in the face of known (and some unknown) shocks, and simultaneously building a capacity for transformability, should it be needed⁶⁰. In order to persist as a functioning system and avoid transformation, Gunderson and Holling identified three necessary system qualities: the system accumulates resources rather than depleting them over time; it also contains destabilizing forces for maintaining diversity, resilience, and opportunity, and stabilizing forces for maintaining productivity and biogeochemical cycles; evolutionary processes should be present in order to generate novelty, implying a balance between persistence and dynamism³⁹. According to Walker et al. resilience and/or adaptation is enhanced when there exists sufficient connectivity across scales to enable feedback, but at the same time there is sufficient autonomy to allow for buffering capacity to prevent a back-loop transition that originates at one scale and spreads to others, and expressions of diversity in function and response⁶⁰.

4.1.4. Discussion

Following the theoretical assumptions discussed above, social-ecological resilience can be defined as a phenomenon that has three main characteristics: (a) the amount of change the system can undergo and still remain within the same domain of attraction, meaning that it retains the same controls on structure and function; (b) the degree to which the system is capable of self-organisation versus lack of organisation, or organisation forced by external factors; (c) the degree to which the system can build the capacity to learn and adapt⁶¹ (see Table 4.1). Resilience can be summarized as having evolved

⁵⁹ Berkes, F., Colding, J., & Folke, C. (2003). Navigating Social-Ecological Systems: Building Resilience for Complexity and Change. *Cambridge University Press, Cambridge, UK*.

⁶⁰ Walker, B., Gunderson, L., Kinzig, A., Folke, C., Carpenter, S., & Schultz, L. (2006). A handful of heuristics and some propositions for understanding resilience in social-ecological systems. *Ecology and Society*, 11(1). [http://doi.org/10.1890/1059-0937\(2006\)11\[1\]<A HANDFUL OF HEURISTICS AND SOME PROPOSITIONS FOR UNDERSTANDING RESILIENCE IN SOCIAL-ECOLOGICAL SYSTEMS>2.0.CO;2](http://doi.org/10.1890/1059-0937(2006)11[1]<A HANDFUL OF HEURISTICS AND SOME PROPOSITIONS FOR UNDERSTANDING RESILIENCE IN SOCIAL-ECOLOGICAL SYSTEMS>2.0.CO;2).

⁶¹ Carpenter, S., Walker, B., Anderies, J. M., & Abel, N. (2001). From Metaphor to Measurement: Resilience of What to What? *Ecosystems*, 4(8), 765–781. <http://doi.org/10.1007/s10021-001-0045-9>. P. 766.

International Survey

from its initial focus on *persistability* of ecological system functions, through emphasis on the *adaptability* of SESs, to its most recent focus of addressing the *transformability* of society in the face of global change⁶².

Table 4.1 Three facets of resilience.⁵³

Resilience Concepts	Characteristics	Focus on	Context
Engineering resilience	Return time, efficiency	Recovery, constancy, robustness	Vicinity of a stable equilibrium
Ecological resilience	Buffer capacity, withstand shock, maintain function	Persistence, robustness	Multiple equilibria, stability landscapes
Social-ecological resilience	Interplay disturbance and reorganisation, sustaining and developing	Adaptive capacity, transformability, learning, innovation	Integrated system feedback, cross-scale dynamic interactions

A three-class typology of resilience suggested by Handmer and Dovers could be used as a useful parallel to the above discussed classification of the concept of resilience in order to further explain evolution of the phenomenon. In their widely cited article, Handmer and Dovers suggested a three-class generic typology of resilience emphasizing its reactive and proactive elements: resistance and maintenance; change at the margins; and openness and adaptability^{63,64}. **Type 1** resilience, or resistance and maintenance, is characterized by system's resistance to change and denial of a problem. In this type of resilience, enormous resources will be expended maintaining the status quo. This type of resilience lacks flexibility and it ensures that the system remains stable in the face shock through preserving the status quo and existing power structures. Such religious communities as Amish of North America can serve as an example of the Type 1 resilience.

Type 2 resilience, or change at the margins, is characterized by acknowledgement of a certain problem, discussion of the implications, and promulgation of reforms that lead to changes in emphasis at the margins and do not challenge the basis of societies⁶⁵. Therefore, this type of resilience allows only for minor changes within the system. According to the authors, *Type 2* resilience is the most common response to both environmental change and to hazards and risks. Current institutions and policy processes are locked in this type of resilience which allows a change only at the margins. This approach can be described as being practical, realistic, balanced, and pragmatic⁶⁶, meaning that responses to environmental change are shaped by what is perceived to be economically and politically beneficial in the nearest future rather than by the scale of the threat itself. This type of resilience also provides society with a certain level of stability, however, it is argued that there is a potentially large risk that this apparent stability is not sustainable and could lead to collapse if society is not able to make political, social and economic changes necessary for its survival⁶⁷.

⁶² Keck, M., & Sakdapolrak, P. (2013). What is social resilience? lessons learned and ways forward. *Erdkunde*, 67(1), 5–19. <http://doi.org/10.3112/erdkunde.2013.01.02>. P. 8.

⁶³ Handmer, J. W., & Dovers, S. R. (1996). Typology of Resilience: Rethinking Institutions for Sustainable Development. *Organisation Environment*, 9(482). <http://doi.org/10.1177/108602669600900403>.

⁶⁴ See for similar classification: Gallopín, G. C. (2006). Linkages between vulnerability, resilience, and adaptive capacity. *Global Environmental Change*, 16(3), 293–303. <http://doi.org/10.1016/j.gloenvcha.2006.02.004>. P. 299.

⁶⁵ Handmer, J. W., & Dovers, S. R. (1996). Typology of Resilience: Rethinking Institutions for Sustainable Development. *Organisation Environment*, 9(482). <http://doi.org/10.1177/108602669600900403>. P. 499.

⁶⁶ Ibid. P. 501.

⁶⁷ Klein, R. J. T., Nicholls, R. J., & Thomalla, F. (2003). Resilience to natural hazards: How useful is this concept? *Environmental Hazards*, 5(1-2), 35–45. <http://doi.org/10.1016/j.hazards.2004.02.001>. P. 39.

It is the **Type 3** resilience, or openness and adaptability, which embodies full flexibility of the system. This approach aims to reduce society's vulnerability by having a high degree of flexibility, and is characterized by preparedness to adopt new basic operating assumptions and institutional structures. An open and adaptable system should enhance the potential for the major changes that are, according to the authors, necessary for global sustainability. In this type of resilience an adaptable society would be prepared to move in fundamentally new direction quickly. Therefore, the system is assumed to adapt to changes and uncertainty instead of resisting them. However, great flexibility and adaptability results in the system being unstable and chaotic⁶³. Change deemed as necessary could turn out to be maladaptive and bring high costs to the society⁶⁷. Thus, the authors concluded a need to differentiate between reactive and proactive resilience⁶⁸. Reactive resilience in this case is associated with adaptive capacity; the ability to prepare and plan for hazards, and to implement strategies to implement strategies to manage hazards prior to, during and after the event. Proactive resilience on the other hand, suggests the capacity of humans to anticipate and learn⁶⁸. It embraces the concept of sustainability, and generally describes what Walker et al. refer to as transformative capital³⁵.

To summarize the discussion, it should be stressed, that the so-called “bounce back” and adaptive types of resilience are acceptable and whether entity bounces back from disturbance or develop resilience in an adaptive manner depends on the entity or system, the discipline, and the context within which the conceptualization of resilience is being made. Moreover, different components within the same system might experience different types of resilience. For example, in the railway system, which is composed of different elements such as rail lines, energy infrastructure, operator of the rail lines, communities, etc., different measures, descriptors and processes should be applied to describe different components of it. For the energy infrastructure itself its ability to return to the pre-crisis functioning, meaning to bounce back to the pre-disturbance state, might be indicative of resilience. However, resilience of, for example, an operator of the railway system, might be better characterized by their ability to identify what caused the disruption of the system, to learn from their experiences, and change accordingly²⁸.

4.2. Disaster Resilience

Resilience is not a new idea in the context of hazards and disasters. Initially referred to as adjustments in a 1975 assessment of natural hazards, the concept of resilience applied an all-hazard perspective and a full range of available approaches to reduce risks of disasters as well as improve approach to hazards. Similar principle was applied in a second assessment in 1999⁶⁹. The concept of resilience gained importance in the international political arena in 2005 with the adoption of Hyogo Framework for action aimed at ensuring that DRR and building resilience to disasters become priority for governments and local communities worldwide²³. DRR is the latest paradigm in disaster management offering a systematic approach to identifying, assessing, and reducing risks of natural hazards⁷⁰, and resilience is perceived as the ultimate goal for reducing disaster risks⁷¹.

In the context of disasters, resilience is understood as the capacity of a system, community, or society potentially exposed to hazards to resist, absorb, accommodate and recover from disasters timely and

⁶⁸ Dovers, S. R., & Handmer, J. W. (1992). Uncertainty, sustainability and change. *Global Environmental Change*, 2(4), 262–276. [http://doi.org/10.1016/0959-3780\(92\)90044-8](http://doi.org/10.1016/0959-3780(92)90044-8).

⁶⁹ Cutter, S. L., Ahearn, J. A., Amadei, B., Crawford, P., Eide, E. A., Galloway, G. E., Goodchild, M.F., Kunreuther, H.C., Li-Vollmer, M., Schoch-Spana, M., Scrimshaw, S.C., Stanley, E.M., Whitney, G., & Zoback, M.L. (2013). Disaster Resilience: A National Imperative. *Environment: Science and Policy for Sustainable Development*, 55(2), 25–29. <http://doi.org/10.1080/00139157.2013.768076>. P. 27.

⁷⁰ Djalante, R., & Thomalla, F. (2010). Community Resilience to Natural Hazards and Climate Change: A Review of Definitions and Operational Frameworks. *5th Annual International Workshop & Expo on Sumatra Tsunami Disaster & Recovery 2010*. <http://doi.org/10.3850/S1793924011000952>

⁷¹ Djalante, R., Holley, C., & Thomalla, F. (2011). Adaptive governance and managing resilience to natural hazards. *International Journal of Disaster Risk Science*, 2(4), 1–14. <http://doi.org/10.1007/s13753-011-0015-6>

efficiently. This is determined by the degree to which the social system is capable of organizing itself to increase its capacity for learning from past disasters for better future protection and to improve risk reduction measures⁷². The application of resilience in DRR is seen as a positive approach because it brings new perspectives to the understanding of socio-economic and ecological resilience by focusing on building the capacity of people to help themselves¹⁹. Understanding, managing, and reducing disaster risks provide a foundation for building disaster resilience⁷³.

One of the earliest works on disaster resilience is that of Timmerman, where he defined resilience as “the capacity of a system to absorb and recover from occurrence of hazardous events”²². Widalsky (1991)³¹, Paton and Johnston (2001)⁷⁴, Godschalk (2003)⁷⁵ further examined how communities can become more disaster resilient through application of various resilience processes, such as bouncing back, mitigation of disaster risks and recovering from disasters. Jung and Song argue that in the context of disasters, the characteristics of the resilience “systems imply three capabilities: decreasing the probability of a shock, buffering a shock as it takes place, and recovering quickly after a disaster”⁷⁶. Thus high levels of resilience are assumed to enhance mitigation, response, and recovery⁷⁶. Widalsky emphasized several common characteristics of resilient community, such as efficiency, autonomy, redundancy, diversity, strength, interdependence, adaptability, and collaboration³¹. Bruneau et al. focused on enhancing community resilience to geological hazards related to earthquakes⁷⁷. Berke and Campanella analysed planning for postdisaster resiliency, stressing the importance of flexible and adaptable pre-disaster recovery planning in the process of building disaster resiliency⁷⁸. In their article, Cutter et al. developed a place-based model for understanding community resilience to natural disasters⁷⁹. They used a Global Information System to integrate indicators of social vulnerability, vulnerability of the built environment, and hazard exposure to hazard mitigation efforts to determine the resilience of a particular place⁷⁹.

The literature on disaster resilience revealed consistent cross-disciplinary treatments in which disaster resilience is viewed as having two aspects: inherent, which functions well during non-crisis periods; and adaptive, which implies system’s flexibility in response during disasters⁸⁰. Disaster resilience incorporates the capacity of the system to reduce or avoid losses, contain the effects of disasters, and recover with minimal social disruptions (Berke & Campanella 2006⁷⁸; Cutter et al. 2013⁶⁹; Manyena 2006¹⁹; Tierney & Bruneau 2007⁸⁰). Thus resilience within hazard research includes pre-event measures to prevent hazard related damage and losses (preparedness) and post-event strategies to help to cope with and minimize disaster impacts, and is generally focused on engineered and social systems⁷⁹. Disaster resilience literature also contains discussion on the topic of resilience as an outcome versus a process. Different authors perceive resilience as an outcome and define it as

⁷² UNISDR. (2009). UNISDR Terminology on Disaster Risk Reduction. International Strategy for Disaster Reduction (ISDR). Available at: www.unisdr.org/publications. Accessed: 23 April 2016.

⁷³ National Research Council. (2012). Disaster Resilience : A National Imperative. Washington, DC. Available at: http://www.nap.edu/catalog.php?record_id=13457. Accessed: 23 April 2016.

⁷⁴ Paton, D., & Johnston, D. (2001). Disasters and communities: vulnerability, resilience and preparedness. *Disaster Prevention and Management*, 10(4), 270–277. <http://doi.org/10.1108/EUM0000000005930>

⁷⁵ Godschalk, D. R. (2003). Urban Hazard Mitigation: Creating Resilient Cities. *Natural Hazards Review*, 4(3), 136–143. [http://doi.org/10.1061/\(ASCE\)1527-6988\(2003\)4:3\(136\)](http://doi.org/10.1061/(ASCE)1527-6988(2003)4:3(136))

⁷⁶ Jung, K., & Song, M. (2015). Linking emergency management networks to disaster resilience: bonding and bridging strategy in hierarchical or horizontal collaboration networks. *Quality & Quantity*, 49(4), 1465–1483. <http://doi.org/10.1007/s11135-014-0092-x>

⁷⁷ Bruneau, M., Chang, S. E., Eguchi, R. T., Lee, G. C., O’Rourke, T. D., Reinhorn, A. M., Shinozuka, M., Tierney, A.M., Wallace, A.M., & Von Winterfeldt, D. (2003). A Framework to Quantitatively Assess and Enhance the Seismic Resilience of Communities. *Earthquake Spectra*, 19(4), 733–752. <http://doi.org/10.1193/1.1623497>

⁷⁸ Berke, P. R., & Campanella, J. T. (2006). Planning for Postdisaster Resiliency. *The ANNALS of the American Academy of Political and Social Science*, 604(1), 192–207. <http://doi.org/10.1177/0002716205285533>

⁷⁹ Cutter, S. L., Barnes, L., Berry, M., Burton, C., Evans, E., Tate, E., & Webb, J. (2008). A place-based model for understanding community resilience to natural disasters. *Global Environmental Change*, 18(4), 598–606. <http://doi.org/10.1016/j.gloenvcha.2008.07.013>

⁸⁰ Tierney, K., & Bruneau, M. (2007). Conceptualizing and Measuring Resilience: A Key to Disaster Loss Reduction. *TR News*, 14–18. Available at: http://onlinepubs.trb.org/onlinepubs/trnews/trnews250_p14-17.pdf. Accessed: 23 April 2016.

system's ability to bounce back or cope with disaster, the ability to survive the disaster with minimum impact and damage (e.g., Bruneau et al. 2003⁸¹; Djalante & Thomalla 2010⁷⁰; Tierney & Bruneau 2007⁸⁰, etc.). On the contrary, others perceive resilience as a process and defines it as the ability of the system to adapt and learn to mitigate future disasters (Cutter et al. 2008⁷⁹; Djalante & Thomalla 2010⁷⁰; Djalante et al. 2013⁸², etc.). Berke and Campanella argue that disasters open the so-called opportunity windows, which are defined as moments of opportunity when a problem has become urgent enough to push for change of entrenched practices⁷⁸. According to Djalante and Thomalla, comprehensive assessment of disaster resilience requires viewing the phenomenon as an outcome and a process. Viewing resilience as a process is crucial to enable the system to learn from past experience and to measure and evaluate progress in building resilience⁸³. Cutter et al. suggested that the characteristics of resilient communities include the following⁸⁴:

- relevant hazards are recognized and understood;
- communities at risk know when a hazard event is imminent;
- individuals at risk are safe from hazards in their homes and places of work;
- disaster-resilient communities experience minimum disruption to life and economy after a hazard event has passed.

Hazard as well as disaster resilience discourse is closely related to the research of sustainability and sustainable development. According to Djalante and Folke, disaster resilience building should address fundamental elements of sustainable development, DRR, and community engagement⁸³. The goal of sustainable development is to create and maintain prosperous ecological, economic, and social systems⁸⁵. Resilience of any community is closely linked to the condition of the environment and the treatment of resources. Therefore, the concept of sustainability should be treated as a central aspect of resilience studies⁷⁹. In the context of natural disasters, sustainability is defined as system's ability to "tolerate – and overcome – damage, diminished productivity, and reduced quality of life from an extreme event without significant outside assistance"⁸⁶. It is assumed that an environment stressed by unsustainable practices may experience more severe natural hazards.

Summarizing recent developments of the theory and practice of disaster resilience, Djalante et al. suggested an adaptive and integrated disaster resilience framework, emphasizing the most important components of the phenomenon⁸² (see Figure 4.7). Treating resilience as both a process and an outcome, Djalante and Thomalla identified three important elements of integrated disaster resilience, namely sustainable development, DRR, and community resilience⁷⁰. The sustainable development components provide a supporting environment for resilience building to take place and represent key elements of development, namely, governance and institutions; education, awareness and capacity building; social and economic development; the built-environment meaning physical infrastructure; and the natural environment or ecosystems. Effective disaster resilience building activities need to target the different stages of DRR (risk knowledge, mitigation, preparedness and emergency

⁸¹ Bruneau, M., Chang, S. E., Eguchi, R. T., Lee, G. C., O'Rourke, T. D., Reinhorn, A. M., Shinozuka, M., Tierney, A.M., Wallace, A.M., & Von Winterfeldt, D. (2003). A Framework to Quantitatively Assess and Enhance the Seismic Resilience of Communities. *Earthquake Spectra*, 19(4), 733–752. <http://doi.org/10.1193/1.1623497>

⁸² Djalante, R., Holley, C., Thomalla, F., & Carnegie, M. (2013). Pathways for adaptive and integrated disaster resilience. *Natural Hazards*, 69(3), 2105–2135. <http://doi.org/10.1007/s11069-013-0797-5>

⁸³ Djalante, R., & Thomalla, F. (2010). Community Resilience to Natural Hazards and Climate Change: A Review of Definitions and Operational Frameworks. *5th Annual International Workshop & Expo on Sumatra Tsunami Disaster & Recovery 2010*. <http://doi.org/10.3850/S1793924011000952>. P. 176.

⁸⁴ Cutter, S. L., Barnes, L., Berry, M., Burton, C., Evans, E., Tate, E., & Webb, J. (2008). Community and Regional Resilience: Perspectives from Hazards, Disasters, and Emergency Management. *CARRI Research Report 1*. Available at: http://www.resilientus.org/library/FINAL_CUTTER_9-25-08_1223482309.pdf. Accessed: 12 September 2015.

⁸⁵ Folke, C., Carpenter, S., Elmqvist, T., Gunderson, L., Holling, C. S., & Walker, B. (2002). Resilience and Sustainable Development: Building Adaptive Capacity in a World of Transformations. *Ambio*, 31(5), 437–440. [http://doi.org/10.1639/0044-7447\(2002\)031\[0437:RASDBA\]2.0.CO;2](http://doi.org/10.1639/0044-7447(2002)031[0437:RASDBA]2.0.CO;2)

⁸⁶ Mileti, D. S. (1999). Disasters by design: a reassessment of natural hazards in the United States. *Joseph Henry Press, Washington*. P. 4.

International Survey

management, recovery and reconstruction). In all of these efforts community should be considered as an active agent of change because disaster effects are locally determined and context-specific⁸⁷.

The middle layer of the Figure 4.7 shows that it is important to consider climate change issues in the context of all factors influencing resilience. The outer layer of the figure signifies the importance of adaptive governance in increasing system's adaptiveness to future uncertainties and complexities. Adaptive governance is defined as notions of governance that are more flexible and innovative and encourage learning to better manage uncertainties⁸⁸. Four main characteristics of adaptive governance are assumed to have significant influence on disaster resilience, namely, polycentric and multi-layer institutions; participation and collaboration; self-organisation and networks; and learning⁸⁷. Polycentric and multi-layer institutions are assumed to have a positive influence on the capacity to manage resilience due to the existence of different organisations and different scales, which allows for a better matching of ecological and organisational scales. Participation and collaboration have influence on improving effectiveness and efficiency and reduce uncertainties in managing environmental problems. Self-organisation and networks influence the process of building resilience, especially with regards to community level. Lastly, the process of social learning enhances resilience by providing access to knowledge⁸⁷.

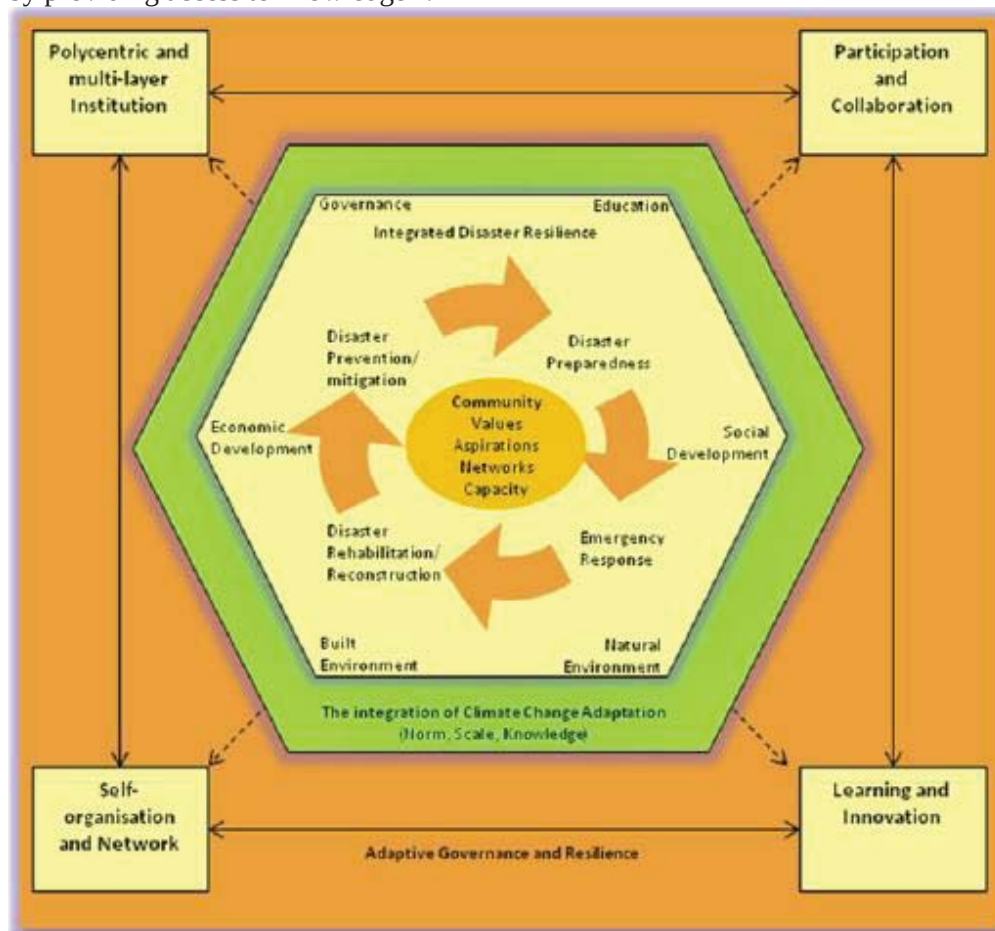


Figure 4.7 An adaptive and integrated disaster resilience framework.⁸⁹

⁸⁷ Djalante, R., Holley, C., Thomalla, F., & Carnegie, M. (2013). Pathways for adaptive and integrated disaster resilience. *Natural Hazards*, 69(3), 2105–2135. <http://doi.org/10.1007/s11069-013-0797-5>. P. 2110–2111.

⁸⁸ Folke, C., Hahn, T., Olsson, P., & Norberg, J. (2005). Adaptive Governance of Social-Ecological Systems. *Annual Review of Environment and Resources*, 30(1), 441–473. <http://doi.org/10.1146/annurev.energy.30.050504.144511>

⁸⁹ Djalante, R., Holley, C., Thomalla, F., & Carnegie, M. (2013). Pathways for adaptive and integrated disaster resilience. *Natural Hazards*, 69(3), 2105–2135. <http://doi.org/10.1007/s11069-013-0797-5>. P.2111.

Up to date, there is no existing set of established indicators or frameworks for measuring disaster resilience. However, throughout the literature a consensus that resilience is a multifaceted concept, which includes social, economic, institutional, infrastructural, ecological and community elements, could be found (see e.g. Bruneau et al. 2003⁸¹; Cutter et al. 2008⁷⁹; Cutter et al. 2010⁹⁰; Jung & Song 2015⁷⁶; Norris et al. 2008⁹¹, etc.).

4.3. Resilience and Vulnerability

In resilience literature, the concept of resilience has very close links with the concept of vulnerability (Adger 2006⁹²; Cutter 1996⁹³; Cutter 2003⁹⁴; Cutter et al. 2008⁷⁹; Mumby et al. 2014⁹⁵; Smit & Wandel 2006⁹⁶, etc.). The concept of vulnerability, which originally measures the expected harm experienced by a system due to its exposure to a disturbance, first emerged in risk-hazard research in the 1970s⁹⁵. It has been used in different research traditions and therefore might have different definitions depending on the research area it is used in (Adger 2006⁹²; Gallopín 2006⁸; Vogel et al. 2007⁹⁷). Generally, vulnerability refers to the degree to which a system is susceptible to and is unable to cope with adverse effects. The key parameters of vulnerability are: stress to which system is exposed, its sensitivity, and its adaptive capacity⁹⁵. Exposure is perceived as the degree to which a system is exposed to a given stressor; sensitivity is the degree to which a stressor impacts the system; and adaptive capacity is perceived as the potential for the system to adjust or cope with impact⁹⁵. Thus, vulnerability and resilience research have common elements of interest, namely shocks experienced by the system, response of the system, and the capacity of the system for an adaptive action. However, the two concepts have subtle differences, which are frequently lost in the course of a growing multidisciplinary discourse⁹⁷. There has been an extensive discussion in the literature whether the two concepts should be treated as positive and negative poles on the same continuum or as two completely distinct notions.

In his monograph “Vulnerability, Resilience and the Collapse of Society” Timmerman linked the concepts of resilience and vulnerability for the first time²². The author concluded that resilience is part of the overall strategy to reduce vulnerability. Whether resilience and vulnerability are treated as distinct or closely related concepts depends on how one defines the two terms. For example, if vulnerability is defined as the degree to which system acts adversely to occurrence of a hazardous event²², then vulnerability is very closely related to resilience. The Resilience Alliance⁹⁸ sees vulnerability of system resulting from reduced resilience⁹⁹. Therefore, based on this approach

⁹⁰ Cutter, S. L., Burton, C. G., & Emrich, C. T. (2010). Disaster Resilience Indicators for Benchmarking Baseline Conditions. *Journal of Homeland Security and Emergency Management*, 7(1). <http://doi.org/10.2202/1547-7355.1732>

⁹¹ Norris, F. H., Stevens, S. P., Pfefferbaum, B., Wyche, K. F., & Pfefferbaum, R. L. (2008). Community resilience as a Metaphor, Theory, Set of Capacities, and Strategy for Disaster Readiness. *American Journal of Community Psychology*, 41(1-2), 127–150. <http://doi.org/10.1007/s10464-007-9156-6>

⁹² Adger, W. N. (2006). Vulnerability. *Global Environmental Change*, 16(3), 268–281. <http://doi.org/10.1016/j.gloenvcha.2006.02.006>

⁹³ Cutter, S. L. (1996). Vulnerability to environmental hazards. *Progress in Human Geography*, 20(4), 529–539. <http://doi.org/10.1177/030913259602000407>

⁹⁴ Cutter, S. L. (2003). The vulnerability of science and the science of vulnerability. *Annals of the Association of American Geographers*, 93(1), 1–12. <http://doi.org/10.1111/1467-8306.93101>

⁹⁵ Mumby, P. J., Chollett, I., Bozec, Y. M., & Wolff, N. H. (2014). Ecological resilience, robustness and vulnerability: How do these concepts benefit ecosystem management? *Current Opinion in Environmental Sustainability*, 7, 22–27. <http://doi.org/10.1016/j.cosust.2013.11.021>

⁹⁶ Smit, B., & Wandel, J. (2006). Adaptation, adaptive capacity and vulnerability. *Global Environmental Change*, 16(3), 282–292. <http://doi.org/10.1016/j.gloenvcha.2006.03.008>

⁹⁷ Vogel, C., Moser, S. C., Kasperson, R. E., & Dabelko, G. D. (2007). Linking vulnerability, adaptation, and resilience science to practice: Pathways, players, and partnerships. *Global Environmental Change*, 17(3-4), 349–364. <http://doi.org/10.1016/j.gloenvcha.2007.05.002>

⁹⁸ A research organisation comprised of scientists and practitioners from many disciplines. For more information see: http://www.resalliance.org/index.php/about_ra.

⁹⁹ Manyena, B. S. (2006). The concept of resilience revisited. *Disasters*, 30(4), 433–450. P. 441.

vulnerability is perceived as an antonym of resilience, where vulnerable system is a system which has lost resilience¹². If one is more on the positive pole of the continuum, then one becomes more resilient than being vulnerable and the opposite is the same¹⁰⁰. However, this simplification of things leads to circular reasoning: a system is vulnerable because it is not resilient; it is not resilient because it is vulnerable¹⁰¹. The absence of vulnerability does not make one resilient.

Instead of viewing the two concepts as the opposite poles of the same continuum, Cutter et al. suggested that there is an overlap within the concepts of resilience and vulnerability⁷⁹. Therefore the two concepts are viewed neither as mutually inclusive, nor mutually exclusive. According to the authors, there are many characteristics that influence only the vulnerability or only resilience of a certain community. Thus, we should not assume that just because a community is vulnerable, it also lacks resilience¹⁰². On the other hand, there are social characteristics that influence both resilience and vulnerability⁷⁹.

According to Gallopín, resilience is related to the capacity of response component of vulnerability, and therefore should not be seen as the flip side of vulnerability⁸. Mumby et al. argue that resilience and vulnerability measure fundamentally different properties of a system and therefore cannot be perceived as the opposite poles of the same continuum. According to the authors, “vulnerability tends to focus on changes to system state without considering the direction of trajectories explicitly”¹⁰³. On the other hand, resilience attempts to prevent the system from going towards an undesirable end-point (e.g., how to maintain the capacity of the system to exhibit trajectories after disturbance)¹⁰³. Intuitively, a vulnerable system is one that would spend much of the time in an undesirable state. This system can be resilient, but maintained in a depleted state because of frequent shocks, therefore while such a system would be resilient, it would also be vulnerable because its state remains at undesirable levels¹⁰³. Rose argued that vulnerability is a pre-disaster condition and resilience is the outcome of a post-disaster response¹⁰⁴.

In his PhD dissertation, Manyena argued that the two concepts should be treated as distinct notions until proven otherwise³⁶. As it was already discussed, the notion of process is of central importance to resilience. In contrary, vulnerability is about outcome. The center of vulnerability paradigm leans towards structural solutions, where building physical capacity, based on structured, standardized engineering systems, reduces system’s vulnerability to disasters. On the other hand resilience is based on agency, meaning the capacity of people to do things³⁶.

5. Community Resilience

Understanding how communities can successfully adapt to rapid and oftentimes crises-driven change is of fundamental importance to governments as well as crises managers. Despite evidence that social, and not physical, infrastructure drives resilience, much research and policy remain highly focused on

¹⁰⁰ Manyena, B. S. (2009). Disaster Resilience in Development and Humanitarian Interventions. *University of Northumbria*. Available at: <http://nrl.northumbria.ac.uk/661/>. Accessed: 23 April 2016.

¹⁰¹ Klein, R. J. T., Nicholls, R. J., & Thomalla, F. (2003). Resilience to natural hazards: How useful is this concept? *Environmental Hazards*, 5(1-2), 35–45. <http://doi.org/10.1016/j.hazards.2004.02.001>. P. 40.

¹⁰² Cutter, S. L., Barnes, L., Berry, M., Burton, C., Evans, E., Tate, E., & Webb, J. (2008). Community and Regional Resilience: Perspectives from Hazards, Disasters, and Emergency Management. *CARRI Research Report 1*. Available at: http://www.resilientus.org/library/FINAL_CUTTER_9-25-08_1223482309.pdf. Accessed: 1 March 2016.

¹⁰³ Mumby, P. J., Chollett, I., Bozec, Y. M., & Wolff, N. H. (2014). Ecological resilience, robustness and vulnerability: How do these concepts benefit ecosystem management? *Current Opinion in Environmental Sustainability*, 7, 22–27. <http://doi.org/10.1016/j.cosust.2013.11.021>. P. 24.

¹⁰⁴ Rose, A. (2006). Economic resilience to disasters: towards a consistent and comprehensive formulation. In D. Paton and D. Johnston (eds.). *Disaster Resilience: An Integrated Approach*. Charles C. Thomas, Springfield, IL. P. 232.

physical infrastructure-centred approaches to resilience¹⁰⁵. Attention to the social aspects of resilience emerged as social ecologists introduced the social capital of communities to their work¹⁰⁶. A major thrust of this work is the focus on the resilience of community rather than of its individual members¹⁰⁷. As observed by Brown and Kulig, people in communities are resilient together, not merely in similar ways¹⁰⁸.

The concept of community resilience raises the same definitional concerns as the concept of resilience per se, but is further complicated by the variation in the meaning of community. Communities typically are defined as entities that have geographic boundaries and shared fate. Communities are composed of **built, natural, social, and economic** environments that influence one other in complex ways⁹¹. There is an extensive body of literature examining the concept of community resilience, however, the lack of consistency in the conceptualization of the phenomenon leads to the fact that community resilience is described differently in various studies and defined quite loosely¹⁰⁹. An additional confounding issue encountered in resilience literature is that the terms of community and social/societal resilience are often used as synonyms¹¹⁰. Other authors argue that the concept of community resilience was developed as part of social resilience and vice versa¹¹¹. Therefore, there is a lot of overlapping in the two concepts and often they can be interchanged¹¹².

In general, literature identifies three forms of community (and social) resilience, namely, resistance, recovery and adaptation¹¹³. Resistance as a form of community resilience primarily focuses on the ability of community to absorb perturbations¹¹⁴. Other authors focus on community's ability to quickly recover from the stressors (see for example Aldrich & Meyer, 2015; Paton & Johnston 2001). Researchers of CASs describe community resilience as the adaptive and learning capacity of communities to self-organize in a way that maintains system function in the face of change or in response to disturbance (Boon et al. 2012¹¹⁰; Cutter et al. 2008⁷⁹; Maclean et al. 2014¹¹²). Zhou et al. identified at least 28 definitions of community (and social/societal resilience)¹¹⁵.

Magis defines community resilience as “the existence, development, and engagement of community resources by community members to thrive in an environment characterized by change, uncertainty, unpredictability, and surprise”¹¹⁶. Therefore, the author draws a very close link between community resilience and the environment it lives in. Cutter et al. define community resilience as the ability of social system to respond and recover from disasters and include those inherent conditions that allow the system to absorb impacts and cope with an event, as well as post-event, adaptive processes that

¹⁰⁵ Aldrich, P. D., & Meyer, A. (2015). Social Capital and Community Resilience. *American Behavioral Scientist*, 59(2), 254–269. <http://doi.org/10.1177/0002764214550299>

¹⁰⁶ Kulig, C. J., Edge, S. D., Townshend, I., Lightfoot, N., & Reimer, W. (2013). Community resiliency: Emerging theoretical insights. *Journal of Community Psychology*, 41(6), 758–775. <http://doi.org/10.1002/jcop>

¹⁰⁷ Adger, W. N. (2000). Social and ecological resilience: are they related? *Progress in Human Geography*, 24(3), 347–364. <http://doi.org/10.1191/030913200701540465>.

¹⁰⁸ Brown, D., & Kulig, J. (1996). The concept of resiliency: Theoretical lessons from community research. *Health and Canadian Society*, 4, 29–52. P. 43.

¹⁰⁹ Kulig, J. C. (2000). Community resiliency: the potential for community health nursing theory development. *Public Health Nursing*, 17(5), 374–385. <http://doi.org/10.1046/j.1525-1446.2000.00374.x>

¹¹⁰ Boon, H. J., Cottrell, A., King, D., Stevenson, R. B., & Millar, J. (2012). Bronfenbrenner's bioecological theory for modelling community resilience to natural disasters. *Natural Hazards*, 60(2), 381–408. <http://doi.org/10.1007/s11069-011-0021-4>.

¹¹¹ Wilson, A. G. (2012). *Community Resilience and Environmental Transitions*. Routledge.

¹¹² Maclean, K., Cuthill, M., & Ross, H. (2014). Six attributes of social resilience. *Journal of Environmental Planning and Management*, 57(1), 144–156. <http://doi.org/10.1080/09640568.2013.763774>

¹¹³ Boon, H. J., Cottrell, A., King, D., Stevenson, R. B., & Millar, J. (2012). Bronfenbrenner's bioecological theory for modelling community resilience to natural disasters. *Natural Hazards*, 60(2), 381–408. <http://doi.org/10.1007/s11069-011-0021-4>. P. 387.

¹¹⁴ Geis, E. D. (2000). By Deign: The Disaster Resistant and Quality-of-Life Community. *Natural Hazards Review*, 1(3).

¹¹⁵ Zhou, H., Wang, J., Wan, J., & Jia, H. (2010). Resilience to natural hazards: A geographic perspective. *Natural Hazards*, 53(1), 21–41. <http://doi.org/10.1007/s11069-009-9407-y>.

¹¹⁶ Magis, K. (2010). Community Resilience: An Indicator of Social Sustainability. *Society & Natural Resources: An International Journal*, 23(5), 401–416. <http://doi.org/10.1080/08941920903305674>. P. 401.

facilitate the ability of the social system to re-organize, change and learn in response to threat¹¹⁷. Aldrich and Meyer define community resilience as the collective ability of neighbourhood or geographically defined area to deal with stressors and efficiently resume the rhythms of daily life through cooperation following shocks¹¹⁸. The authors further argue that while disaster situations may typically call for images of trained professionals and rescue operations, it is neighbours who regularly serve as actual first responders. Colten et al. define community resilience as community's or region's capability to prepare for, respond to, and recover from significant multi-hazard threats with minimum damage to public safety and health, the economy and national security¹¹⁹. The authors emphasize that this goes beyond infrastructure to include community's capacity to respond and remain resilient. As noted by Godschalk, building resilient communities goes beyond changing land use and physical facilities, it must also build the capacity of the multiple involved communities to anticipate and respond to disasters¹²⁰.

Throughout resilience literature, different authors outline variant **dimensions of community resilience**. For example, Cutter et al. identified six dimensions of community resilience, namely ecological, social, economic, institutional, infrastructure, and community competence⁷⁹. In their other article Cutter et al. argued that community resilience include physical, social, political, economic, institutional and ecological dimensions¹⁰². In his book "Community Resilience and Environmental Transitions", Wilson outlined three dimensions of community resilience, namely social, ecological and economic¹²¹ (see also Adger 2000¹²²; Ostrom 2009¹²³; Pickett et al. 2014¹²⁴). According to the author, these three pillars of resilience are fundamental for understanding community-level processes. Strongest resilience is achieved when all three capitals are equally developed. Colten et al. described resilient communities as those that have: integrated emergency institutions and communications; formal disaster plans; trained emergency responders; a reserve of personnel, material and financial resources; public education and information about risks and potential disasters and long-term planning for recovery and vulnerability reduction¹¹⁹. Another conceptualization of community resilience is brought by Zhou et al.¹¹⁵. The authors put emphasis geographical principles and community resilience with regard to disasters primarily means that locals are able to withstand a natural disaster without suffering devastating losses, damage, diminished productivity, or quality of life, and, importantly without much assistance from outside the community.

Bruneau et al. developed one of the most influential models assessing community resilience¹²⁵. The authors concentrated on analysing community seismic resilience and developed a model aimed at assessing it. The authors defined community seismic resilience as the ability of social units (for example organisations, communities) to mitigate hazards, contain the effects of disasters when they occur, and carry out recovery activities in ways that minimize social disruption and mitigate effects of

¹¹⁷ Cutter, S. L., Barnes, L., Berry, M., Burton, C., Evans, E., Tate, E., & Webb, J. (2008). A place-based model for understanding community resilience to natural disasters. *Global Environmental Change*, 18(4), 598–606. <http://doi.org/10.1016/j.gloenvcha.2008.07.013>. P. 599.

¹¹⁸ Aldrich, P. D., & Meyer, A. (2015). Social Capital and Community Resilience. *American Behavioral Scientist*, 59(2), 254–269. <http://doi.org/10.1177/0002764214550299>. P. 255.

¹¹⁹ Colten, C. E., Kates, R. W., & Laska, S. B. (2008). Three Years after Katrina: Lessons for Community Resilience. *Environment*, 50(5), 36–47.

¹²⁰ Godschalk, D. R. (2003). Urban Hazard Mitigation: Creating Resilient Cities. *Natural Hazards Review*, 4(3), 136–143. [http://doi.org/10.1061/\(ASCE\)1527-6988\(2003\)4:3\(136\)](http://doi.org/10.1061/(ASCE)1527-6988(2003)4:3(136)). P. 140.

¹²¹ Wilson, A. G. (2012). *Community Resilience and Environmental Transitions*. Routledge.

¹²² Adger, W. N. (2000). Social and ecological resilience: are they related? *Progress in Human Geography*, 24(3), 347–364. <http://doi.org/10.1191/030913200701540465>.

¹²³ Ostrom, E. (2009). A general framework for analyzing sustainability of social-ecological systems. *Science (New York, N.Y.)*, 325(5939), 419–422. <http://doi.org/10.1126/science.1172133>.

¹²⁴ Pickett, S.T.A., McGrath, B., Cadenasso, M. L., & Felson, A. J. (2014). Ecological resilience and resilient cities. *Building Research & Information*, 42(2), 143–157. <http://doi.org/10.1080/09613218.2014.850600>.

¹²⁵ Bruneau, M., Chang, S. E., Eguchi, R. T., Lee, G. C., O'Rourke, T. D., Reinhorn, A. M., Shinozuka, M., Tierney, A.M., Wallace, A.M., & Von Winterfeldt, D. (2003). A Framework to Quantitatively Assess and Enhance the Seismic Resilience of Communities. *Earthquake Spectra*, 19(4), 733–752. <http://doi.org/10.1193/1.1623497>.

future earthquakes¹²⁶. The authors concentrated on infrastructure as means to enhance community seismic resilience. They argued that resilience of both physical and social systems can be defined as consisting of robustness, redundancy, resourcefulness, and rapidity (**4Rs model**). Bruneau et al. further defined community resilience by arguing that it is composed of four interrelated dimensions: **technical, organisational, social, and economic (TOSE)**¹²⁷. Similar perception of community resilience is adopted by Jung and Song¹²⁸. Technical and organisational performance measures refer to the ability of the physical system and the organisation that manages it to withstand earthquake forces and recover quickly from its impacts. Social and economic performance measures refer to the ability of community to withstand and recover quickly from the disaster¹²⁸. However, this model and perception of community resilience does not consider resilience as a process and excludes the elements of adaptation, flexibility and learning, which are considered to be critical for a comprehensive assessment of resilience in general and community resilience specifically (e.g. Boon et al. 2012¹¹⁰; Cutter et al. 2008⁷⁹; Djalante & Thomalla 2010⁷⁰; Norris et al. 2007; Sherrieb et al. 2010¹²⁹, etc.).

Norris et al. outlined a theory in which they apply the concept of resilience to explain the responses of communities to disasters⁹¹ (see Figure 5.1). They built their theory on the basis of 4Rs model by introducing significant changes in order to be able to assess community as a process rather as an outcome. Resilience is perceived as a process that leads to adaptation, not an outcome or stability. The authors define community resilience as a process linking a set of networked *adaptive capacities* to a positive trajectory of functioning and adaptation in constituent populations after disturbance. *Adaptive capacities* here are defined as *resources* (objects, conditions, and energies that people value) with dynamic attributes, for example, resources that are robust, redundant, or rapidly accessible. Resilience-*resources* have three *dynamic properties*: robustness, meaning the strength of resource, in combination with a low probability of resource deterioration; redundancy, a condition related to resource diversity; and rapidity, which reflect how quickly the resource can be accessed and used. The authors speculate that a resource need have only one of the attributes to engender resilience⁹¹.

¹²⁶ Ibid. P. 735.

¹²⁷ Ibid. P. 738.

¹²⁸ Jung, K., & Song, M. (2015). Linking emergency management networks to disaster resilience: bonding and bridging strategy in hierarchical or horizontal collaboration networks. *Quality & Quantity*, 49(4), 1465–1483. <http://doi.org/10.1007/s11135-014-0092-x>. P. 1466.

¹²⁹ Sherrieb, K., Norris, F. H., & Galea, S. (2010). Measuring Capacities for Community Resilience. *Social Indicators Research*, 99(2), 227–247. <http://doi.org/10.1007/s11205-010-9576-9>.

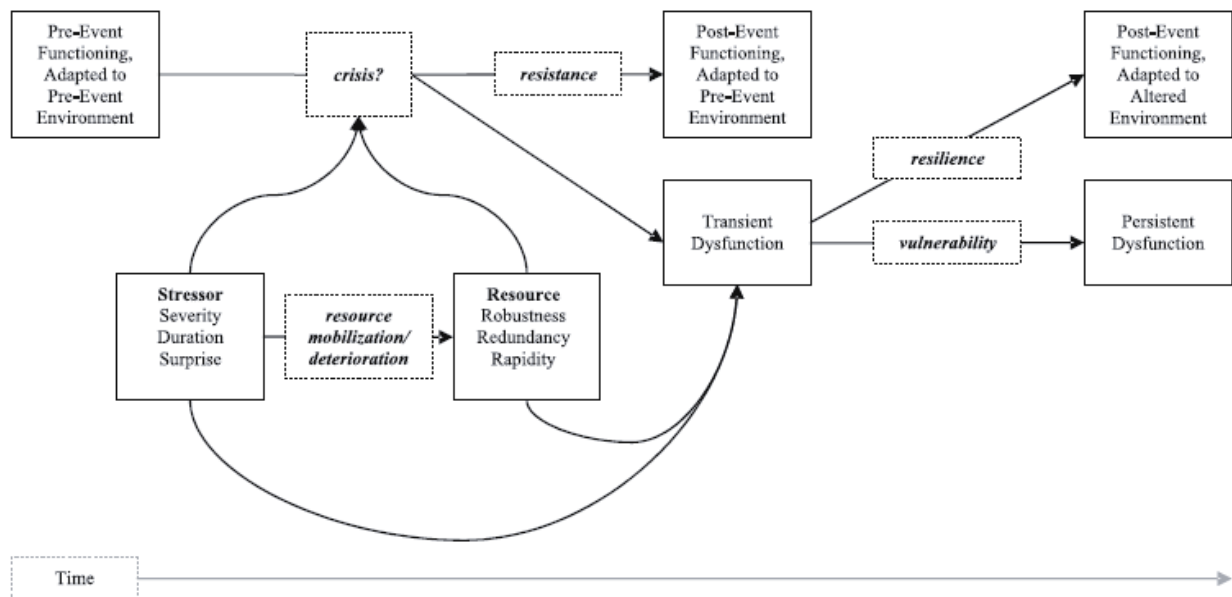


Figure 5.1 Model of stress resistance and resilience over time.¹³⁰

The four sets of networked resources or capacities – Economic Development, Social Capital, Information and Communication, Community Competence – define and shape the process of community resilience (see Figure 5.2).⁹¹

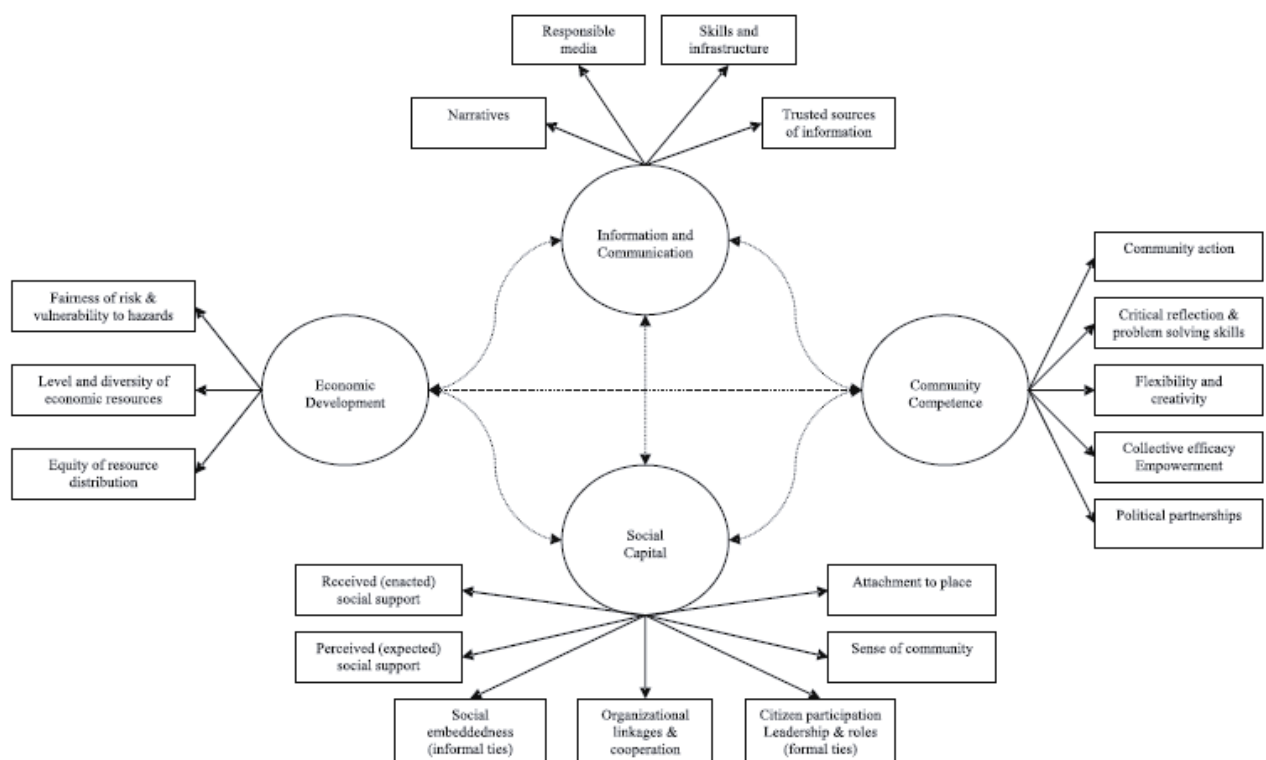


Figure 5.2 Community resilience as a set of adaptive capacities.¹³¹

¹³⁰ Norris, F. H., Stevens, S. P., Pfefferbaum, B., Wyche, K. F., & Pfefferbaum, R. L. (2008). Community resilience as a Metaphor, Theory, Set of Capacities, and Strategy for Disaster Readiness. *American Journal of Community Psychology*, 41(1-2), 127–150. <http://doi.org/10.1007/s10464-007-9156-6>, P. 130.

The authors concluded that the more rapid is the return to pre-event functioning, the greater is the resilience of a certain community. However, post-event functioning does not mean the same equilibrium. Post-event functioning may not be qualitatively equivalent to pre-event functioning when there is a need to adapt to an altered environment. Moreover, adapted functioning is not necessarily superior in level or character or effectiveness to pre-event functioning⁹¹.

Cutter et al. developed one of the most influential qualitative models for assessing community resilience⁷⁹ (see Figure 5.3). The **disaster resilience of place (DROP) model** analyses resilience at community level with the main focus on the social resilience of places. The authors contest that the DROP model fills a gap in the resilience measurement literature, which is littered with inconsistent indicators and non-standard metrics¹³². This is particularly the case in the disaster literature, where resilience models are most often highly focused on engineered systems and fail to capture social factors, inherent resilience, and the antecedent processes that promote or degrade resilience¹³². The model argues that natural and social systems as well as built environment are interconnected and their separation is arbitrary. The authors also emphasize the importance of exogenous factors such as federal policies and state regulations do exert powerful influences on resilience at the community level⁷⁹. Six dimensions with underlying candidate variables are suggested as resilience indicators, including: ecological resilience, social resilience, economic resilience, institutional resilience, infrastructure resilience, and community capital. However, there has been no attempt to operationalize this model as a whole. The DROP model's theoretical application is powerful and meaningful, but practically very difficult to apply¹³³.

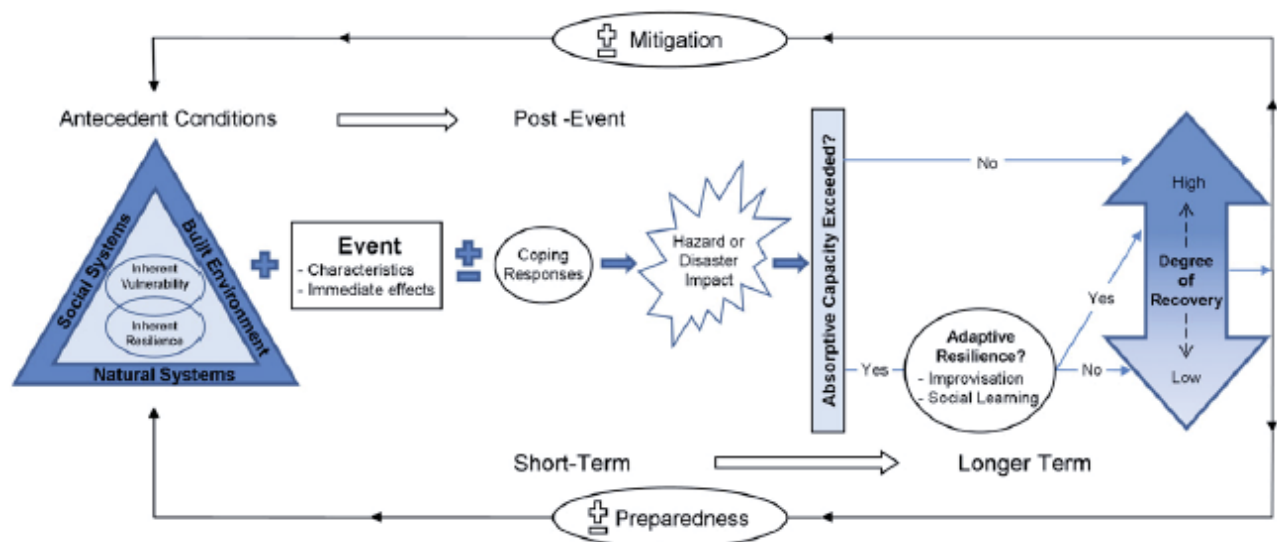


Figure 5.3 Disaster resilience of place model.⁷⁹

In order to reflect the concept of community resilience and collect as much relevant information for the purpose of the project as possible, the following sub-sections will analyse **five dimensions** of **community resilience**, namely: technical, organisational, social/societal, economic, and ecological. As it is outlined in the description of the project IMPROVER, the emphasis is placed on the concepts of **technical**, **organisational**, and **social/societal** dimensions of resilience as they will be further evaluated and assessed in other work packages with the overall goal of the project to improve

¹³¹ Ibid. P. 136.

¹³² Prior, T., & Hagmann, J. (2012). Measuring Resilience: Benefits and Limitations of Resilience Indices. *SKI Focus Report 8*, (March), 1–26. Available at: <http://www.isn.ethz.ch/Digital-Library/Publications/Detail/?lng=en&id=173644>. Accessed: 23 April 2016.

¹³³ Ibid. P. 14.

European critical infrastructure resilience. Nevertheless, we also collected information on economic and environmental concepts of resilience as they compose constituent part of the overall community resilience and might be included into the future efforts to assess and improve European critical infrastructure resilience to disruptions.

5.1. Technical Dimension of Resilience

Every CI facility relies on its physical infrastructure to perform properly when subject to a crisis. Therefore, the aspect of technical resilience is of paramount importance for the current project. To increase CIR, it is important to understand behaviour of physical systems under stress and choose such technical solutions that are not susceptible to changes of the environment. This sub-section provides an overview of the concept of technical resilience and lists possible indicators for measuring the phenomenon that will be further assessed and evaluated in the subsequent work packages of the project.

Technical resilience views and analyses resilience from **engineering approach** point of view and therefore is closely related to the concept of **engineering resilience** already discussed in the Section 4.1.1. As it was already discussed, the concept is focused on system's behaviour near a stable equilibrium and the rate at which a system returns to steady state following some disturbance. Therefore it argues for the **bounce back** approach to resilience. In the context of CI, technical resilience refers to the ability of all the physical components within a particular CI facility to retain and/or restore the functionality after some disturbing event as soon as possible.

According to Bruneau and Tierney, technical resilience refers primarily to the physical properties of systems, including their ability to resist damage and loss of function and “to fail gracefully”. The technical domain also includes the physical components that add redundancy.¹³⁴ It refers to “the ability of physical systems (including components, their interconnections and interactions, and entire systems) to perform to acceptable/desired levels” when subject to some disturbance¹³⁵. Madni et al. argue that resilience of physical systems is more properly thought of as a characteristic of how the system behaves (process), as opposed to a property that the system has (state).¹³⁶

5.1.1. 4R's Model and Resilience Triangle

As it was already mentioned, Bruneau et al. resilience of physical systems can be defined as consisting of robustness, redundancy, resourcefulness, and rapidity (**4R's model**).

- **Robustness** - strength, or the ability of a system or system's elements to withstand a given level of stress or demand without suffering degradation or loss of function;
- **Redundancy** - the extent to which a system or system's elements exist that are substitutable, i.e., capable of satisfying functional requirements in the event of disruption, degradation, or loss of functionality;
- **Resourcefulness** - the ability to direct resources to support a system or system component to increase robustness in the event of a disturbance or shock;

¹³⁴ Tierney, K., & Bruneau, M. (2007). Conceptualizing and Measuring Resilience: A Key to Disaster Loss Reduction. *TR News*, 14–18. Available at: http://onlinepubs.trb.org/onlinepubs/trnews/trnews250_p14-17.pdf. Accessed: 10 December 2015.

¹³⁵ Bruneau, M., Chang, S. E., Eguchi, R. T., Lee, G. C., O'Rourke, T. D., Reinhorn, A. M., ... Von Winterfeldt, D. (2003). A Framework to Quantitatively Assess and Enhance the Seismic Resilience of Communities. *Earthquake Spectra*, 19(4), 733–752. <http://doi.org/10.1193/1.1623497>.

¹³⁶ Madni, AM & Jackson, S. (2009). Towards a conceptual framework for resilience engineering. *Systems Journal, IEEE* 3, no.2: 181–191.

- **Rapidity** – restoration of the functionality a system or system's elements in a timely manner.¹³⁷

Robustness in the context of technical systems can be increased by newer structures and updated building codes. An example of increased redundancy is capacity for technical substitutions, “work-arounds”. Resourcefulness can be increased by increasing availability of materials for restoration, repair. Rapidity of an infrastructure can be increased by decreasing its downtime and restoration time.¹³⁸

Although 4R's model is widely used in discussions about the assessment of physical infrastructures resilience, their generic nature yields limited practical application power in realistic assessments of infrastructures resilience. In addition, different authors define these four characteristics of resilient systems differently, or omit one from their examinations making the same terminology rarely obvious.¹³⁹

Park et al. add the principle of **safe-to-fail** as another attribute of resilient physical systems.¹⁴⁰ According to the authors, safe-to-fail principle is the extent to which innovative design approaches are developed, allowing (where relevant) controlled, planned failure during unpredicted conditions, recognising that the possibility of failure can never be eliminated. This may involve new approaches to design, to complement traditional, incremental risk-based design.¹⁴¹

The so-called **resilience triangle** is used across the literature to illustrate resilience of physical systems (see Figure 5.4). The triangle shows the loss of functionality from damage and disruption, as well as the pattern of restoration and recovery over time after a 50 percent loss of functionality.

FIGURE 1 The Resilience Triangle

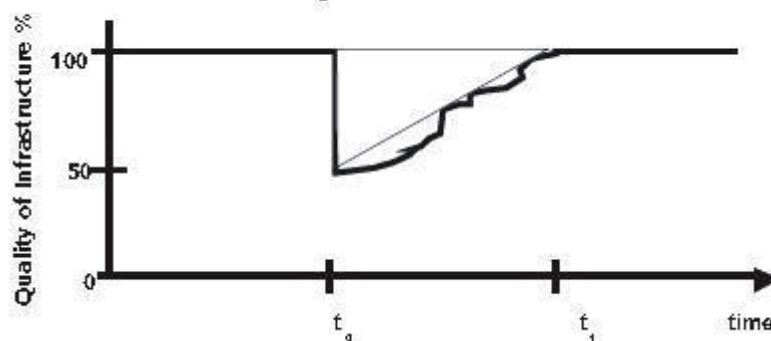


Figure 5.4 Resilience triangle.¹³⁴

¹³⁷ Bruneau, M., Chang, S. E., Eguchi, R. T., Lee, G. C., O'Rourke, T. D., Reinhorn, A. M., ... Von Winterfeldt, D. (2003). A Framework to Quantitatively Assess and Enhance the Seismic Resilience of Communities. *Earthquake Spectra*, 19(4), 733–752. <http://doi.org/10.1193/1.1623497>. P. 737-738.

¹³⁸ Bruneau, M. The 4R's of Resilience and Multi-Hazard Engineering. Available at: <https://mceer.buffalo.edu/meetings/AEI/presentations/01Bruneau-ppt.pdf>. Accessed: 19 May 2016.

¹³⁹ Prior, T. (2015). Measuring Critical Infrastructure Resilience: Possible Indicators. *Risk and Resilience Report 9*. Center for Security Studies/ETH Zurich. Available at: <http://www.css.ethz.ch/content/dam/ethz/special-interest/gess/cis/center-for-securities-studies/pdfs/SKI-Focus-Report-10.pdf>. Accessed: 18 May 2016.

¹⁴⁰ Park, J., Seager, T.P., Rao, P.S.C., Convertino, M., & Linkov, I. (2013). Integrating Risk and Resilience Approaches to Catastrophe Management in Engineering Systems. *Risk Analysis*, Vol. 33, No. 3. DOI: 10.1111/j.1539-6924.2012.01885.x.

¹⁴¹ Hughes, J.F. & Healy, K. (2014). Measuring the resilience of transport infrastructure. *NZ Transport Agency research report 546*. Available at: <http://www.nzta.govt.nz/assets/resources/research/reports/546/docs/546.pdf>. Accessed: 18 May 2016.

5.1.2. Indicators

Typically, indicators aimed at measuring and assessing resilience of physical structures are classified in relation to shock or disturbance. They are applied in **a-priori** manner, assessing resilience of infrastructure before a disturbing event; and **post-hoc** manner, giving an absolute measure of the indicator that is directly benchmarked against a predetermined baseline, and assessed following some shock or disturbance.

A-priori infrastructure resilience indicators include: probability of failure; quality of infrastructure; pre-event functionality of infrastructure; substitutability; interdependence; quality/extent of mitigating features; quality of disturbance planning/response; quality of crisis communications/information sharing; security of infrastructure.¹³⁹

Ad-hoc resilience indicators include: systems failure; severity of failure; post-event functionality; post-event damage assessment; cost of reinstating functionality post-event; recovery time post-event; recovery/loss ratio.¹³⁹

Linkov et al. argue that technical resilience can be assessed by measuring state and capability of equipment and personnel, network structure; event recognition and system performance to maintain function; system changes to recover previous functionality; changes to improve system resilience.^{142,143}

More information on implementation of technical resilience concepts to critical infrastructure is provided in the sections discussing the concept of resilience in different countries.

5.2. Organisational Dimension of Resilience

The concept of organisational resilience is attracting growing attention among academics and practitioners. According to Jordan and Alcantara, it has largely emerged since the global financial crisis of 2007-2008 due to a perception of failure within conventional risk management¹⁴⁴. In the context of the project IMRPOVER, it is important to understand how to increase the resilience of organisations operating critical infrastructure facilities to various disruptions. Therefore, first of all, this sub-section provides detailed information on the concept of resilience itself, which is needed to select the definition of CIR for the purpose of the project. It also discusses models and indicators used for measuring and evaluating organisational resilience which will be further evaluated in the Work Package 2 of the project, as well as provides information about the existing standards in the field.

When talking about organisational resilience in the context of CI, we primarily concentrate on organisations that own and manage CI facilities. Implementing resilience concepts to critical infrastructure resilience is a rather complicated task due to the fact that organisations must take into account such factors as strong and flexible leadership, an awareness and understanding of their operating environment, their ability to adapt in response to rapid change and so on.¹⁴⁵ “If we are to move (carefully and slowly) towards measuring indicators [...] we should look at ways to estimate how flexible procedures are, how adaptive planning is, how learning is managed in the organisation

¹⁴² Linkov, I. et al. (2013). Measurable Resilience for Actionable Policy. *Environmental Science & Technology*. Vol 47, No. 18. pp. 10108-10110.

¹⁴³ For more information on indicators evaluating technical and CIR also see: Labaka, L., Hernantes, J., & Sarriegi, J. M. (2015). Resilience framework for critical infrastructures: An empirical study in a nuclear plant. *Reliability Engineering & System Safety*, 141, 92–105. <http://dx.doi.org/10.1016/j.res.2015.03.009>; Petit, F.D. et al. (2013). Resilience Measurement Index: An Indicator for Critical Infrastructure Resilience. Argonne National Laboratory, US Department of Energy.

¹⁴⁴ Jordan, T., & Alcantara, P. (2014). Conceptualising organisational resilience. *Business Continuity Institute, Working Paper Series*. Available at: http://static.ow.ly/docs/BCIWorkingPaper3_2JOq.pdf. Accessed: 15 December 2015.

¹⁴⁵ Lee, Amy V, John Vargo, and Erica Seville. (2013). Developing a Tool to Measure and Compare Organisations' Resilience. *Natural Hazards Review (February)*: 29–41.

which manages CI facility, to what extent unpredictability is included in exercise, etc.”¹⁴⁶ “To be able to implement CI resilience, we first of all have to talk about high reliability organisations, namely, redundancy, a shift in operation and preparedness. It is about adaptation and staying ahead, but within a framework with zero tolerance for errors. Resilient organisation should concentrate on what went wrong in times of crisis, as well as what went well.”¹⁴⁷ In a personal interview, Paul Theron, resilience expert from France, argued that up until today there are no clearly defined methods to measure resilience of an operator of critical infrastructure, and more research needs to be done in this direction. “The first projects looking at this subject are just now getting started and therefore there is no real work already done on this subject, meaning that there are no applicable/operational measures. The reality is much more complicated than people expect, and so when people speak about measures, it remains abstract, and reality is too complicated to be explained by these abstract measures”¹⁴⁸.

It is rather not surprising that there is little consistency in the use of the term of organisational resilience, as well as lack of common understanding as to the essential concepts it prevails (see e.g. Banahene et al. 2014¹⁴⁹; Braes & Brooks 2010¹⁵⁰; Burnard & Bhamra 2011¹⁵¹; Robert & Hémond 2013¹⁵², etc.). There is a plethora of definitions aimed at explaining the concept of organisational resilience concentrating on different equilibrium state(s), flexibility and strategic implications, and operational capabilities (e.g. Allen et al. 2006¹⁵³; Crichton et al. 2009¹⁵⁴; Deverell & Olsson 2010¹⁵⁵; Smith & Fischbacher 2009¹⁵⁶, etc.). When applied to organisations, the prevailing objective of resilience included in most of the existing definitions is the ability of an organisation to survive certain disturbance or shock¹⁵⁷. Nevertheless, the key to successful resilience is an organisation’s ability to maintain adaptive, proactive and reactive strategies to deal with risks and threats¹⁵⁸. Thus, organisational resilience can be defined as the maintenance of positive adjustments under some challenging conditions such that the organisation emerges from these conditions strengthened and more resourceful¹⁵⁹.

¹⁴⁶ Personal interview, Rasmus Dalberg, PhD-fellow, Copenhagen Center for Disaster Research, University of Copenhagen, 18 April 2016.

¹⁴⁷ Personal interview, resilience expert from Norway, 22 April 2016.

¹⁴⁸ Personal interview. Paul Theron, resilience expert from France. 18 April 2016.

¹⁴⁹ Banahene, O., Anvuur, A., & Dainty, A. (2014). Conceptualising organisational resilience: an investigation into project organising. Leicestershire, UK. Retrieved from: https://dspace.lboro.ac.uk/dspace-jspui/bitstream/2134/15955/3/Conceptualising_organisational_resilience_-_2014_ARCOM_Conference_Proc_Vol_2_pp795-804.pdf.

¹⁵⁰ Braes, B., & Brooks, D. (2010). Organisational Resilience: A Propositional Study to Understand and Identify the Essential Concepts. *Proceedings of the 3rd Australian Security and Intelligence Conference, Edith Cowan University, Perth Western Australia, 30th November 2010*, (November), 13–22.

¹⁵¹ Burnard, K., & Bhamra, R. (2011). Organisational resilience: development of a conceptual framework for organisational responses. *International Journal of Production Research*, 49(18), 5581–5599. <http://doi.org/10.1080/00207543.2011.563827>

¹⁵² Robert, B., & Hémond, Y. (2013). Organisational resilience: A multidisciplinary sociotechnical challenge. *Resilience and Urban Risk Management*, (13), 119–125. Available at: <http://www.crcnetbase.com/doi/pdfdirect/10.1201/b12994-14npapers2://publication/uuid/07F96A10-1DED-4D2A-977F-72B0A8C1FFF1>. Accessed: 20 December 2015.

¹⁵³ Allen, M. P., Datta, P. P., & Christopher, M. (2006). Improving the Resilience and Performance of Organisations Using Multi-Agent Modelling of a Complex Production-Distribution Systems. *Risk Management*, 8(4), 294–309.

¹⁵⁴ Crichton, M. T., Ramsay, C. G., & Kelly, T. (2009). Enhancing organisational resilience through emergency planning: Learnings from cross-sectoral lessons. *Journal of Contingencies and Crisis Management*, 17(1), 24–37. <http://doi.org/10.1111/j.1468-5973.2009.00556.x>.

¹⁵⁵ Deverell, E., & Olsson, K. E. (2010). Organisational culture effects on strategy and adaptability in crisis management. *Risk Management*, 12(2), 116–134.

¹⁵⁶ Smith, D., & Fischbacher, M. (2009). The changing nature of risk and risk management: The challenge of borders, uncertainty and resilience. *Risk Management*, 11, 1–12. <http://doi.org/10.1057/rm.2009.1>.

¹⁵⁷ Mallak, L. (1998). Putting Organisational Resilience to Work. *Industrial Management*, 40(6), 8–13.

¹⁵⁸ Braes, B., & Brooks, D. (2010). Organisational Resilience: A Propositional Study to Understand and Identify the Essential Concepts. *Proceedings of the 3rd Australian Security and Intelligence Conference, Edith Cowan University, Perth Western Australia, 30th November 2010*, (November), 13–22. P. 16.

¹⁵⁹ Vogus, T. J., & Sutcliffe, K. M. (2007). Organisational resilience: Towards a theory and research agenda. *Conference Proceedings - IEEE International Conference on Systems, Man and Cybernetics*, 3418–3422. <http://doi.org/10.1109/ICSMC.2007.4414160>. P. 3418.

Paton and Hill define organisational resilience as the capacity of the people and systems that facilitate organisational performance to maintain functional relationships in the presence of some significant disturbance as a result of capability to draw upon their resources and competences to manage the demands, challenges and changes encountered¹⁶⁰. Organisational resilience is associated with the capability of some organisation that is responsible for operating critical emergency functions to take action and induce decision making¹⁶¹. Tierney and Bruneau argue that organisational resilience relates to the organisations and institutions that manage the physical components of the systems¹⁶². According to the authors this type of resilience encompasses measures of organisational capacity, planning, training, leadership, experience, and information management that improve disaster-related organisational performance and problem solving¹⁶². In their article analysing seismic resilience of communities, Bruneau et al. argue that organisational resilience refers to the “capacity of organisations that manage critical facilities and have the responsibility for carrying out critical disaster-related functions to make decisions and take actions that contribute to achieving the properties of resilience [...], that is, that help to achieve greater robustness, redundancy, resourcefulness, and rapidity¹⁶³. Cutter et al argue that organisational resilience includes institutions and organisations and requires assessments of the physical properties of the organisations such as number of members, communications technology, and number of emergency assets (e.g. vehicles, hospital beds, etc.)¹⁶⁴. McManus argues that organisational resilience is a function of an “organisation’s overall situation awareness, keystone vulnerability and adaptive capacity in a complex, dynamic and interconnected environment”¹⁶⁵. Mallak defines a resilient organisation as one which is able to design and implement effective actions to advance organisational development and ensure survival¹⁶⁶. “Resilient Organisations” founded by Universities of Canterbury and Auckland define organisational resilience as “the ability of an organisation to survive a crisis and thrive in a world of uncertainty”¹⁶⁷ (see also Chang-Richards et al. 2013¹⁶⁸).

5.2.1. Business Continuity Management

There is a branch of research in the existing literature draws a close link between organisational resilience and the concept of business continuity (BC)¹⁶⁹. Business continuity management (BCM) is a management process by which businesses can assess risk and develop plans and strategies to mitigate those risks (Paton 1999¹⁷⁰; Paton & Hill 2006¹⁷¹; Shaw & Harrald 2004¹⁷²). According to Smith and

¹⁶⁰ Paton, D., & Hill, R. (2006). Managing Company Risk and Resilience Through Business Continuity Management. In D. Paton and D. Johnston (eds.). “Disaster Resilience: An Integrated Approach. Charles C. Thomas, Springfield, IL. P. 250.

¹⁶¹ Jung, K., & Song, M. (2015). Linking emergency management networks to disaster resilience: bonding and bridging strategy in hierarchical or horizontal collaboration networks. *Quality & Quantity*, 49(4), 1465–1483. <http://doi.org/10.1007/s11135-014-0092-x>. P. 1467.

¹⁶² Tierney, K., & Bruneau, M. (2007). Conceptualizing and Measuring Resilience: A Key to Disaster Loss Reduction. *TR News*, 14–18. Available at: http://onlinepubs.trb.org/onlinepubs/trnews/trnews250_p14-17.pdf. Accessed: 31 August 2015.

¹⁶³ Bruneau, M., Chang, S. E., Eguchi, R. T., Lee, G. C., O’Rourke, T. D., Reinhorn, A. M., Shinozuka, M., Tierney, A.M., Wallace, A.M., & Von Winterfeldt, D. (2003). A Framework to Quantitatively Assess and Enhance the Seismic Resilience of Communities. *Earthquake Spectra*, 19(4), 733–752. <http://doi.org/10.1193/1.1623497>. P. 738.

¹⁶⁴ Cutter, S. L., Barnes, L., Berry, M., Burton, C., Evans, E., Tate, E., & Webb, J. (2008b). A place-based model for understanding community resilience to natural disasters. *Global Environmental Change*, 18(4), 598–606. <http://doi.org/10.1016/j.gloenvcha.2008.07.013>. P. 604.

¹⁶⁵ McManus, S. (2008). Organisational Resilience in New Zealand. *University of Catenbury*. Available at: http://ir.canterbury.ac.nz/bitstream/10092/1574/1/thesis_fulltext.pdf. Accessed: 31 August 2015.

¹⁶⁶ Mallak, L. (1998). Putting Organisational Resilience to Work. *Industrial Management*, 40(6), 8–13.

¹⁶⁷ Resilient Organisations, A collaboration between research & industry. *Resilience of Organisations*. Available at: <http://www.resorgs.org.nz/Current-Research/resilience-of-organisations.html>. Accessed: 31 August 2015.

¹⁶⁸ Chang-Richards, A., Vargo, J., & Seville, E. (2013). Organisational Resilience to Natural Disasters : New Zealand ’ s Experience. *China Policy Review*, 10(February 2011), 117–119.

¹⁶⁹ Sahebjamnia, N., Torabi, S. a., & Mansouri, S. A. (2015). Integrated business continuity and disaster recovery planning: Towards organisational resilience. *European Journal of Operational Research*, 242(1), 261–273. <http://doi.org/10.1016/j.ejor.2014.09.055>.

¹⁷⁰ Paton, D. (1999). Disaster business continuity: promoting staff capability. *Disaster Prevention and Management*, 8(2), 127-133.

¹⁷¹ Paton, D., & Hill, R. (2006). Managing Company Risk and Resilience Through Business Continuity Management. In D. Paton and D. Johnston (eds.). “Disaster Resilience: An Integrated Approach. Charles C. Thomas, Springfield, IL.

Fischbacher, resilience has become “a politically accepted term of choice to describe the processes around crisis management and BC”¹⁷³. Jourdan and Alcantara argue that BC as the discipline has organisational resilience as its objective¹⁷⁴. Organisational resilience is concerned with the development of suitable BC plans (short-term plans) to resume disrupted critical operations of an organisation to their minimum acceptable operating levels as quickly and efficiently as possible and disaster recovery plans (long-term plans) to restore all disrupted operations to their normal operating levels following any disruptive event¹⁷⁵.

Sahebjamnia et al. suggested an integrated business continuity and disaster recovery planning framework that aims to increase organisational resilience¹⁶⁹. In order to create resilient organisation, business continuity planning requires three core elements¹⁷⁶. First, management and information systems should be available to facilitate continuity of core business operations¹⁷⁷. Second, crisis management systems and mechanisms for managing the transition between routine and crisis operations should be present¹⁷⁸. Third, competences and systems must be designed in order to ensure continuity of functioning under the crisis operating conditions necessitated by a large-scale natural disaster¹⁶⁰.

5.2.2. Tenets of Organisational Resilience

Several fundamental tenets of organisational resilience could be found in the literature, namely the organisational personnel’s adaptive capacity¹⁶⁵, flexibility (Cuter et al. 2008⁷⁹; Vogus & Sutcliffe 2007¹⁵⁹), learning¹⁵⁹, and coping ability¹⁷⁹. “Resilient Organisations” argue that organisational resilience is composed of three interdependent attributes: leadership and culture, networks, and being change ready or flexible¹⁸⁰. An organisation that is hierarchical and built on the principle of command and control is seen as being less flexible in the face of a disaster than the one that has a more vertical and integrated management structure that encourages flexibility and adaptation to changing conditions¹⁶⁴.

Bruneau et al. suggest that organisational resilience could be measured using four dimensions: robustness, redundancy, resourcefulness, and rapidity¹²⁵. Robustness is perceived as constant and continued capacity to conduct designated functions; redundancy is the back-up or substitutable resources for maintaining operations; resourcefulness is defined as plans, information, and resources for dealing with disruption and loss (e.g. emergency plans, reciprocal aid, decision support system); rapidity is the ability of organisation to minimize the time required to restore the system or services, and performing the core response task in a timely manner¹⁶¹.

¹⁷² Shaw, G. L., & Harrald, J. R. (2004). Identification of the core competences required of executive level business crisis and continuity managers. *Journal of Homeland Security and Emergency Management*, 1(1), 1-15.

¹⁷³ Smith, D., & Fischbacher, M. (2009). The changing nature of risk and risk management: The challenge of borders, uncertainty and resilience. *Risk Management*, 11, 1–12. <http://doi.org/10.1057/rm.2009.1>. P. 6.

¹⁷⁴ Jordan, T., & Alcantara, P. (2014). Conceptualising organisational resilience. *Business Continuity Institute, Working Paper Series*. Available at: http://static.ow.ly/docs/BCIWorkingPaper3_2JOq.pdf. Accessed: 31 August 2016.

¹⁷⁵ Losada, C., Scaparra, M. P., & O’Hanley, J. R. (2012). Optimizing system resilience: A facility protection model with recovery time. *European Journal of Operational Research*, 217(3), 519–530. <http://doi.org/10.1016/j.ejor.2011.09.044>.

¹⁷⁶ Paton, D., & Hill, R. (2006). Managing Company Risk and Resilience Through Business Continuity Management. In D. Paton and D. Johnston (eds.). “Disaster Resilience: An Integrated Approach. Charles C. Thomas, Springfield, IL. P. 251.

¹⁷⁷ Davies, H., & Walters, M. (1998). Do all crises have to become disasters? Risk and risk mitigation. *Disaster Prevention and Management*, 7(5), 396–400. <http://doi.org/10.1108/09653569810795647>.

¹⁷⁸ Shaw, G. L., & Harrald, J. R. (2004). Identification of the core competences required of executive level business crisis and continuity managers. *Journal of Homeland Security and Emergency Management*, 1(1), 1-15.

¹⁷⁹ Banahene, O., Anvuur, A., & Dainty, A. (2014). Conceptualising organisational resilience: an investigation into project organising. Leicestershire, UK. Available at: [https://dspace.lboro.ac.uk/dspace-jspui/bitstream/2134/15955/3/Conceptualising organisational resilience - 2014 ARCOM Conference Proc Vol 2 pp795-804.pdf](https://dspace.lboro.ac.uk/dspace-jspui/bitstream/2134/15955/3/Conceptualising%20organisational%20resilience%20-%202014%20ARCOM%20Conference%20Proc%20Vol%202%20pp795-804.pdf). Accessed: 30 August 2015.

¹⁸⁰ Resilient Organisations, A collaboration between research & industry. *Resilience of Organisations*. Available at: <http://www.resorgs.org.nz/Current-Research/resilience-of-organisations.html>. Accessed 31 August 2015.

International Survey

Cutter et al. suggest that organisational resilience should be measured by using such indicators as, for example, participations in hazard reduction programs, hazard mitigation plans, emergency services, zoning and building standards, emergency response plans, continuity of operations plans, etc.¹⁶⁴ Vogus and Sutcliffe argue that resilient organisations assume their model of risks is in need of constant updating, their countermeasures are incomplete, and their grasp on safe operations is fragile¹⁸¹. The authors also conclude that these organisations believe that they can readily cope with a wide array of anomalies and are constantly striving to grow their capabilities to do so.

5.2.3. Indicators

In the literature, there are quite a few models that aim to evaluate resilience of different organisations. For example, Gibson and Tarrant developed the so called **herringbone resilience model** (see Figure 5.5)¹⁸². The model suggests an organisation possesses a range of capabilities and undertakes certain activities that will contribute towards improved overall organisational resilience. Furthermore, the authors argue that the organisation also exhibits a number of characteristics that will affect the effectiveness of the capabilities and activities and help to enhance the organisation's resilience. Gibson and Tarrant argue that although most of the capabilities, activities and characteristics are critical to functioning in the routine environment, it is the manner in which they can adapt to the changed environment that will create resilience.¹⁸²



Figure 5.5 Herringbone resilience model.¹⁸²

McManus was one of the first authors who suggested a way to operationalize and assess organisational resilience¹⁸³. In her study, McManus suggested to define organisational resilience as “[...] a function of an organisation's overall **situation awareness, management of keystone vulnerabilities** and **adaptive capacity** in a complex, dynamic and interconnected environment”¹⁸⁴.

The author conducted a qualitative study using semi-structured interviews, with ten case study organisations from New Zealand to assess their resilience qualities from 2005 till 2007. Based on the

¹⁸¹ Vogus, T. J., & Sutcliffe, K. M. (2007). Organisational resilience: Towards a theory and research agenda. *Conference Proceedings - IEEE International Conference on Systems, Man and Cybernetics*, 3418–3422. <http://doi.org/10.1109/ICSMC.2007.4414160>. P. 3419.

¹⁸² Gibson, C A, and M Tarrant. (2010). A ‘Conceptual Models’ Approach to Organisational Resilience. *The Australian Journal of Emergency Management* 25(2): 6–12.

¹⁸³ McManus, S. (2008). Organisational Resilience in New Zealand. *University of Catenbury*. Available at: http://ir.canterbury.ac.nz/bitstream/10092/1574/1/thesis_fulltext.pdf. Accessed: 15 March 2016.

¹⁸⁴ Ibid. P. 82

conducted case studies, the author developed **Relative Overall Resilience (ROR)** model comprised of three dimensions or factors, namely, situation awareness, management of keystone vulnerabilities, and adaptive capacity; and also proposed fifteen indicators of organisational resilience (five for each dimension) (for the summary of resilience indicators and interview prompt questions see Appendix 1). However, McManus notes that the indicators used in the ROR model are limited to the case study organisations. Thus, the model should be reviewed before building it into an organisational resilience measurement tool. We have linked the indicators (which consist of concepts of Level 2 classification) to the Level 1 classification (phases), based on their description.

In her PhD dissertation, Stephenson reviewed ROR model and developed a new model allowing to measure and benchmark organisational resilience¹⁸⁵. The author introduced **few new dimensions and indicators** allowing receiving a more comprehensive result when measuring organisational resilience. The new model is built upon the central idea that organisational resilience is composed of two factors, namely, adaptive capacity and planning. Adaptive capacity is defined as “strong leadership and culture which enables clear communication, good working relationships, and a shared vision across the organisation. The organisation is innovative and creative and people are able to constantly and continuously act to match or exceed the needs of the organisation’s operating environment in anticipation of, or in response to change”¹⁸⁶. The organisational resilience measurement tool consists of 14 demographic and background questions, 53 resilience measurement, and 15 organisational performance questions (see Appendix 2). The spine of the model is composed of **13 indicators** aimed at measuring organisational resilience (see Table 5.1). In the thesis, all the indicators and dimensions were calculated as having **equal influence** on organisation’s resilience. The sample of the research was 1009 organisations, of which 68 organisations (249 individuals) participated.

Table 5.1 Indicators of organisational resilience.¹⁸⁵

Adaptive Capacity	Minimisation of Silos	Minimisation of divisive social, cultural and behavioural barriers, which are often manifested as communication barriers creating disjointed, disconnected and detrimental ways of working.
	Internal Resources	The management and mobilisation of the organisation’s resources to ensure its ability to operate during business as usual, as well as being able to provide the extra capacity required during a crisis.
	Decision Making	Staff have the appropriate authority to make decisions related to their work and authority is clearly delegated to enable a crisis response. Highly skilled staff are involved in making decisions where their specific knowledge adds significant value, or where their involvement will aid implementation.
	Innovation & Creativity	Staff are encouraged and rewarded for using their knowledge in novel ways to solve new and existing problems, and for utilising innovative and creative approaches to developing solutions.
	Information & Knowledge	Critical information is stored in a number of formats and locations and staff have access to expert opinions when needed. Roles are shared and staff are trained so that someone will always be able to fill key roles.
	Leadership	Strong crisis leadership to provide good management and decision making during times of crisis, as well as continuous evaluation of strategies and work programs against organisational goals.
	Staff Involvement	The engagement and involvement of staff who understand the link between their own work, the organisation’s resilience, and its long term success. Staff are empowered and use their skills to solve problems.
	Situation Monitoring and Reporting	Staff are encouraged to be vigilant about the organisation, its performance and potential problems. The organisation has a culture which values learning from past problems and staff are able to report information that might help the organisation to improve.

¹⁸⁵ Stephenson, A. (2011). Benchmarking The Resilience In Organisations. *University of Canterbury*, PhD thesis.

¹⁸⁶ Ibid. P. 100.

International Survey

Planning	Planning Strategies	The development and evaluation of plans and strategies to manage risks and vulnerabilities in relation to continuous changes in the organisation's environment and its stakeholders.
	Participation in Exercises	The participation of staff in simulations or scenarios designed to practise response arrangements and validate plans.
	External Resources	An understanding of the relationships and resources the organisation might need to access from other organisations during a crisis, and planning and management to ensure this access.
	Recovery Priorities	An organisation wide awareness of what the organisation's priorities would be following a crisis, clearly defined at the organisation level, as well as an understanding of the organisation's minimum operating requirements.
	Proactive Posture	A strategic and behavioural readiness to respond to early warning signals of change in the organisation's internal and external environment before they escalate into crisis.

5.2.4. Standards

There are several international standards in the area. For example, **ASIS SPC.1-2009** standard is using a *process* approach, to implement, establish, operate, monitor, review, maintain and improve organisational resilience.¹⁸⁷ It emphasizes particularly on:

- (a) Understanding an organisation's risks, security, preparedness, response, continuity, and recovery requirements;
- (b) Establishing a policy and objectives to manage risks;
- (c) Implement and operate controls to manage risks;
- (d) Monitor and review the system's performance;
- (e) Continual improvement.

This standard also adopts the PDCA model (plan- do-check- act) that you can find in the ISO standard on business continuity management (ISO 22301-2012). As well as several other ISO standards that are applicable to their document. (ISO Guide 72:2002; ISO 9001: 2000; ISO 14001: 2004; ISO/EIC 27001: 2005; ISO 28000: 2007).

ISO 28002:2011¹⁸⁸ standard is accompanied by ASIS SPC.4-2012, which provides guidance for the use of a maturity model for phased implementation of the ANSI/ASIS SPC.1-2009 as a series of steps designed to help organisations:

- Evaluate where they currently are with regard to resilience management and preparedness.
- Set goals for where they want to go, and benchmark where they are relative to those goals.
- Plot a business/mission appropriate path to get there.

The model outlines six phases ranging from an unplanned approach to managing events, to going beyond the requirements of the Standard, and creating a holistic environment for resilience management.

BS 65000:2014 standard defines organisational resilience as the ability to anticipate, prepare for, respond and adapt to events – both sudden shocks and gradual change. That means being adaptable, competitive, agile and robust.¹⁸⁹ BS 65000 is also built up upon other existing standards and aims at

¹⁸⁷ ANSI/ASIS.SPC.1:2009, Organisational Resilience: Security, Preparedness, and Continuity Management Systems — Requirements with Guidance for Use

¹⁸⁸ ISO 28002:2011, Security management systems for the supply chain -- Development of resilience in the supply chain -- Requirements with guidance for use.

¹⁸⁹ BS 65000:2014, Guidance on organisational resilience.

clarifying the meaning of resilience, highlight the key components of resilience, help in measuring resilience and improve resilience, as well as identify good practices and existing standards.

The standard includes a Maturity Model for organisational resilience and a series of 24 questions that help determine the consistency of an organisations planning. These questions are particularly useful as they provide a ‘stress test’ to assess just how well planning is integrated into the processes and activities from the boardroom through to the factory floor.¹⁹⁰ It enables upper level management to describe a strategy for the organisational resilience which identifies benefits, behaviours of resilient organisations. It also offers basic tools for assessing the resilience measures of an organisation and a maturity model for measurement. Finally, it includes questions organisations can use to assess their resilience measures.

Finally, **ISO/DIS 22316** standard is currently under development with due date on April 2017.¹⁹¹ It will be closely aligned with BS 65000:2014 but it will place more emphasis on measurement.

More information on implementation of organisational resilience concepts to critical infrastructure is provided in the sections discussing the concept of resilience in different countries.

5.3. Social/Societal Dimension of Resilience

In recent years, there has been an increase in the scientific interest to apply the concept of resilience for social systems¹⁹². Scholars began to urge for better understanding of social processes like social learning and social memory, leadership, social networks, and systems of adaptive governance in order to build a comprehensive picture of resilience¹². Critical infrastructures form the backbone of modern societies around the world. People are highly dependent of such services as water, electricity, transportation network, telecommunications, etc. Therefore, for the purpose of the current project, it is important to understand the concept and practise of social/societal resilience in order to increase resilience of people living around and depending upon CI services in times of disruptions. The resilience of societies in the context of CIs can be increased through improved population engagement and the unitisation of the concept of shared responsibility. Therefore, this sub-section provides a comprehensive overview of the concept of social/societal resilience, discusses its components and the interaction between them, as well as indicators for measuring and assessing social/societal resilience. It also discusses the use of social media and crowdsourcing platforms as tools for engaging societies with CI operators for increased resilience.

The notion of social/societal resilience is strongly focused on human learning pathways and how these may affect the resilience of communities¹⁹³. However, at the same time an extensive discussion in the literature emerged discussing whether the concept of resilience could be applied in the social domain (see e.g. Cannon & Müller-Mahn 2010¹⁹⁴; Davidson 2010⁴⁸; Judkins et al. 2008¹⁹⁵; Keck & Sakdapolrak 2013¹⁹⁶; Lidskog 2001¹⁹⁷, etc.). For example Cannon and Müller-Mahn raise the problem

¹⁹⁰ See: <http://www.continuityforum.org/content/news/180048/bsi-publishes-new-organisational-resilience-standard-bs-650002014>.

¹⁹¹ ISO/DIS 22316 Security and resilience – Guidelines for organisational resilience. See:

http://www.iso.org/iso/catalogue_detail.htm?csnumber=50053.

¹⁹² Adger, W. N. (2000). Social and ecological resilience: are they related? *Progress in Human Geography*, 24(3), 347–364. <http://doi.org/10.1191/030913200701540465>.

¹⁹³ Wilson, A. G. (2012). *Community Resilience and Environmental Transitions*. Routledge.

¹⁹⁴ Cannon, T., & Müller-Mahn, D. (2010). Vulnerability, resilience and development discourses in context of climate change. *Natural Hazards*, 55(3), 621–635. <http://doi.org/10.1007/s11069-010-9499-4>.

¹⁹⁵ Judkins, G., Smith, M., & Keys, E. (2008). Determinism within human-environment research and the rediscovery of environmental causation. *Geographical Journal*, 174(1), 17–29. <http://doi.org/10.1111/j.1475-4959.2008.00265.x>.

¹⁹⁶ Keck, M., & Sakdapolrak, P. (2013). What is social resilience? lessons learned and ways forward. *Erdkunde*, 67(1), 5–19. <http://doi.org/10.3112/erdkunde.2013.01.02>.

¹⁹⁷ Lidskog, R. (2001). The Re-Naturalization of Society? Environmental Challenged for Sociology. *Current Sociology*, 49(1), 113–136.

that the evolution of the concept of resilience in natural sciences makes it inadequate and even false to be uncritically transferred to social phenomena¹⁹⁸. Davidson argues that the application of resilience framework to social systems require improved articulation of relationship between complexity and disturbance in a less deterministic manner than is presented by ecological systems, in order to specify the conditions favoring the likelihood for resilience, adaptation or transformation¹⁹⁹. However, Keck and Sakdapolrak argue that social resilience still has the potential to be crafter into a coherent analytical framework¹⁹⁶. According to the authors, social/societal resilience is best understood as a concept in the process of making. In fact, the questions of how social resilience can be properly defined and operationalized are far from being settled (ibid.). From social science perspective, the ecological resilience concept provides a common basis which then needs further development²⁰⁰.

Generally, social/societal resilience attempts to understand how human systems respond to external and internal disturbances¹¹¹. Social/societal resilience can be perceived as the ability of human communities to withstand external shocks to their social infrastructure, such as environmental variability or social, economic and political upheaval¹²². It has been described as the capacity of people to successfully adapt, and function positively regardless of chronic stress, severe trauma or their vulnerability to risk²⁰¹. It assesses how people develop adaptive capacity to respond to endogenous disturbances (for example, political upheaval, revolutions, etc.) or exogenous threats (for example, climate change, volcanic eruptions, flooding, etc.)¹²². Thus it is about pre-emptive change which sees resilience as a desirable state, rather than simply a process to avoid disturbances⁴⁸. Social/societal resilience does not mean that the system changes as fast as possible, but that the new structure in the case of any change involves sustainable variance that enable the system to persist into the future under any given terms²⁰². Cuthill et al. define social/societal resilience as the way in which individuals, communities and societies adapt, transform, and potentially become stronger when faced with environmental, social, economic or political changes²⁰³. Lorenz argues that due to the symbolic dimension of social/societal resilience, disasters should be defined as the failure of future expectations, and social resilience could be defined as the property of social system of avoiding or withstanding disasters²⁰⁴. Researchers of CASs describe social/societal resilience as the adaptive and learning capacity of individuals, groups and institutions to self-organise in a way that maintains system function in the face of some change or in response to any disturbance²⁰⁵. Thus, social/societal resilience research usually focuses on the importance of politics, power and socio-economic, psychological and moral parameters²⁰⁶.

Several authors, such as, for example, Keck & Sakdapolrak (2013)⁶², Obrist et al. (2010)²⁰⁷, and Voss (2008)²⁵² argue that three different types of capacities are necessary for understanding the notion of

¹⁹⁸ Cannon, T., & Müller-Mahn, D. (2010). Vulnerability, resilience and development discourses in context of climate change. *Natural Hazards*, 55(3), 621–635. <http://doi.org/10.1007/s11069-010-9499-4>. P. 623.

¹⁹⁹ Davidson, D. J. (2010). The Applicability of the Concept of Resilience to Social Systems: Some Sources of Optimism and Nagging Doubts. *Society & Natural Resources*, 23(12), 1135–1149. <http://doi.org/10.1080/08941921003652940>. P. 1142.

²⁰⁰ Lorenz, D. F. (2013). The diversity of resilience: Contributions from a social science perspective. *Natural Hazards*, 67(1), 7–24. <http://doi.org/10.1007/s11069-010-9654-y>.

²⁰¹ Egeland, B. R., Carlson, E., & Sroufe, L. A. (1993). Resilience as a process. *Development & Psychopathology. Special Milestones in the development of resilience*, 5, 517–528.

²⁰² Lorenz, D. F. (2013). The diversity of resilience: Contributions from a social science perspective. *Natural Hazards*, 67(1), 7–24. <http://doi.org/10.1007/s11069-010-9654-y>. P. 10.

²⁰³ Cuthill, M., Ross, H., Maclean, K., Owens, K., & Witt, B. (2008). Reporting Social Outcomes of Development: An Analysis of Diverse Approaches. *The International Journal of Interdisciplinary Social Science*, 3, 145–158. P. 146.

²⁰⁴ Lorenz, D. F. (2013). The diversity of resilience: Contributions from a social science perspective. *Natural Hazards*, 67(1), 7–24. <http://doi.org/10.1007/s11069-010-9654-y>. P. 7.

²⁰⁵ Maclean, K., Cuthill, M., & Ross, H. (2014). Six attributes of social resilience. *Journal of Environmental Planning and Management*, 57(1), 144–156. <http://doi.org/10.1080/09640568.2013.763774>. P. 145.

²⁰⁶ Cumming, G. S., Barnes, G., Perz, S., Schmink, M., Sieving, K. E., Southworth, J., Binford, M., Holt, R.D., Stickler, C., & Van Holt, T. (2005). An exploratory framework for the empirical measurement of resilience. *Ecosystems*, 8(8), 975–987. <http://doi.org/10.1007/s10021-005-0129-z>.

²⁰⁷ Obrist, B., Pfeiffer, C., & Henley, R. (2010). Multi-layered social resilience: a new approach in mitigation research. *Progress in Development Studies*, 10(4), 283–293. <http://doi.org/10.1177/146499340901000402>.

social/societal resilience in its full meaning, namely, coping capabilities, adaptive capacities, and transformative capacities. The so-called **coping capacities** address reactive and absorptive measures of how people cope with and overcome immediate threats by the means of those resources that are directly available²⁰⁸. **Adaptive capacities** refer to proactive or preventive measures that people employ to learn from past experiences, anticipate future risks and adjust their lives accordingly²⁰⁹. **Transformative capacities** or participative capacities encompass people's abilities to access assets and assistance from the wider socio-political arena, to participate in decision-making process, and to craft institutions that improve people's individual welfare and foster societal robustness toward future crises (Keck & Sakdapolrak 2013⁶²; Voss 2008²⁵²). In his article, Lorenz made similar observations by arguing that social systems have three capacities, namely, adaptive, coping, and participative, that constitute social/societal resilience²⁰⁰. According to the author, the adaptive capacity is the property of a system in which structures are modified in order to prevent future disasters. The coping capacity could be perceived as the system's property of coping with disastrous processes that occurred in the past. Finally, the participative capacity is aimed at measuring the system's ability to change its own structures with regard to interventions by other systems, decreasing the system's resilience²⁰⁰.

There is an extensive discussion in the literature analysing social/societal resilience on the possible **indicators** for measuring the phenomenon. For example, Folke stresses the importance of vision, leadership and trust, information and knowledge flow through social networks²¹⁰. Paton et al. argue that social/societal resilience can be increased through improvements in communication, risk awareness, and preparedness²¹¹. Cutter et al. suggest that indicators such as demographics, social networks and social embeddedness, community values, and faith-based organisations are important measures of social/societal resilience⁷⁹. Governance, including participation, representation, deliberation, accountability, empowerment, and social justice²¹²; collaborative and social learning²¹³ are seen as yet another group of social/societal resilience indicators. Cutter et al. suggest assessing social/societal resilience by looking at age, gender, race and ethnicity, education, employment, occupation, etc.²¹⁴ The EU-funded Land and Ecosystem Degradation and Desertification: Assessing the Fit of Responses (LEDDRA) Project (2010-2014)²¹⁵, which investigated interlinkages between community resilience and land degradation, developed a set of indicators aimed at assessing social/societal resilience: community identity, relationships, contentment with life, conflicts, power, political structures, learning and knowledge, etc.²¹⁶

Learning and flexibility are seen as core components of social/societal resilience²¹⁷. The most conspicuous difference between ecological and coupled human-environment systems is the ability of

²⁰⁸ Keck, M., & Sakdapolrak, P. (2013). What is social resilience? lessons learned and ways forward. *Erdkunde*, 67(1), 5–19. <http://doi.org/10.3112/erdkunde.2013.01.02>. P. 10.

²⁰⁹ Béné, C., Wood, R. G., Newsham, A., & Davies, M. (2012). Resilience: new utopia or new tyranny? Reflection about the potentials and limits of the concept of resilience in relation to vulnerability reduction programmes. *IDS Working Paper*. Available at: <https://www.ids.ac.uk/files/dmfile/Wp405.pdf>. Accessed: 22 April 2016.

²¹⁰ Folke, C. (2003). Freshwater for resilience: a shift in thinking. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*, 358(1440), 2027–2036. <http://doi.org/10.1098/rstb.2003.1385>. P. 2032.

²¹¹ Paton, D., Smith, L., & Violanti, J. (2000). Disaster response: risk, vulnerability and resilience. *Disaster Prevention and Management*, 9, 173–180. Retrieved from <http://www.ingentaconnect.com/content/mcb/073/2000/00000009/00000003/art00001>.

²¹² Lebel, L., Anderies, J. M., Campbell, B., Folke, C., Hatfield-Dodds, S., Hughes, T. P., & Wilson, J. (2006). Governance and the capacity to manage resilience in regional social-ecological systems. *Ecology and Society*, 11(1). [http://doi.org/10.1890/1059-0935\(2007\)5\[375:ACALTL\]2.0.CO;2](http://doi.org/10.1890/1059-0935(2007)5[375:ACALTL]2.0.CO;2).

²¹³ Fazey, I., Fazey, J. A., Fischer, J., Sherren, K., Warren, J., Noss, R. F., Dovers, S.R. (2011). Adaptive leverage capacity for and learning to learn as. *Frontiers in Ecology and Environment*, 5(7), 375–380. [http://doi.org/10.1890/1540-9295\(2007\)5\[375:ACALTL\]2.0.CO;2](http://doi.org/10.1890/1540-9295(2007)5[375:ACALTL]2.0.CO;2).

²¹⁴ Cutter, S. L., Barnes, L., Berry, M., Burton, C., Evans, E., Tate, E., & Webb, J. (2008a). Community and Regional Resilience: Perspectives from Hazards, Disasters, and Emergency Management. *CARRI Research Report 1*. Available at: http://www.resilientus.org/library/FINAL_CUTTER_9-25-08_1223482309.pdf. Accessed: 25 August 2015.

²¹⁵ For more information see: <http://www.ecologic.eu/3354>. Accessed: 1 September 2015.

²¹⁶ Wilson, A. G. (2012). *Community Resilience and Environmental Transitions*. Routledge. P. 44-47.

²¹⁷ Sapountzaki, K. (2007). Social resilience to environmental risks: A mechanism of vulnerability transfer? *Management of Environmental Quality: An International Journal*, 18(3), 274–297. <http://doi.org/10.1108/14777830710731743>.

humans to learn from extreme events and institute individual and institutional adjustments (Adger 2000²¹⁸; Colten & Sumpter 2009²¹⁹; Godschalk 2003⁷⁵). Social sources such as **social capital** (including trust and **social networks**) and **social memory** (including experience for dealing with change) are essential for the capacity of social systems to adapt and shape change¹².

5.3.1. Social Capital

Sociologists and geographers recognize **social capital** as playing a vital role in building and maintaining social resilience (see e.g. Adger 2000¹²²; Folke 2006¹²; Pelling & High 2005²²⁰; Wolf et al. 2010²²¹, etc.). The notion of social capital emerged in 1980s as one of the key sociological foundations for community survival and generally describes how well social, political and cultural networks are developed in a given community²²². According to Adger, social/societal resilience is defined at the community level rather than being a phenomenon about individuals, hence it is related to the social capital of societies and communities¹²². Similar to the concept of resilience, social capital is a concept that has been transferred from one discipline (in this case economics) to another²²³. The basic idea of social capital is that individuals invest, access, and use resources embedded in social networks to gain returns²²⁴. Bourdieu defines it as the aggregate of the actual or potential resources that are linked to possessions of a durable network of relationship²²⁵. Magis argued that “social capital refers to the ability and willingness of community members to participate in actions directed to community objectives, and to processes of engagement”²²⁶. In resilience framework, social capital is essential component for building community networks, which encompass the social processes and activities that support people and groups in a place¹¹². Many sociologists see well-developed social capital playing key role in resilient societies, especially in the context of bonding (group cohesion), bridging (ties between groups), linking (vertical relationships), and capitals (e.g. Pretty & Ward 2001²²⁷). Strong social ties, well-established trust and participatory, democratic and inclusive processes, are seen as key ingredients for strong social capital.

Another block of social/societal resilience theory is built upon institutions and **power relations**. According to Pelling, only with supportive institutional framework social capital could be transformed into social organisation aimed at building adaptive potential of the society²²⁸. Adger argues that social/societal resilience is an institutionally determined phenomenon, in the sense that institutions permeate all social systems and institutions fundamentally determine the economic system in terms of its structure and distribution of assets²²⁹.

²¹⁸ Adger, W. N. (2000). Indicators of social and economic vulnerability to climate change in Vietnam. Available at: http://cleanairasia.org/portal/system/files/69516_paper.pdf. Accessed: 22 April 2016.

²¹⁹ Colten, C. E., & Sumpter, A. R. (2009). Social memory and resilience in New Orleans. *Natural Hazards*, 48(3), 355–364. <http://doi.org/10.1007/s11069-008-9267-x>.

²²⁰ Pelling, M., & Manuel-Navarrete, D. (2011). From resilience to transformation: The adaptive cycle in two Mexican urban centers. *Ecology and Society*, 16(2). <http://doi.org/11>.

²²¹ Wolf, J., Adger, W. N., Lorenzoni, I., Abrahamson, V., & Raine, R. (2010). Social capital, individual responses to heat waves and climate change adaptation: An empirical study of two UK cities. *Global Environmental Change*, 20(1), 44–52. <http://doi.org/10.1016/j.gloenvcha.2009.09.004>.

²²² Wilson, A. G. (2012). Community Resilience and Environmental Transitions. Routledge. P. 22.

²²³ Norris, F. H., Stevens, S. P., Pfefferbaum, B., Wyche, K. F., & Pfefferbaum, R. L. (2008). Community resilience as a Metaphor, Theory, Set of Capacities, and Strategy for Disaster Readiness. *American Journal of Community Psychology*, 41(1-2), 127–150. <http://doi.org/10.1007/s10464-007-9156-6>. P. 137.

²²⁴ Lin, N. (2001). Social capital: A theory of social structure and action. New York: Cambridge University Press.

²²⁵ Bourdieu, P. (1985). The forms of capital. In J. Richardson (eds.) Handbook of theory and research for the sociology of education. New York: Greenwood.

²²⁶ Magis, K. (2010). Community Resilience: An Indicator of Social Sustainability. *Society & Natural Resources: An International Journal*, 23(5), 401–416. <http://doi.org/10.1080/08941920903305674>. P. 407.

²²⁷ Pretty, J., & Ward, H. (2001). Social capital and the environment. *World Development*, 29(2), 209–227. [http://doi.org/10.1016/S0305-750X\(00\)00098-X](http://doi.org/10.1016/S0305-750X(00)00098-X).

²²⁸ Pelling, M., & Manuel-Navarrete, D. (2011). From resilience to transformation: The adaptive cycle in two Mexican urban centers. *Ecology and Society*, 16(2). <http://doi.org/11>. P. 64.

²²⁹ Adger, W. N. (2000b). Social and ecological resilience: are they related? *Progress in Human Geography*, 24(3), 347–364. <http://doi.org/10.1191/030913200701540465>. P. 354.

5.3.2. Social Networks

In times of change community or **social networks** provide essential support, operationalise community capacity, identify opportunities, and provide a focus for renewed optimism²³⁰. Social networks help local groups to self-organise, learn and adapt in the face of crisis. Effective work within community networks are facilitated by local leaders and volunteer workers. While disturbances and crises lead people to draw on existing community networks for support, they also facilitate network building by providing a specific focus for individuals and groups to work together and direct collective effort to diverse activities such as celebrations, supporting those in need, volunteer workers, etc. Generally, studies that deal with the phenomenon of social capital in the framework of resilience can be divided into those that analyse the structure of social networks (see e.g. Ernstson et al. 2010²³¹; Ernstson et al. 2010²³²) and those that tend to focus on the meaning and content of social relations⁶². For example, Bodin et al. aimed to assess the optimal case-specific ratio of strong and weak ties necessary to build social resilience²³³. Moore and Westley explored different types of social networks needed to build social resilience²³⁴. The authors analysed the applicability of theories of diffusion as a way of spreading ideas within networks. The authors acknowledged the importance of the so-called social entrepreneurs that make innovative process happen²³⁴. On the other hand Pelling and High placed emphasis on the content of social relations and on the critical roles of trust, reciprocity and mutual support in building social/societal resilience²³⁵. In their article the authors concluded that informal social interactions are the best resources of communities in building social resilience and in changing collective direction²³⁵.

5.3.3. Social Memory

Social memory composes yet another aspect of social/societal resilience which is widely analysed by different authors and is considered to be of fundamental importance for self-organisation (e.g. Berkes et al. 2003⁵¹; Colten & Sumpster 2009²¹⁹; Davidson 2010⁴⁸; Folke 2003²³⁶; Folke et al. 2002²³⁷; Olick & Robbins 1998²³⁸; Sapountzaki 2007²³⁹; Tidball et al. 2010²⁴⁰, etc.). As opposed to ecological systems, social systems have the unique property of developing novelties and innovations based on their memory and experience²⁴¹. Human systems, such as communities, are usually anticipatory and therefore social memory composes a crucial part of it⁴⁸. According to Adger et al, after catastrophic

²³⁰ Maclean, K., Cuthill, M., & Ross, H. (2014). Six attributes of social resilience. *Journal of Environmental Planning and Management*, 57(1), 144–156. <http://doi.org/10.1080/09640568.2013.763774>. P. 149.

²³¹ Ernstson, H., Barthel, S., Andersson, E., & Borgström, S. T. (2010). Scale-crossing brokers and network governance of urban ecosystem services: The case of Stockholm. *Ecology and Society*, 15(4). <http://doi.org/28>.

²³² Ernstson, H., Leeuw, S. E. Van Der, Redman, C. L., Meffert, D. J., Davis, G., Alfsen, C., & Elmqvist, T. (2010). Urban transitions: On urban resilience and human-dominated ecosystems. *Ambio*, 39(8), 531–545. <http://doi.org/10.1007/s13280-010-0081-9>.

²³³ Bodin, O., Crona, B. I., & Ernstson, H. (2006). Social networks in natural resource management: what is there to learn from a structural perspective? *Ecology And Society*, 11(2), r2. <http://doi.org/http://www.ecologyandsociety.org/vol11/iss2/resp2/>.

²³⁴ Moore, M. L., & Westley, F. (2011). Surmountable chasms: Networks and social innovation for resilient systems. *Ecology and Society*, 16(1). <http://doi.org/Article>.

²³⁵ Pelling, M., & High, C. (2005). Understanding adaptation: What can social capital offer assessments of adaptive capacity? *Global Environmental Change*, 15(4), 308–319. <http://doi.org/10.1016/j.gloenvcha.2005.02.001>.

²³⁶ Folke, C. (2003). Freshwater for resilience: a shift in thinking. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*, 358(1440), 2027–2036. <http://doi.org/10.1098/rstb.2003.1385>.

²³⁷ Folke, C., Carpenter, S., Elmqvist, T., Gunderson, L., Holling, C. S., & Walker, B. (2002). Resilience and Sustainable Development: Building Adaptive Capacity in a World of Transformations. *Ambio*, 31(5), 437–440. [http://doi.org/10.1639/0044-7447\(2002\)031\[0437:RASDBA\]2.0.CO;2](http://doi.org/10.1639/0044-7447(2002)031[0437:RASDBA]2.0.CO;2).

²³⁸ Olick, J. K., & Robbins, J. (1998). Social Memory Studies: From “Collective Memory” to the Historical Sociology of Mnemonic Practices. *Annual Review of Sociology*, 24(1), 105–140. <http://doi.org/10.1146/annurev.soc.24.1.105>.

²³⁹ Sapountzaki, K. (2007). Social resilience to environmental risks: A mechanism of vulnerability transfer? *Management of Environmental Quality: An International Journal*, 18(3), 274–297. <http://doi.org/10.1108/14777830710731743>.

²⁴⁰ Tidball, K. G., Krasny, M. E., Svendsen, E., Campbell, L., & Helphand, K. (2010). Stewardship, learning, and memory in disaster resilience. *Environmental Education Research*, 16(5–6), 591–609. <http://doi.org/10.1080/13504622.2010.505437>.

²⁴¹ Gunderson, L. (1999). Resilience, flexibility and adaptive management - Antidotes for spurious certitude? *Ecology and Society*, 3(1), 1–10.

change, remnants (“memory”) of the former system become growth points for renewal and reorganisation of the socio-ecological system²⁴². The position of a system in any transitional process is directly linked to events in the past and transitional pathways do not occur in a vacuum but are rather embedded in on often complex antecedent histories²⁴³. Memory is perceived as the accumulated experience and history of the system, and it provides context and sources for renewal, recombination, innovation, novelty and self-organisation following some disturbance¹². Social or collective memory refers to representations of important shared experiences by social groups, ranging from families to nations²⁴⁴. According to Berkes et al, collective memories play a vital role in the ability of SESs to respond to crisis, and thus may be one source of SES resilience²⁴⁵. Furthermore, when shared through social learning processes, such memories are particularly important after a major disturbance or when disaster drives a system into a less desirable state, and the system is in the reorganisation and rebuilding phase of adaptive cycle²⁴⁰. Social learning refers to learning that occurs through iterative feedback between learners and their environment resulting in changes in both²⁴⁶. Adger et al. defined social learning as “the diversity of adaptations, and the promotion of strong social cohesion and mechanisms for collective action”²⁴⁷. Thus resilience resides, in part, in the ability of society to draw on past experiences and is inherently historical²¹⁹.

5.3.4. Knowledge and Culture

There is a recent block of studies that emphasize the importance of **knowledge** and **culture** in the framework of resilience (see e.g. Furedi 2007²⁴⁸, Marshall 2007²⁴⁹; Marshall 2010²⁵⁰; Schwarz et al. 2011²⁵¹; Voss 2008²⁵², etc.). Social systems tend to exhibit a symbolic dimension of meaning²⁵³ or so-called structures of signification that enables a higher level of self-organisation²⁵⁴ than could be found in ecological systems. Interpretation and intentionality play important roles in social systems²⁵⁵. For example, Voss argues that social/societal resilience is a matter of people’s power to define what is perceived as a threat or disaster and what is not²⁵². Lorenz argues that in order to be able to fully understand resilience of some social entity, their symbolic order of meaning should be taken into account²⁰⁰. The ways in which people cope in an emergency situation or disaster are shaped by their cultural narrative that creates a set of expectations and sensitizes people to some problems more than

²⁴² Adger, W. N., Hughes, T. P., Folke, C., Carpenter, S. R., & Rockström, J. (2005). Social-ecological resilience to coastal disasters. *Science (New York, N.Y.)*, 309, 1036–1039. <http://doi.org/10.1126/science.1112122>. P. 1037.

²⁴³ Brierley, G. J. (2010). Landscape memory: The imprint of the past on contemporary landscape forms and processes. *Area*, 42(1), 76–85. <http://doi.org/10.1111/j.1475-4762.2009.00900.x>.

²⁴⁴ Tidball, K. G., Krasny, M. E., Svendsen, E., Campbell, L., & Helphand, K. (2010). Stewardship, learning, and memory in disaster resilience. *Environmental Education Research*, 16(5–6), 591–609. <http://doi.org/10.1080/13504622.2010.505437>.

²⁴⁵ Berkes, F., Colding, J., & Folke, C. (2000). Rediscovery of Traditional Ecological Knowledge As Adaptive Management. *Ecological Applications*, 10(5), 1251–1262.

²⁴⁶ Barab, S. A., & Roth, W.-M. (2006). Curriculum-Based Ecosystems: Supporting Knowing From an Ecological Perspective. *Educational Researcher*, 35(5), 3–13. <http://doi.org/10.3102/0013189X035005003>.

²⁴⁷ Adger, W. N., Hughes, T. P., Folke, C., Carpenter, S. R., & Rockström, J. (2005). Social-ecological resilience to coastal disasters. *Science (New York, N.Y.)*, 309, 1036–1039. <http://doi.org/10.1126/science.1112122>. P. 1039.

²⁴⁸ Furedi, F. (2007). The changing meaning of disaster. *Area*, 39(4), 482–489. <http://doi.org/10.1111/j.1475-4762.2007.00764.x>.

²⁴⁹ Marshall, N. A. (2007). Can policy perception influence social resilience to policy change? *Fisheries Research*, 86(2–3), 216–227. <http://doi.org/10.1016/j.fishres.2007.06.008>.

²⁵⁰ Marshall, N. A. (2010). Understanding social resilience to climate variability in primary enterprises and industries. *Global Environmental Change*, 20(1), 36–43. <http://doi.org/10.1016/j.gloenvcha.2009.10.003>.

²⁵¹ Schwarz, A.-M., Béné, C., Bennett, G., Boso, D., Hilly, Z., Paul, C., Posala, R., Sibiti, S., & Andrew, N. (2011). Vulnerability and resilience of remote rural communities to shocks and global changes: Empirical analysis from Solomon Islands. *Global Environmental Change*, 21(3), 1128–1140. <http://doi.org/10.1016/j.gloenvcha.2011.04.011>.

²⁵² Voss, M. (2008). The vulnerable can’t speak. An integrative vulnerability approach to disaster and climate change research. *Behemoth: A Journal on Civilisation*, 1(03), 39–56. <http://doi.org/10.1524/behe.2008.0022>.

²⁵³ Luhmann, N. (2005). Social systems. *Stanford University Press, Stanford*.

²⁵⁴ Westley, F., Carpenter, S. R., Brock, A.W., Holling, C. S., & Gunderson, L. (2002). Why systems of people and nature are not just social and ecological systems. In L.H. Gunderson and C.S. Holling (eds.). *Panarchy: Understanding Transformations in Human and Natural Systems*. Islands Press, Washington DC.

²⁵⁵ Holling, C. S., & Sanderson, S. (1996). Dynamics of (dis)harmony in ecological systems. In S.S. Hanna, C. Folke and G.K. Maler (eds.). *Rights to nature. Ecological economic, cultural, and political principles of institutions for the environment*. Islands Press, Washington.

others²⁵⁶. According to Schwarz et al., peoples' perceptions of risk, preference, belief, knowledge, and experience are the key factors that determine whether and how adaptation takes place at individual or societal level²⁵⁷. These studies also urge for the need of resilience theory to acknowledge and incorporate much more explicitly the role of stakeholder agency and the process through which legitimate visions of resilience are generated²⁵⁸.

5.3.5. Shared Responsibility and Social Media

Recent research has suggested that the mitigation of cascading effects from man-made and natural disasters depends on both '**hard**' resilience and '**soft**' resilience.²⁵⁹ While the former focuses on the robustness of physical infrastructure, the latter refers to the ability of communities to 'learn from and adapt to the changed realities that the disaster may cause'²⁶⁰. Both are interdependent, although some scholars have argued that the creation of soft resilience should be given a higher priority than increasing the resilience of infrastructures²⁵⁹.

Soft resilience may be enhanced through the assessment of post-disaster needs and educating communities about the risk factors associated with these incidents before they occur again²⁶⁰. This traditionally involved DRR organisations issuing instructions to the general public via the news media. However, recently such 'top-down' communication practices have been replaced in countries like Australia, the United Kingdom (UK) and the United States (US) by an emphasis on 'shared responsibility'. In line with the concept of shared responsibility, local communities are encouraged to play an active role in preparing for and responding to disasters^{261,262,263}. For example, as Hurricane Sandy struck, Internet usage in the US East Coast in October 2012 increased by 114%, with communities turning to Twitter, Facebook, Reddit, and other social media platforms to retrieve and share information²⁶⁴. Thus, incidents like this in the US or the violent disturbances seen in several English cities in August 2011 have shown how key agencies can leverage the 'power of collective intelligence' via social media in disaster response²⁶⁵. Social media sites such as Facebook and Twitter may enable members of the public to play a more active role in preparing for disasters and in responding to them. This may enable them not only to share responsibility for disaster management with professional emergency managers but also to be active in building their own resilience. Yet, there is an important drawback to the Sandy case as not all the information that was shared was accurate.

²⁵⁶ Furedi, F. (2007). The changing meaning of disaster. *Area*, 39(4), 482–489. <http://doi.org/10.1111/j.1475-4762.2007.00764.x>. P. 485.

²⁵⁷ Schwarz, A.-M., Béné, C., Bennett, G., Boso, D., Hilly, Z., Paul, C., Posala, R., Sibiti, S., & Andrew, N. (2011). Vulnerability and resilience of remote rural communities to shocks and global changes: Empirical analysis from Solomon Islands. *Global Environmental Change*, 21(3), 1128–1140. <http://doi.org/10.1016/j.gloenvcha.2011.04.011>. P. 1138.

²⁵⁸ Larsen, R. K., Calgaro, E., & Thomalla, F. (2011). Governing resilience building in Thailand's tourism-dependent coastal communities: Conceptualising stakeholder agency in social-ecological systems. *Global Environmental Change*, 21(2), 481–491. <http://doi.org/10.1016/j.gloenvcha.2010.12.009>.

²⁵⁹ Miao, X. & Banister, D. (2012). Coping with natural disasters through resilience, Available at: <http://www.tsu.ox.ac.uk/pubs/1059-miao-banister.pdf>. Accessed: 28 October 2015.

²⁶⁰ Duffy, N. (2011). Engagement or Education. *AJEM*, Vol. 26, n 3, July 2011, 34–39. P. 34.

²⁶¹ Cabinet Office (2011). Strategic National Framework on Community Resilience. Cabinet Office, London. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/60922/Strategic-National-Framework-on-Community-Resilience_0.pdf. Accessed 19 November 2015.

²⁶² Council of Australian Governments (2011). National Strategy for Disaster Resilience. Commonwealth of Australia. Available at: <https://www.ag.gov.au/EmergencyManagement/Documents/NationalStrategyforDisasterResilience.PDF>. Accessed 19 November 2015.

²⁶³ Department of Homeland Security. (2011). Presidential Policy Directive / PPD-8: National Preparedness. Available at: <http://www.dhs.gov/presidential-policy-directive-8-national-preparedness>. Accessed 18 October 2015.

²⁶⁴ Giroux, J., Roth, F., & Herzog, M. (2013). Using ICS & Social Media in Disasters: Opportunities & Risks for Government. *Center for Security Studies/ETH Zurich*. P. 4. Available at: <http://www.isn.ethz.ch/Digital-Library/Publications/Detail/?id=166079&lng=en>. Accessed: 25 April 2016.

²⁶⁵ Palen, L., Starbird, K., Vieweg, S., & Hughes, A. (2010). Twitter-based information distribution during the 2009 Red River Valley flood threat. *American Society for Information and Technology*, 36(5), 13–17.

International Survey

This demonstrates the importance of verification of data obtained via these sites before it can be converted into information that aids disaster response.

Given such shifts in the crisis communication channels, citizens increasingly expect governmental agencies to use online media for two-way communication. Social media generally encourages interaction and dialogue between users, creating information space that is essentially decentralized and devoid of hierarchy²⁶⁶. For example, due to this shift in crisis communication, key roles in emergency management, such as that of the Public Information Officer (PIO), have consequently become more focused on the monitoring and evaluation of user-generated content and increasingly social media is used to communicate directly with the public, bypassing the news media. A case in point is America's **Preparathon!** - a nationwide, community based campaign by Ready.gov. to improve the emergency preparedness of members of the public, the campaign relays preparedness information to members of the public via TweetChats²⁶⁷. Thus, social media sites such as Facebook and Twitter appear to function as high-speed communication platforms (in addition to siren alerts or alarms) that can be deployed by key stakeholders to deliver information that addresses the needs of individuals who reside in disaster-affected areas²⁶⁶.

This is not to suggest that social media should automatically be viewed as the most effective mode of communication adopted by stakeholders during the various stages of a disaster. As well as the persistence of the digital divide, the gap between those who are able to benefit from the Internet and those who are not, there remains some skepticism amongst social media users about the accuracy and trustworthiness of information posted online. Several studies have suggested that the general public perceives traditional media (e.g. newspapers, radio) to be more credible and trustworthy than online sources (Flanagin & Metzger 2000²⁶⁸; Stephens et al. 2013²⁶⁹). Only heavy users of social media were likely to perceive social media sites (e.g. Facebook, Twitter) as more credible during crises, mainly due to the frequency with which they are updated in comparison to other media²⁷⁰. A more nuanced interpretation of such research suggests that while people are most likely to seek out familiar social networks in the aftermath of a disaster, the means by which they access these may also ultimately depend on what media are available to them. Thus, it is about striking a balance between the traditional and social media in order to reach as broad a cross-section of disaster-affected communities as possible. Moreover, employing new communication channels requires development of a social media strategy in order to avoid dissemination of inaccurate or misleading information. Social media can also sometimes work against the interest of governmental agencies, as two-way communication decreases information control on the side of government and can sometimes be used by community members to disseminate false or even malicious information²⁶⁶.

Empirical data gathered from disasters such as Hurricane Sandy and the Tohoku earthquake in Japan in March 2011 suggested that new assemblages of what could be dubbed 'old and new media practices' were adopted by some individuals in order to seek situational information and emotional support during these events²⁷¹. Residents in areas affected by Sandy used every method possible in

²⁶⁶ Giroux, J., Roth, F., & Herzog, M. (2013). Using ICS & Social Media in Disasters: Opportunities & Risks for Government. Center for Security Studies/ETH Zurich. P. 5. Available at: <http://www.isn.ethz.ch/Digital-Library/Publications/Detail/?id=166079&lng=en>. Accessed: 25 April 2016.

²⁶⁷ Culleton, E. (2015). Imagine a world where using social media for disaster resilience is the social norm. Available at: <http://emergency20wiki.org/20150311/imagine-a-world-where-using-social-media-for-disaster-resilience-is-the-social-norm>. Accessed 28 October 2015.

²⁶⁸ Flanagin, A.J. and Metzger, M.J. (2000) Perceptions of Internet information Credibility, *Journalism & Mass Communication Quarterly*, 77: 515-540.

²⁶⁹ Stephens, K., Barrett, A., & Mahometa, M. (2013) Organisational Communication in Emergencies using Multiple Channels and Sources to Combat Noise and Capture Attention, *Human Communication Research*, 39:230-251.

²⁷⁰ Austin, L., Liu, B.F., & Jin, Y. (2012) How Audiences Seek Out Crisis Information: Exploring the Social-Mediated Crisis Communication Model, *Journal of Applied Communication Research*, 40, 2: 188-207.

²⁷¹ Burger, J., Gochfeld, M., Jeitner, C., Pittfield, T. & Donio, M. (2013). Trusted information sources used during and after Superstorm Sandy: TV and radio were used more often than social media, *Journal of Toxicology and Environmental Health*, 76:20:1138-1150.

order to obtain information, receiving news from peer networks, radio, television and social media sites²⁷¹. This suggests that emergency management may require the use of multiple communication channels in order to communicate effectively with citizens in affected areas (Hobfoll et al. 2007²⁷²; Reynold & Seger 2005²⁷³; Stephens et al. 2013²⁷⁴). In effect, the redundancy principle, whereby the same information is repeated multiple times in order to trigger some form of response by the audience²⁷⁵, remains orthodoxy amongst those responsible for disseminating information.

The ‘shortened existence’ of user groups that emerge on sites such as Twitter in the immediate aftermath of disasters may, however, pose a significant challenge to those responsible for building resilience within affected communities²⁷⁶. Many of these social media users will have questions (for example, ‘When will the power be put back on?’), which can be answered relatively quickly. Once their questions had been answered, these social media users will immediately disengage from the hashtag (in the context of Twitter) or other online space to which they contributed²⁷⁶. Others will quickly realize that their questions are unlikely to be addressed online and will also choose to ignore further messages posted on these sites²⁷⁶.

Nonetheless, social media would appear to have significant potential as a tool for empowering local communities to develop resilient characteristics and take greater responsibility for emergency management. Many of these sites can be used to develop systems and skills that enable local residents to ‘bounce back’ from incidents (faster). Three key examples of the role of social media in promoting soft resilience are detailed below.

5.3.5.1. Early warning systems

Systems such as the Flood Alert App in the UK and the ‘One Source One Message’ in Australia allow users to obtain live data on potential natural disasters²⁶⁰. The latter is just one component of a national community bushfire warning system, which includes NGOs such as Bushfire Connect²⁷⁷ that collate reports of bushfires by users and pass them on to the relevant authorities. The EmergencyAus app, which also provides push notification warnings based on geolocation data, further empowers Australian citizens to act as early warning detectors by enabling them to share their eyewitness perspectives on such incidents²⁷⁸.

5.3.5.2. Disaster Preparedness Apps

Apps have also been developed in order to disseminate disaster preparedness information to communities vulnerable to both man-made and natural disasters. Most notably, the US Government Federal Emergency Agency (FEMA) App was created in order to provide evacuation shelter lists to US citizens in such areas. This app also grants users access to live tweets from official agencies and enables them to share their own images from disaster zones²⁷⁹.

²⁷² Hobfoll, S. E., Watson, P., Bell, C. C., Bryant, R. A., Brymer, M. J., Friedman, M. J., Friedman, M., Gersons, B.P., de Jong, J., Layne, C. M., Maguen, S., Neria, Y., Norwood, A. E., Pynoos, R. S., Reissman, D., Ruzek, J. I., Shalev, A. Y., Solomon, Z., Hughes, A.L & Palen, L (2012) The Evolving Role of the Public Information Officer: An Examination of Social Media in Emergency Management, *Journal of Homeland Security and Emergency Management*, 9, Issue 1.

²⁷³ Reynolds, B., and Seeger, M. W. (2005) Crisis and emergency risk communication as an integrative model. *J. Health Communication*. 10: 43–55.

²⁷⁴ Stephens, K., Barrett, A., & Mahometa, M. (2013) Organisational Communication in Emergencies using Multiple Channels and Sources to Combat Noise and Capture Attention, *Human Communication Research*, 39:230-251.

²⁷⁵ Mileti, D. S. (1999). Disasters by design: a reassessment of natural hazards in the United States. *Joseph Henry Press, Washington*.

²⁷⁶ Potts, L. (2014). Social media in disaster response: how experience architects can build for participation. *London: Routledge*.

²⁷⁷ See www.bushfireconnect.org.

²⁷⁸ See <http://emergencyaus.info/>.

²⁷⁹ Federal Emergency Management Agency (2015). Disaster Reporter. Available at: <https://www.fema.gov/disaster-reporter>. Accessed 28: October 2015.

International Survey

5.3.5.3. Twitter Alerts

These alerts allow disaster agencies to send push notifications (e.g. public safety warnings, evacuation information) to the mobile phones of members of the public who have signed up to receive them²⁸⁰. Most organisations participating in Twitter Alerts are non-European, but organisations from the Republic of Ireland, the UK and Spain have subscribed to this service²⁸¹. The list of Apps enabling members of the public to receive and to share information and thus, also responsibility for preparedness and response is ever growing²⁸².

5.3.5.4. Crowdsourcing

When those affected by disasters share images, videos and eyewitness testimonies on social media sites such as Facebook, Twitter and YouTube, such data can be transformed into information that can aid disaster relief efforts. However, social media does not in and of itself provide a panacea for the problems associated with the coordination of disaster response between the various ‘blue light’ organisations who respond to such incidents (e.g. Police, Fire and Rescue Services). This is where **crowdsourcing platforms** offer a mechanism whereby such responsibilities can be shared with local communities and members of the public. Research has shown that it is possible to leverage social media to generate community crisis maps, which can in turn help these organisations identify those communities most in need of assistance²⁸³.

For example, **Ushahidi**²⁸⁴ is an open source crisis map platform that was created in 2007 for the purpose of monitoring the violence that followed the disputed Kenyan Presidential Election²⁸⁵. It integrates data from multiple sources - phones, email, social media sites such as Facebook and Twitter - to provide an up-to-date, publicly available crisis map, which is in turn made available to relief organisations. Crowdsourcing tools can help partition the data into bins (e.g. most-frequently requested resources) and requests into predetermined, categories (e.g. medical help, food, shelter, trapped people). Relief agencies can then concentrate on the issues and events that are most important to the relief effort.

There are, however, a number of challenges associated with the use of crowdsourcing platforms, which fall into the categories of coordination, accuracy and security. Existing platforms do not provide a common mechanism specifically designed for the coordination of disaster response between different relief organisations.²⁸⁶ What this means is that existing crisis maps, for example, do not have a feature that allows appointing a relief organisation to respond to a damage report, which may lead to multiple relief organisations responding to the same request. Another concern relates to the accuracy of geotags. For example, citizens might file erroneous reports from locations far away from where the incident has occurred. Finally, crowdsourcing applications need enhanced security. Crowdsourcing applications are often fully accessible to members of the public, but publicizing details about relief efforts might endanger both the responders and the people who filed the reports²⁸⁷.

²⁸⁰ See <https://support.twitter.com/articles/20170444#>.

²⁸¹ Twitter, Participating organisations. Available at: <https://about.twitter.com/products/alerts/participating-organisations>. Accessed: 29 October 2015.

²⁸² Emergency 2.0 Wiki (2015). Smartphone Apps. Available at: http://emergency20wiki.org/wiki/index.php/Smartphone_Apps. Accessed: 29 October 2015.

²⁸³ Goolsby, R. (2010) Social media as crisis platform: The future of community maps/crisis Maps, ACM Trans. Intelligent Systems Technology, DOI 10.1145/1858948.1858955.

²⁸⁴ See www.ushahidi.com.

²⁸⁵ Meier, P. & Brodock, K. (2008). Crisis mapping Kenya's election violence, iRevolutions. Available at: <http://irevolution.net/2008/10/23/mapping-kenyas-election-violence-2/>. Accessed: 28 October 2015.

²⁸⁶ Project CascEff interviews (2015).

²⁸⁷ Purohit, H., Castillo, C., Diaz, F., Sheth, A. & Meier, P. (2014). Emergency-relief coordination on social media: Automatically matching resource requests and offers. *First Monday, Peer-Reviewed Journal of the Internet*, 19(1-6). Available at: <http://firstmonday.org/ojs/index.php/fm/article/view/4848/3809>. Accessed: 29 October 2015.

5.3.5.5. Emergency Management

Probably the most significant impact of social media upon the field of emergency management to date has been in the education of both resilience practitioners and members of the public. For example, the Scottish Resilience Development Service (ScoRDS) developed a series of online training resources for members of the emergency services in the form of a **Virtual Resilience Camp**²⁸⁸. However, this pales in comparison with the scale of the resources provided by FEMA in the US. Like ScoRDS, FEMA provides advice on how resilience practitioners can use social media to develop skills and competencies within local communities. It also goes much further, by providing instructional video content on Twitter and YouTube that is aimed directly at members of the public. The video-sharing website is used by FEMA to provide viewers with information on topics like how to prepare a disaster kit and take appropriate action during an emergency²⁶⁰. Information has also been provided to users wishing to know more about how to differentiate between accurate and false information posted online during crises, complementing the successful trial of its **Rumour Control page** during Hurricane Sandy in 2012²⁸⁹. However, it may be too early to establish the extent to which such initiatives are directly contributing to community disaster resilience and the ways in which they intersect with the pre-existing knowledge base that exists within affected communities.

More information on implementation of social/societal resilience concepts is provided in the sections discussing the concept of resilience in different countries.

5.4. Economic Dimension of Resilience

Business plays an important role in community development and constitutes significant part in building community resilience. At the same time businesses are highly dependent on services provided by CI operators, such as for example electricity, water, telecommunications, transport systems, etc. Therefore, it is important to increase the overall economic resilience of communities towards the disruptions of critical services. In times of a crisis, business should be able to substitute and conserve needed critical services inputs, be innovative and capable of improvising, be able to timely regain their full capacity and lost revenue. This sub-section provides information about the concept of economic resilience and its attributes, discusses the levels of its application, as well as possible indicators for further evaluation in the subsequent work packages of the project.

Adger argues that economic capital is the key foundation of financial and economic well-being of community¹²². Natural and man-made disasters affect businesses and local economies in various different ways such as job losses, transportation interruptions, and disruption of goods and services provision (Albala-Bertrand 2009²⁹⁰; Mayer et al. 2008²⁹¹; Tierney 1997²⁹²; Xiao & Van Zandt 2012²⁹³; Xiao & Drucker 2013²⁹⁴). However, Zhang et al. acknowledge that there is still a lack of research

²⁸⁸ See <http://www.scor.ds.gov.uk>.

²⁸⁹ Antoniou, N. & Ciaramicoli, M. (2013) Social media in the disaster cycle – Useful tools or mass distraction?, *Secure World Foundation*. Retrieved from: http://swfound.org/media/119739/IAC-13.E5.5.3_NA.pdf, at 4.

²⁹⁰ Albala-Bertrand, M. J. (2009). Economic Localization , Societal Networking & Functionality. Available at: [https://www.gfdrr.org/sites/gfdrr/files/Economic Localization, Societal Networking and Functionality Jan08.pdf](https://www.gfdrr.org/sites/gfdrr/files/Economic%20Localization,%20Societal%20Networking%20and%20Functionality%20Jan08.pdf). Accessed: 1 September 2015.

²⁹¹ Mayer, B. W., Moss, J., & Dale, K. (2008). Disaster and preparedness: Lessons from Hurricane Rita. *Journal of Contingencies and Crisis Management*, 16(1), 14–23. <http://doi.org/10.1111/j.1468-5973.2008.00531.x>

²⁹² Tierney, K. J. (1997). Business Impacts of the Northridge Earthquake. *Journal of Contingencies and Crisis Management*, 5(2), 87–97. <http://doi.org/10.1111/1468-5973.00040>.

²⁹³ Xiao, Y., & Van Zandt, S. (2012). Building Community Resiliency: Spatial Links between Household and Business Post-disaster Return. *Urban Studies*, 49(11), 2523–2542. <http://doi.org/10.1177/0042098011428178>.

²⁹⁴ Xiao, Y., & Drucker, J. (2013). Does Economic Diversity Enhance Regional Disaster Resilience? *Journal of the American Planning Association*, 79(2), 148–160. <http://doi.org/10.1080/01944363.2013.882125>.

aimed at understanding economic resilience in the context of disasters²⁹⁵ (see also Rose 2006²⁹⁶). Interest in resilience as an economic development topic has increased since the Great Recession and several environmental catastrophes (Christopherson et al. 2010²⁹⁷; Xiao & Drucker 2013²⁹⁴).

In general, economic resilience could be defined as “the ability or capacity of a system to absorb or cushion itself against damage or loss”²⁹⁸. Bruneau et al. define economic resilience as the capacity to reduce direct and indirect economic losses resulting from disaster²⁹⁹. Tierney and Bruneau argue that economic resilience relate to the ability to identify and access a range of options for coping with disaster – the more limited the options of individuals and social groups, the lower is their resilience³⁰⁰. **Regional economic resilience** could be defined as an economy responding to an external shock by sustaining a stable state or path of growth, which implies resistance to the shock, or by recuperating from a downturn and returning rapidly to a pre-shock equilibrium state or path of growth, which implies resilience after shock³⁰¹.

Rose and Liao define economic resilience as the **inherent** and **adaptive** responses to disasters that enables firms and regions to avoid maximum potential losses³⁰². Thus the authors distinguish two types of economic resilience: inherent – ability under normal circumstances; and adaptive – ability in crisis situations due to ingenuity or extra effort³⁰³. In their article aiming to develop a resilience index for business recovery, Rose and Krausmann further argue that economic resilience could be divided into static economic resilience and dynamic economic resilience³⁰⁴. According to the authors, static economic resilience is the ability of a system to maintain function when shocked. It pertains to making the best of the existing capital stock. Dynamic economic resilience implies the speed of recovery from a shock. It refers to the efficient utilization of resources for repair and reconstruction, and focuses on enhancing system’s capacity.

5.4.1. Levels of Economic Resilience

Rose argue that economic resilience take place at the level of a household, firm, market, or macro-economy³⁰³. Economic resilience can take place at **three levels**: microeconomic (individual behavior of firms, households, or organisations), mesoeconomic (economic sector, individual market, or cooperative group), and macroeconomic (all individual units and market combined)³⁰⁴. Literature identifies number of determinants of individual business vulnerability, such as business size, ownership type, industrial sector, etc. For example, businesses with more flexible operations, such as legal and financial services, and greater resources are assumed to be more resilient to disasters;

²⁹⁵ Zhang, Y., Lindell, M. K., & Prater, S. C. (2009). Modeling and managing the vulnerability of community businesses to Environmental Disasters. *Disasters*, 33(1), 38–57.

²⁹⁶ Rose, A. (2006). Economic resilience to disasters: towards a consistent and comprehensive formulation. In D. Paton and D. Johnston (eds.). *Disaster Resilience: An Integrated Approach*. Charles C. Thomas, Springfield, IL.

²⁹⁷ Christopherson, S., Michie, J., & Tyler, P. (2010). Regional resilience: Theoretical and empirical perspectives. *Cambridge Journal of Regions, Economy and Society*, 3(1), 3–10. <http://doi.org/10.1093/cjres/rsq004>.

²⁹⁸ Rose, A. (2006). Economic resilience to disasters: towards a consistent and comprehensive formulation. In D. Paton and D. Johnston (eds.). *Disaster Resilience: An Integrated Approach*. Charles C. Thomas, Springfield, IL. P. 228.

²⁹⁹ Bruneau, M., Chang, S. E., Eguchi, R. T., Lee, G. C., O’Rourke, T. D., Reinhorn, A. M., Shinozuka, M., Tierney, A.M., Wallace, A.M., & Von Winterfeldt, D. (2003). A Framework to Quantitatively Assess and Enhance the Seismic Resilience of Communities. *Earthquake Spectra*, 19(4), 733–752. <http://doi.org/10.1193/1.1623497>. P. 738.

³⁰⁰ Tierney, K., & Bruneau, M. (2007). Conceptualizing and Measuring Resilience: A Key to Disaster Loss Reduction. *TR News*, 14–18. Available at: http://onlinepubs.trb.org/onlinepubs/trnews/trnews250_p14-17.pdf. P. 17. Accessed: 20 September 2015.

³⁰¹ Xiao, Y., & Drucker, J. (2013). Does Economic Diversity Enhance Regional Disaster Resilience? *Journal of the American Planning Association*, 79(2), 148–160. <http://doi.org/10.1080/01944363.2013.882125>. P. 149.

³⁰² Rose, A., & Liao, S.-Y. (2005). Modeling Regional Economic Resilience to Disasters: A Computable General Equilibrium Analysis of Water Service Disruptions. *Journal of Regional Science*, 45(1), 75–112. <http://doi.org/10.1111/j.0022-4146.2005.00365.x>. P. 76.

³⁰³ Rose, A. (2004). Defining and measuring economic resilience to disasters. *Disaster Prevention and Management*, 13(4), 307–314. <http://doi.org/10.1108/09653560410556528>. P. 307.

³⁰⁴ Rose, A., & Krausmann, E. (2013). An economic framework for the development of a resilience index for business recovery. *International Journal of Disaster Risk Reduction*, 5, 73–83. <http://doi.org/10.1016/j.ijdr.2013.08.003>.

businesses with already marginal finances may be pushed over the edge (Xiao & Van Zandt 2012²⁹³; Xiao & Drucker 2013²⁹⁴; Zhang et al. 2009²⁹⁵). Xiao and Drucker examined the effects of economic diversity on resilience to natural disaster shocks²⁹⁴. The authors found that economic diversity boosted employment growth and hastened income recovery after the flood, aiding in regaining lost ground. Therefore, they concluded that the economic development strategy of increasing economic diversity served to enhance resilience after disaster (ibid.).

5.4.2. Indicators

Several studies have attempted to examine economic resilience empirically or with the use of simulation studies³⁰⁴. Tierney surveyed businesses in the aftermath of the Northridge Earthquake (1997). Rose and Lim used Tierney's findings to construct specific micro-level indicators to measure resilience of the Los Angeles electricity system³⁰⁵. Kajitani and Tatano used a survey in order to estimate the resilience of Japanese industries to various types of disruptions from disasters³⁰⁶. For example, Cutter et al. suggested measuring economic resilience by using such indicators as housing capital, equitable incomes, employment, business size, and position access³⁰⁷.

Bruneau et al. used avoidance of losses, redundant capacity, stabilizing measures, and recovery time as economic resilience indicators in the context of the seismic resilience of communities anchored in an engineering-based definition of resilience¹⁶³. Similar to Bruneau et al., Fisher et al. constructed an index for critical infrastructure resilience³⁰⁸. Sub-component variables include percent employment, percent home ownership, business size, female labour force participation and a proxy for single sector employment dependence³⁰⁸. Jourdan et al. suggested looking at employment, home ownership, income equity, and single-sector dependence for assessing resilience³⁰⁹.

In his PhD dissertation, Burton concluded that economic resilience should be measured by using such indicators as percent employed, household income, economic diversity, number of commercial establishments per 1000 population and business size³¹⁰. EU-funded LEDDRA project used indicators such as stability of economic sectors, sources of income, quality of road infrastructure, economic decision-making, economic development over time, and so on. (Wilson 2012, 42-43).

Further information on implementation of economic resilience concepts to critical infrastructure is provided in the sections discussing the concepts of resilience in different countries.

5.5. Ecological Dimension of Resilience

As humans are becoming more dependent on ecosystem services, the ecosystems become more vulnerable to unexpected events³¹¹. This process that signals a loss of ecological resilience has been

³⁰⁵ Rose, A., & Lim, D. (2002). Business interruption losses from natural hazards: Conceptual and methodological issues in the case of the Northridge earthquake. *Environmental Hazards*, 4(1), 1–14. [http://doi.org/10.1016/S1464-2867\(02\)00012-8](http://doi.org/10.1016/S1464-2867(02)00012-8).

³⁰⁶ Kajitani, Y., & Tatano, H. (2009). Estimation of lifeline resilience factors based on surveys of Japanese industries". *Earthquake Spectra*, 25(4), 755-776.

³⁰⁷ Cutter, S. L., Burton, C. G., & Emrich, C. T. (2010). Disaster Resilience Indicators for Benchmarking Baseline Conditions. *Journal of Homeland Security and Emergency Management*, 7(1). <http://doi.org/10.2202/1547-7355.1732>.

³⁰⁸ Fisher, R. E., Bassett, W. A., Collins, M. J., Dickinson, D. C., Eaton, L. K., Haffenden, R. A., Klett, M.S., Lawloe, M.A., Miller, D.J., Petit, F.D., Peyton, S.M., Wllace, K.E., Whitfield, R.G., & Peerenboom, J. P. (2010). Constructing a Resilience Index for the Enhanced Critical Infrastructure Protection Program. *Decision and Information Sciences Division, Argonne National Library*. Available at: <http://www.ipd.anl.gov/anlpubs/2010/09/67823.pdf>. Accessed: 13 September 2015.

³⁰⁹ Jordan, E., Javernick-Will, A., & Amadei, B. (2011). Pathways to communicate recovery and resiliency. In T.M. Toole (eds.). *Proceedings of the engineering project organisations conference. Colorado, USA*.

³¹⁰ Burton, C. G. (2012). The Development of Metrics for Community Resilience to Natural Disasters. *University of South Carolina*. Available at: http://webra.cas.sc.edu/hvri/education/docs/Chris_Burton_2012.pdf. Accessed: 21 October 2015.

³¹¹ Gunderson, H. L. (2003). Adaptive dancing: Interactions between social resilience and ecological crises". In F. Berkes, J. Colding and C. Folke (eds.) *Navigating Social-Ecological Systems: Building Resilience for Complexity and Change*. Cambridge University Press, Cambridge, UK. P. 33.

described by Holling as a pathology of resource development. Although being beyond the scope of the project IMPROVER, ecological resilience is an inherent part of community wellbeing. Societies, including CI operating organisations are highly dependent on natural capital, such as for example water, for their functioning. Therefore, increased resilience of the natural environment should be one of the key priorities for sustainable development realised by modern societies and CI operators. Current sub-section provides a brief discussion on the concept of ecological resilience and its attributes. As the application of the ecological resilience in the context of CIR is beyond the scope of the current project, analysis of ecological resilience is not included in the case studies performed as part of the Work Package 1.

The notion and definition of ecological resilience were discussed in the previous sections of the report (see Section 4.1.2). As it was already mentioned, in 1973 Holling introduced the term of resilience into the ecological literature as a way of helping to understand the non-linear dynamics observed in ecosystems⁵. In ecology literature, resilience as a system was defined in two very different ways, each reflecting different aspects of stability. The concepts of engineering and ecological resilience were identified³¹². Recent advancements suggest that adaptation and transformation should be added to describe ecological change (see Davidson 2010¹⁹⁹; Walker et al. 2004³¹³, Walker et al. 2006³¹⁴). The resilience of ecological systems is influenced by diverse factors, such as biodiversity, redundancy, response diversity, regulatory population feedbacks, spatiality, and governance as well as management plans (Adger 2006³¹⁵; Adger et al. 2005³¹⁶; Brenkert & Malone 2005³¹⁷; Cutter et al. 2008⁷⁹; Pickett et al. 2014³¹⁸).

It is self-evident that any community relies on the environment it lives in for survival (Magis 2010226; Thampapillai & Uhlin 1997³¹⁹; Wilson 2012²¹⁶). Folke argued that “shifts between states in ecosystems are increasingly a consequence of human actions that cause erosion of resilience”³²⁰. Therefore, it is difficult to understand the resilience of human systems without taking into consideration the importance of understanding environmental processes and the notion of environmental capital (Chaskin 2008³²¹; Wilson 2012²¹⁶). Moreover, the concept of resilience entered social domain directly from the science of ecology⁵. According to Guerry et al., “sustainable developments in the 21st century requires explicit recognition that social and economic development are part of – and dependent upon – a stable and resilient biosphere”³²². Berkes et al. argue that a

³¹² Holling, C. S. (1996). Engineering resilience versus ecological resilience. In P. Schulze (eds.). *Engineering Within Ecological Constraints*. National Academy Press, Washington DC.

³¹³ Walker, B., Holling, C. S., Carpenter, S. R., & Kinzig, A. (2004). Resilience, adaptability and transformability in social-ecological systems. *Ecology and Society*, 9(2). <http://doi.org/5>.

³¹⁴ Walker, B. & Salt, D. (2006). *Resilience thinking: sustaining ecosystems and people in changing world*. Washington: Islands Press.

³¹⁵ Adger, W. N. (2006). Vulnerability. *Global Environmental Change*, 16(3), 268–281. <http://doi.org/10.1016/j.gloenvcha.2006.02.006>.

³¹⁶ Adger, W. N., Hughes, T. P., Folke, C., Carpenter, S. R., & Rockström, J. (2005). Social-ecological resilience to coastal disasters. *Science (New York, N.Y.)*, 309, 1036–1039. <http://doi.org/10.1126/science.1112122>

³¹⁷ Brenkert, A. L., & Malone, E. L. (2005). Modeling vulnerability and resilience to climate change: A case study of India and Indian states. *Climatic Change*, 72(1-2), 57–102. <http://doi.org/10.1007/s10584-005-5930-3>

³¹⁸ Pickett, S.T.A., McGrath, B., Cadenasso, M. L., & Felson, A. J. (2014). Ecological resilience and resilient cities. *Building Research & Information*, 42(2), 143–157. <http://doi.org/10.1080/09613218.2014.850600>

³¹⁹ Thampapillai, D. J., & Uhlin, H.-E. (1997). Environmental capital and sustainable income: Basic concepts and empirical tests. *Cambridge Journal of Economics*, 21(3), 379–394. Retrieved from <http://www.scopus.com/inward/record.url?eid=2-s2.0-0031452088&partnerID=40&md5=c171d91ad3ef70cceb6d8033d591234>.

³²⁰ Folke, C. (2006). Resilience: The emergence of a perspective for social-ecological systems analyses. *Global Environmental Change*, 16(3), 253–267. <http://doi.org/10.1016/j.gloenvcha.2006.04.002>. P. 257.

³²¹ Chaskin, R. J. (2008). Resilience, Community, and Resilient Communities: Conditioning Contexts and Collective Action. *Child Care in Practice*, 14(1), 65–74. <http://doi.org/10.1080/13575270701733724>.

³²² Guerry, A. D., Polasky, S., Lubchenco, J., Chaplin-Kramer, R., Daily, G. C., Griffin, R., Ruckelshaus, M., Batemanj, I.J., Duraiappahk, A., Elmqvist, T., Feldmann, M.W., Folke, Hoekstra, J., Kareivap, P.M., Keller, B.L., Liq, S., McKenzie, E., Ouyangs, Z., Reyers, B., Ricketts, T.H., Rockström, J., Tallis, H., & Vira, B. (2015). Natural capital and ecosystem services informing decisions: From promise to practice. *Proceedings of the National Academy of Sciences*, 112(24), 201503751. <http://doi.org/10.1073/pnas.1503751112>. P. 7349.

resilient social-ecological system is synonymous with ecological, economic, and social sustainability³²³.

Research on ecological resilience and its interaction with social systems is rather scattered and covers diverse issues related to the phenomenon. Similar to the discussion in social resilience, Berkes et al. discussed the importance of **ecological memory**, which is perceived as a fundamental aspect of self-organisation, in analyzing ecological resilience³²⁴. Olsson and Folke argued that **ecological knowledge** is of key importance in understanding ecological resilience as it is assumed to be a key link between ecological and social systems and can be used to interpret and respond to signals of ecosystem change³²⁵ (see Figure 5.6). There is a growing body of literature analyzing the potential in combining local knowledge systems with scientific knowledge in order to be able to better cope with change in resource and ecosystem management (see Mackinson & Nøttestad 1998³²⁶; Moller & Berkes 2004³²⁷; Riedlinger & Berkes 2001³²⁸). Gadgil et al. found that self-organized local responses for active adaptation to environmental change have emerged among communities and societies that have survived over long periods of time³²⁹.

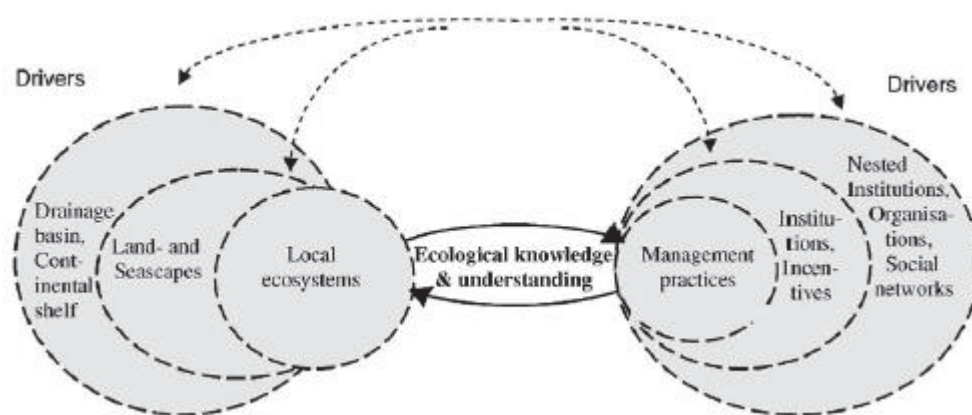


Figure 5.6 A conceptual framework that focuses on knowledge and understanding of ecological systems dynamics.³³⁰

5.5.1. Loss of Ecological Resilience

In their study, Gunderson and Pritchard found at least three different pathways which can lead to the loss of resilience in ecological systems³³¹. The first pathway involves removal of key sources or resources of resilience. The second pathway involves the addition of key substances into the ecosystem. The third pathway involves the manipulation of keystone ecological processes by human

³²³ Berkes, F., Colding, J., & Folke, C. (2003). Navigating Social-Ecological Systems: Building Resilience for Complexity and Change. Cambridge University Press, Cambridge, UK. P. 15.

³²⁴ Ibid. P. 12.

³²⁵ Olsson, P., & Folke, C. (2001). Local ecological knowledge and institutional dynamics for ecosystem management: A study of Lake Racken watershed, Sweden. *Ecosystems*, 4(2), 85–104. <http://doi.org/10.1007/s100210000061>. P. 87.

³²⁶ Mackinson, S., & Nøttestad, L. (1998). Combining local and scientific knowledge. *Reviews in Fish Biology and Fisheries*, 49(0), 481–490.

³²⁷ Moller, H., & Berkes, F. (2004). Combining science and traditional ecological knowledge: monitoring populations for co-management. *Ecology and Society*, 9(3), 2. Available at: <http://www.ecologyandsociety.org/vol9/iss3/art2/inline.html>. Accessed: 15 September 2015.

³²⁸ Riedlinger, D., & Berkes, F. (2001). Contributions of traditional knowledge to understanding climate change in the Canadian Arctic. *Polar Record*. Retrieved from http://journals.cambridge.org/abstract_S0032247400017058.

³²⁹ Gadgil, M., Berkes, F., & Folke, C. (1993). for Knowledge Indigenous Conservation. *Ambio*, 22(2-3), 151–156.

³³⁰ Folke, C. (2006). Resilience: The emergence of a perspective for social-ecological systems analyses. *Global Environmental Change*, 16(3), 253–267. <http://doi.org/10.1016/j.gloenvcha.2006.04.002>. P. 261.

³³¹ Gunderson, H. L., & Pritchard, L. (2002). Resilience and the Behavior of Large Scale Ecosystems. Washington DC: Islands Press.

intervention³³². Biggs et al. concentrated their research on ecosystem services (ES) which are essential to meet the needs of growing world population³³³. According to the authors, all SESs produce diverse ES, including provisioning (e.g. freshwater, meat, crops, etc.), regulating (e.g. climate and flood regulation), and cultural services (e.g. recreation and spiritual values). Resilience of ES is defined as the “capacity of the SES to sustain a desired set of ES in the face of disturbance and ongoing changes in SES” (ibid.). The authors identified principles that should increase ES resilience, such as: maintaining of diversity and redundancy, management of connectivity, encouragement of learning and experimentation, promotion of polycentric governance systems, etc. (ibid. 424). There has been an extensive discussion in resilience literature on the importance of institutions in managing natural capital and the interaction between social and ecological aspects of CASSs. Natural capital refers to the “living and nonliving components of ecosystems – other than people and what they manufacture – that contribute to the generation of goods and services of value for people”³³².

5.5.2. Adaptive Governance

There is a large body of work in ecological resilience literature analysing adaptive governance (AG) and its implications for natural resource management within SESs (see e.g. Berkes & Seixas 2005³³⁴; Chaffin et al. 2014³³⁵; Dietz et al. 2003³³⁶; Moller & Berkes 2004³³⁷; Olsson & Folke 2001³³⁸; Olsson et al. 2004³³⁹; Schultz et al. 2015³⁴⁰, etc.). The concept of AG was briefly touched upon in the section on disaster resilience, however, as it is based on the governance of natural resources, the notion is further analysed in this section of the document. Dietz et al. argue that human institutions, understood as the ways of organizing activities, affect the resilience of environment³⁴¹. Thus, AG emerged as a framework for the management of complex environmental issues³⁴². AG could be defined as environmental and natural resource governance approaches that share the principles of polycentric and multilayered institutions, participation and collaboration, self-organising networks, and learning and innovation³⁴³. Resilience is at the center of AG as governing to build resilience is at the forefront of the paradigm³³⁵. Governing SESs from a resilience perspective shifts the whole role of governance institutions and organisations from limiting change to managing and shaping the ability of the system to cope with, adapt to, and allow for further changes (Berkes et al. 2003³²³; Chaffin et al. 2014³³⁵; Gunderson & Light 2006³⁴²). AG of SESs can be understood as a range of interactions between actors,

³³² Gunderson, L. (1999). Resilience, flexibility and adaptive management - Antidotes for spurious certitude? *Ecology and Society*, 3(1), 1–10. P. 38.

³³³ Biggs, R., Schlüter, M., Biggs, D., Bohensky, E. L., BurnSilver, S., Cundill, G., Dakos, V., Daw, T.M., Evans, L.S., Kotschy, K., Leitch, A.M., Meek, C., Quinlan, A., Raudsepp-Hearne, C., Robards, M.D., Schoon, M.L., Schultz, L., & West, P. C. (2012). Toward Principles for Enhancing the Resilience of Ecosystem Services. *Annual Review of Environment and Resources*, 37(1), 421–448. <http://doi.org/10.1146/annurev-environ-051211-123836>. P. 423.

³³⁴ Berkes, F., & Seixas, C. S. (2005). Building resilience in lagoon social-ecological systems: A local-level perspective. *Ecosystems*, 8(8), 967–974. <http://doi.org/10.1007/s10021-005-0140-4>.

³³⁵ Chaffin, B. C., Gosnell, H., & Cosens, B. a. (2014). A decade of adaptive governance scholarship: synthesis and future directions. *Ecology and Society*, 19(3). <http://doi.org/10.5751/ES-06824-190356>.

³³⁶ Dietz, T., Ostrom, E., & Stern, P. C. (2003). Struggle to Govern the Commons, 302(5652), 1907–1912. <http://doi.org/10.1126/science.1091015>.

³³⁷ Moller, H., & Berkes, F. (2004). Combining science and traditional ecological knowledge: monitoring populations for co-management. *Ecology and Society*, 9(3), 2. Available at: <http://www.ecologyandsociety.org/vol9/iss3/art2/inline.html>. Accessed: 11 September 2011.

³³⁸ Olsson, P., & Folke, C. (2001). Local ecological knowledge and institutional dynamics for ecosystem management: A study of Lake Racken watershed, Sweden. *Ecosystems*, 4(2), 85–104. <http://doi.org/10.1007/s100210000061>.

³³⁹ Olsson, P., Folke, C., & Berkes, F. (2004). Adaptive comanagement for building resilience in social-ecological systems. *Environmental Management*, 34(1), 75–90. <http://doi.org/10.1007/s00267-003-0101-7>.

³⁴⁰ Schultz, L., Folke, C., Österblom, H., & Olsson, P. (2015). Adaptive governance, ecosystem management, and natural capital. *Proceedings of the National Academy of Sciences*, 112(24), 201406493. <http://doi.org/10.1073/pnas.1406493112>.

³⁴¹ Dietz, T., Ostrom, E., & Stern, P. C. (2003). Struggle to Govern the Commons, 302(5652), 1907–1912. <http://doi.org/10.1126/science.1091015>. P. 1907.

³⁴² Gunderson, L., & Light, S. S. (2006). Adaptive management and adaptive governance in the everglades ecosystem. *Policy Sciences*, 39(4), 323–334. <http://doi.org/10.1007/s11077-006-9027-2>.

³⁴³ Djalante, R., Holley, C., & Thomalla, F. (2011). Adaptive governance and managing resilience to natural hazards. *International Journal of Disaster Risk Science*, 2(4), 1–14. <http://doi.org/10.1007/s13753-011-0015-6>. P. 3.

networks, organisations, and institutions aiming to pursue a desired state for social-ecological system. Although the existing research on AG is rather extensive and diverse, the large majority of AG scholarship falls within three broad groupings, namely, adaptive management, cooperative management, and collaborative governance³⁴⁴.

Adaptive management could be defined as an approach to resource management that was originally developed from ecological theories of resilience and is a critical component of AG³⁴⁵. It emphasizes **learning-by-doing** approach to the management of ecological resources, and takes the view that resource management policies should be treated as experiments the managers should learn from³²³. Berkes et al. argue that the main difference of adaptive management from the conventional practice of resource management is that it is based on the importance of feedbacks from the environment in shaping policy³⁴⁶. Although derived from ecological theories, adaptive management requires a specific set of social, economic, and governance factors for implementation³⁴².

The second major field within the area of AG is built on the combination of adaptive management and a cooperative approach to managing local resources and is generally called adaptive comanagement³⁴⁷. Adaptive comanagement extends adaptive management into the social domain and requires the presence of social networks, already discussed in the report³⁴⁸. While there is no common model of adaptive comanagement, common principles that could be found throughout the literature include dynamic, multilevel, polycentric natural resource management process, that seeks to find a balance between centralized and decentralized control (Folke et al. 2005³⁴⁸; Olsson et al. 2004³³⁹). Folke et al. define adaptive comanagement as a process by which ecological knowledge and institutional arrangements are tested and constantly revised in a dynamic, ongoing, self-organized process of learning by doing³⁴⁹. It relies on the collaboration of diverse set of stakeholders operating at different levels, such as municipalities, regions, national as well as international organisations³⁴⁸.

The third block of literature within the AG scholarship is derived from legal and natural resource management research and focuses on collaborative governance of environmental problems³⁴³. In recent years a wide range of theories were developed within this block of AG scholarship, such as, for example, new environmental governance³⁵⁰, collaborative ecosystem governance³⁵¹, democratic experimentalism³⁵², etc. Although the aforementioned theories are rather divergent in their theoretical onset, they are bound together through an engagement with forms of environmental policy that favours less rigid, perceptive and hierarchical approaches to resource governance, and embraces more collaborative, decentralized, flexible and multilevel approaches for addressing complex environmental challenges³⁵³.

³⁴⁴ Ibid. P. 2.

³⁴⁵ Gunderson, H. L., & Pritchard, L. (2002). Resilience and the Behavior of Large Scale Ecosystems. *Washington DC: Islands Press*. P. 324.

³⁴⁶ ³⁴⁶ Berkes, F., Colding, J., & Folke, C. (2003). Navigating Social-Ecological Systems: Building Resilience for Complexity and Change. *Cambridge University Press, Cambridge, UK*. P. 9.

³⁴⁷ Djalante, R., Holley, C., & Thomalla, F. (2011). Adaptive governance and managing resilience to natural hazards. *International Journal of Disaster Risk Science*, 2(4), 1–14. <http://doi.org/10.1007/s13753-011-0015-6>.

³⁴⁸ Folke, C., Hahn, T., Olsson, P., & Norberg, J. (2005). Adaptive Governance of Social-Ecological Systems. *Annual Review of Environment and Resources*, 30(1), 441–473. <http://doi.org/10.1146/annurev.energy.30.050504.144511>.

³⁴⁹ Folke, C., Carpenter, S., Elmqvist, T., Gunderson, L., Holling, C. S., & Walker, B. (2002). Resilience and Sustainable Development: Building Adaptive Capacity in a World of Transformations. *Ambio*, 31(5), 437–440. [http://doi.org/10.1639/0044-7447\(2002\)031\[0437:RASDBA\]2.0.CO;2](http://doi.org/10.1639/0044-7447(2002)031[0437:RASDBA]2.0.CO;2).

³⁵⁰ Holley, C., Gunningham, N., & Shearing, C. (2011). The Environmental Governance. *London: Routledge*.

³⁵¹ Karkkainen, B. C. (2002). Collaborative ecosystem governance: Scale, complexity, and dynamism. *Virginia Environmental Law Journal*, 21, 189–243. Retrieved from http://heinonlinebackup.com/hol/cgi-bin/get_pdf.cgi?handle=hein.journals/velj21&section=13.

³⁵² Dorf, M. C., & Sabel, C. F. (1998). A constitution of democratic experimentalism. *Columbia Law Review*, 98(2), 267–268. <http://doi.org/10.2307/1123411>.

³⁵³ Holley, C. (2010). Facilitating Monitoring, Subverting Self-Interest and Limiting Discretion: Learning from “New” Forms of Accountability in Practice. *Columbia Journal of Environmental Law*, 36(2), 127–211.

6. Critical Infrastructure Resilience

While there is not a commonly accepted definition of critical infrastructure (CI), all definitions emphasize the contributing role of an infrastructure to the society or the potential debilitating effect in the case of a disruption. In Europe, the 2008 Directive on European Critical Infrastructures refers to a critical infrastructure as an “asset, system or part thereof located Member States which is essential for the maintenance of vital societal functions, health, safety, security, economic or social well-being of people, and the disruption or destruction of which would have a significant impact in a Member State as a result of the failure to maintain those functions”^{354,355}. Another common characteristic is that modern infrastructures are considered to be complex systems. This means that they have unique properties, such as “large number of interacting components, emergent properties difficult to anticipate from the knowledge of single components, adaptability to absorb random disruptions, and highly vulnerability to widespread failure under adverse conditions”³⁵⁶. In several cases, a “systems of systems” approach is needed for critical infrastructures, as it allows the understanding large-scale, highly complex phenomena that are comprised of highly interdependent participating systems, which themselves may be large-scale and highly complex³⁵⁷. This approach also accounts for emergent, synergistic behaviours of the participating systems, which is important when examining overall resilience.

With respect to resilience of critical infrastructures, there are not many national, official definitions of the concept, but recently, several national policy and strategy reports include resilience as a key component in their Critical Infrastructure Protection programs, which depicts a shift of the Critical Infrastructure Protection field towards Resilience³⁵⁸. For instance, Australia’s 2010 Critical Infrastructure Resilience Strategy details this change in perspective³⁵⁹. The report argues that such a shift enables an all hazards approach. The main argument is that due to the adverse and changing landscape of hazards and threats to critical infrastructures, it is not possible to foresee, prevent, prepare for or mitigate all of these events, which in several cases can be unknown or emergent. Moreover, “protective security measures alone cannot mitigate supply chain disruption, nor ensure the rapid restoration of services. Owners and operators of critical infrastructure often have limited capacity to continue operations indefinitely if the essential goods and services they require are interrupted”³⁶⁰. This strategy takes into account the **dependencies** between infrastructures and sectors³⁶¹. It defines resilience in the context of critical infrastructure, as:

“coordinated **planning across** sectors and networks, responsive, flexible and timely **recovery measures**, and development of an **organisational culture** that has the ability to provide a

³⁵⁴ European Council (2008). Council Directive 2008/114/EC of 8 December 2008 on the identification and designation of European critical infrastructures and the assessment of the need to improve their protection. 23.12.2008 *Official Journal of the European Union*, L345, 75–82.

³⁵⁵ For a complete list of CI definitions, see: <http://www.cipedia.eu>

³⁵⁶ Dueñas-Osorio, L., & Vemuru, S. M. (2009). Cascading failures in complex infrastructure systems, *Structural Safety*, 31(2), 157–167. <http://dx.doi.org/10.1016/j.strusafe.2008.06.007>. P. 157.

³⁵⁷ Tolone, W.J., Johnson, E. W., Seok-Won, A.L., Xiang, W.-N., Marsh, L., Yeager, C., & Blackwell, J. (2009). Enabling System of Systems Analysis of Critical Infrastructure Behaviors. In Setola, R. & Geretshuber, S. (eds.) *Critical Information Infrastructure Security*, LNCS, 5508, 24–35. Springer Berlin Heidelberg. http://dx.doi.org/10.1007/978-3-642-03552-4_.

³⁵⁸ Pursiainen, C., & Gattinesi, P. (2014). Towards Testing Critical Infrastructure Resilience. Publications Office of the European Union, JRC Scientific and Policy Reports, ISBN: 978-92-79-36632-1, April 2014. <http://dx.doi.org/10.2788/41633>.

³⁵⁹ Australian Government (2010). Critical Infrastructure Resilience Strategy. ISBN: 978-1-921725-25-8. Available at: <http://www.tisn.gov.au/Documents/Australian+Government+s+Critical+Infrastructure+Resilience+Strategy.pdf>. Accessed: 25 April 2016.

³⁶⁰ Ibid. P. 30.

³⁶¹ Rinaldi, S.M., Peerenboom, J.P. & Kelly, T.K. (2001). Identifying, understanding, and analyzing critical infrastructure interdependencies. *IEEE Control Systems*, 21(6), 11–25. <http://doi.org/10.1109/37.969131>

minimum level of service during interruptions, emergencies and disasters, and **return to full operations quickly**^{362,363}.

Similarly, the U.S. National Infrastructure Advisory Council (NIAC) defines infrastructure resilience as “the ability to reduce the magnitude and/or duration of disruptive events. The effectiveness of a resilient infrastructure or enterprise depends upon its ability to **anticipate, absorb, adapt** to, and/or **rapidly recover** from a potentially disruptive event”³⁶⁴.

This shift in perspective is also observed in the academic literature, where the concept of critical infrastructure is usually associated with the concepts of “**system resilience**”, “**technological resilience**”, “**technical resilience**”, “**engineering resilience**” etc. The research field draws heavily from the engineering field and definitions of resilience from the technical or system point of view. However, in various cases, it is also associated and enriched with other views as the ones discussed in this report, such as economic resilience, societal resilience or organisational resilience³⁵⁸.

6.1. CI System Resilience

The definitions of resilience in the context of critical infrastructure systems have evolved from existing definitions in other fields and are related to the concepts of risk, reliability and security. Evaluating and strengthening the resilience of a critical infrastructure encompasses the study of the **capabilities** of a system to **anticipate**, to **resist** or **absorb**, to **react** or **adapt** and to **recover** from events, such as natural hazards, man-made or artificial threats, unscheduled discontinuities of service, accidents, outages and a plethora of other context-dependent classes of adverse circumstances and perturbations, which we will refer to generally as disruptive events (Galbusera & Giannopoulos 2013³⁶⁵; Francis & Bekera 2014³⁶⁶; Ouyang et al. 2012³⁶⁷). For a system to be characterized as resilient, it is important to be able to (a) bring the system back to its **original state** or an **adjusted state** and (b) to provide a **minimum level of services** while undergoing changes or facing disturbances (Biringer et al. 2013³⁶⁸; Francis & Bekera 2014³⁶⁹). Dalziell & McManus describes resilience as “the overarching goal of a system to continue to function to the fullest possible extent in the face of stress to achieve its purpose, where resilience is a function of both the **vulnerability** of the system and its **adaptive capacity**”³⁷⁰. Haimes et al. defines resilience as “the ability of the system to **withstand** a major disruption within **acceptable degradation** parameters and to recover within **acceptable cost and time**.”³⁷¹

³⁶² In this way, building capacity in organisations to be agile, adaptive and to improve by learning from experience (i.e. organisational resilience) is part of the concept of CIR.

³⁶³ Australian Government (2010). Critical Infrastructure Resilience Strategy. ISBN: 978-1-921725-25-8. P. 8. Available at: <http://www.tisn.gov.au/Documents/Australian+Government+s+Critical+Infrastructure+Resilience+Strategy.pdf>. Accessed: 25 April 2016.

³⁶⁴ NIAC (2009). Critical Infrastructure Resilience Final Report and Recommendation, National Infrastructure Advisory Council. Available at: http://www.dhs.gov/xlibrary/assets/niac/niac_critical_infrastructure_resilience.pdf. Accessed: 25 April 2016.

³⁶⁵ Galbusera, L., & Giannopoulos, G. (2013). State of the art analysis of using control techniques to improve the resilience of critical infrastructures. Publications Office of the European Union, JRC Scientific and Technical Reports, JRC 87442.

³⁶⁶ Francis, R. & Bekera, B. (2014). A metric and frameworks for resilience analysis of engineered and infrastructure systems. *Reliability Engineering & System Safety*, 121 (January), 90–103. <http://dx.doi.org/10.1016/j.res.2013.07.004>

³⁶⁷ Ouyang M., Dueñas-Osorio, L. & Min, X. (2012). A three-stage resilience analysis framework for urban infrastructure systems. *Structural Safety*, 36–37 (May–July), 23–31. <http://dx.doi.org/10.1016/j.strusafe.2011.12.004>

³⁶⁸ Biringer, B., Vugrin, E., & Warren, D. (2013). Critical infrastructure system security and resiliency. CRC press, ISBN: 978-1-4665-5750-5.

³⁶⁹ Francis, R. & Bekera, B. (2014). A metric and frameworks for resilience analysis of engineered and infrastructure systems. *Reliability Engineering & System Safety*, 121 (January), 90–103. <http://dx.doi.org/10.1016/j.res.2013.07.004>.

³⁷⁰ Dalziell, E., McManus, S. (2004). Resilience, vulnerability, and adaptive capacity: implications for system performance. Presented at the International Forum for Engineering Decision Making (IFED), Stoos, Switzerland. December 6–8, 2004.

³⁷¹ Haimes, Y.Y., Crowther, K., & Horowitz, B.M. (2008). Homeland security preparedness: balancing protection with resilience in emergent systems. *Systems Engineering archive*. 11(4), 287–308.

The latter condition is particularly important for critical infrastructure systems as their main characteristic is that they serve key societal functions. Maintaining a minimum level of such services ensures that significant impacts do not occur (see EU definition of a CI). This is the reason why in this field, a key parameter to be examined and associated with resilience is the **performance** of the system and its acceptable level of **degradation** or **inoperability**. Resilience is addressed under this view as a system attribute or characteristic that needs to be measured, strengthened or achieved. However, this approach faces the problem that the performance level differs for each type of infrastructure system examined. This makes the definition of resilience for critical infrastructures even more complex. For example, the performance level can be measured by different measures, such as the amount of flow or services delivered, the availability of critical facilities, the number of people served, and the level of economic activity, which correspond to different dimensions of resilience³⁶⁷. If the focus is placed solely on the technological part of the problem, performance level is usually measured by the number of normally operating components within an infrastructure system.³⁶⁷

According to Biringer et al., the above approaches are classified as **performance based**, as they evaluate the system resilience by measuring its performance before and after a disruption.³⁷² Galbusera et al. refer to this notion as ‘operability state’ [of each infrastructure component], which, when exposed to the effects of an event affecting the network, depends on the following factors: (a) *static resilience* (the ability to continue its operation despite the event) and (b) *dynamic resilience* (the ability to promptly recover to a serviceable status after the impacting event.).³⁷³ Henry & Ramirez-Marquez also take a step forward from the static analysis of resilience and study its dynamic features as a function of time.³⁷⁴

There are, however, **structural** approaches which focus on the structure or topology of the system and its components to evaluate its resilience (Akter et al. 2014³⁷⁵, Zhao et al. 2011³⁷⁶, Verma et al. 2015³⁷⁷, Zio & Piccinelli 2010³⁷⁸, Nguyen et al. 2013³⁷⁹). The term used in these cases is usually reliability, failure rate or inoperability. For example, Zhao et al. study different network topologies and how these affect the network's resilience against both random and targeted disruptions.³⁷⁶ Verma et al. apply simulated node removal strategies that trigger cascading failures in the high-voltage European power grid.³⁷⁷ Zio and Piccinelli extend the topological concept of betweenness centrality to account for random flow propagation across a network and identify vulnerabilities in the network structure of an electrical power transmission system.³⁸⁰ Finally, Nguyen et al. focus on detecting critical nodes in multiple, interdependent power networks; they consider intra-centrality (centrality of nodes in each network) and inter-centrality (centrality due to the dependencies between two networks).³⁷⁹

³⁷² Biringer, B., Vugrin, E., & Warren, D. (2013). Critical infrastructure system security and resiliency. CRC press, ISBN: 978-1-4665-5750-5.

³⁷³ Galbusera, L., Azzini, I., & Giannopoulos, G. (2015). A methodology for resilience optimisation of interdependent critical infrastructures. In Rome, E., Theocharidou, M., & Wolthusen, S. (eds.) Proceedings of CRITIS 2015, Critical Information Infrastructure Security, LNCS, Springer Berlin Heidelberg (to appear).

³⁷⁴ Henry, D., & Ramirez-Marquez, J.E. (2012). Generic metrics and quantitative approaches for system resilience as a function of time. *Reliability Engineering & System Safety*, Volume 99, March 2012, 114–122.

³⁷⁵ Akter, M.N., Nasiruzzaman, A.B.M., Mahmud, M.A., & Pota, H.R. (2014). Topological resiliency analysis of the Australian electricity grid with increased penetration of renewable resources. *Proceedings of the 2014 IEEE International Symposium on Circuits and Systems (ISCAS)*, 494–497. <http://doi.org/10.1109/ISCAS.2014.6865180>.

³⁷⁶ Zhao, K., Kumar, A., Harrison, T.P., & Yen, J. (2011). Analyzing the Resilience of Complex Supply Network Topologies Against Random and Targeted Disruptions. *IEEE Systems Journal*, 5(1), 28–39. <http://doi.org/10.1109/JSYST.2010.2100192>

³⁷⁷ Verma, T., Ellens, W., & Kooij, R. (2015). Context-independent centrality measures underestimate the vulnerability of power grids. *International Journal of Critical Infrastructure*, 11(1), 62–81. <http://dx.doi.org/10.1504/IJCIS.2015.067398>.

³⁷⁸ Zio, E., & Piccinelli, R. (2010). Randomized flow model and centrality measure for electrical power transmission network analysis. *Reliability Engineering & System Safety*, 95(4), 379–385. <http://dx.doi.org/10.1016/j.res.2009.11.008>.

³⁷⁹ Nguyen, D., Shen, Y., & Thai, M. (2013). Detecting critical nodes in interdependent power networks for vulnerability assessment. *IEEE Transactions on Smart Grid*, 4(1), 151–159. <http://dx.doi.org/10.1109/TSG.2012.2229398>.

³⁸⁰ Zio, E., & Piccinelli, R. (2010). Randomized flow model and centrality measure for electrical power transmission network analysis. *Reliability Engineering & System Safety*, 95(4), 379–385. <http://dx.doi.org/10.1016/j.res.2009.11.008>.

During a personal interview, a representative of electrical power production and distribution company in Norway defined critical infrastructure resilience as avoiding “downtime on systems where failure has severe consequences. For power distribution systems: the system with high voltage must be more resilient because failures on these systems are more severe. Avoid queue, overload in the power distribution network”.³⁸¹ Another resilience expert from Norway (preferred not to be named in the report) argued that resilience is “the ability of critical infrastructure system to withstand changes both by ‘**safety 1**’ by using reliable systems and barriers towards known risk, and by ‘**safety 2**’ with the ability to manage change and learn continuously”.³⁸² Former employee of an organisation operating Öresund fixed link (bridge and tunnel) argued that “in case of a major bridge resilience is connected to avoid collapse or, if it is not possible, allow collapse in a “manageable way”, that is the damage should be limited. This means that the drop in the “performance” should not be more than 10-20% for any foreseen hazard scenario.”³⁸³

“From an engineering perspective resilience is a refocus from protection to adaptation and recovery of a system. However listening to, e.g. Hollnagel and Woods suggest a more complex definition of resilience focusing on a margin of error in organisations. If you take a systemic view then resilience is a system property. The resilience triangle is a good fallback description / illustration, however there could and should be far more to it.”³⁸⁴

Looking at the different definitions and approaches, one can notice commonalities and differences. Alsubaie et al. propose the following figure which summarizes the link between CIR definitions and other disciplines as well as the commonalities between them.³⁸⁵

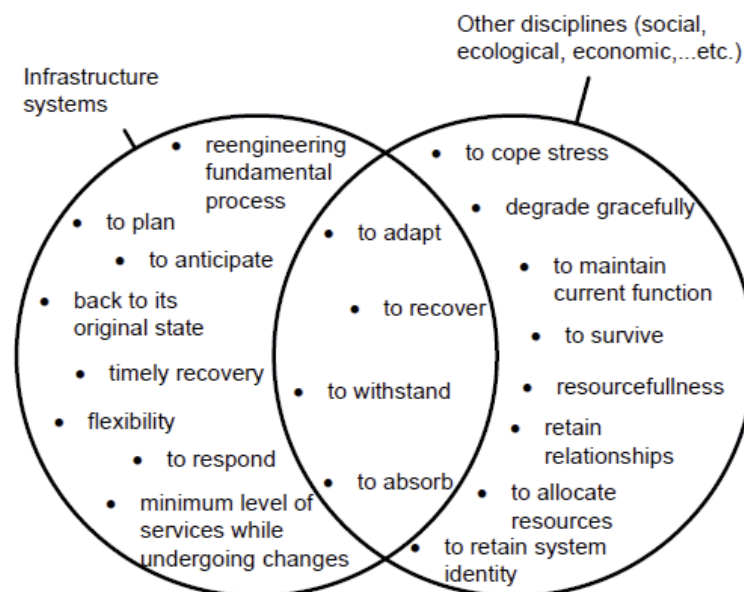


Figure 6.1 Resilience concepts.³⁸⁵

³⁸¹ Personal interview, representative of electrical power production and distribution company, Norway, 22 April 2016.

³⁸² Personal interview, resilience expert, Norway, 22 April 2016.

³⁸³ Personal interview, former employee of an organisation operating Öresund bridge and tunnel, Sweden, 17 May 2016.

³⁸⁴ Personal interview, resilience expert, Sweden, 4 May 2016.

³⁸⁵ Alsubaie, A., Alutaibi, K., & Marti, J. (2015). Resilience Assessment of Interdependent Critical Infrastructure, *In Rome, E., Theocharidou, M., & Wolthusen, S. (eds.) Proceedings of CRITIS 2015, Critical Information Infrastructure Security, LNCS*, Springer Berlin Heidelberg (to appear).

Alsubaie et al. observe that properties such as ‘ability to recover’ and ‘ability to adapt’ were incorporated in several definitions.³⁸⁵ Some consider the long term resilience by including a planning component, such as McCarthy who emphasizes that building resilience involves reengineering fundamental processes, both technical and social.³⁸⁶ Others think about resilience as an emerging behavior after a disturbance. Most of the proposed definitions include ‘the ability to withstand’ or ‘absorb’ a disturbance as a key attribute. However, other argues that this attribute is the definition of ‘survivability’ while resilience is the ‘ability to bounce back’. Similarly, Bruneau et al. assign four properties to resilience for both physical and social systems: robustness, redundancy, resourcefulness, and rapidity⁸¹.

In another review of resilience concepts used for critical infrastructures, Francis & Bekera observe the evolution in the resilience concept and also conclude that the definitions seem to converge “in the direction of a common definition, as these definitions share several common elements: absorptive capacity, recoverability, adaptive capacity, and retention of identity (structure and functions³⁸⁷)”³⁸⁸. They argue that the objective of resilience is to retain predetermined dimensions of **system performance** and **identity or structure** in view of forecasted scenarios. Factors that affect resilience are robustness (ability to withstand a given level), resourcefulness (level of preparedness to effectively combat an adverse event), redundancy (degree of substitutability of elements of a system), rapidity (ability to return to normal operating capacity in a timely manner), interconnectedness, cross-functional stakeholders, anticipative capacity, stakeholders' cooperation, capacity to recognize threats, evaluation of the model used to obtain and retain competence, capacity to prepare for future protection efforts, and ability to reduce likely risks. In short, resilience is a conceptual framework composed of multiple dimensions.

Three resilience capacities, i.e. **absorptive**, **adaptive**, and **restorative** capacities (Ouang et al 2014³⁸⁹; 2012³⁶⁷; Francis & Bekera 2014³⁸⁸) are at the center of these approaches and are linked with the various stages of typical infrastructure response cycle to disruption (before, during and after the event). Ouyang et al. argue that in order to enhance system resilience, improvement strategies can be applied at each stage, enhancing one of the three capacities respectively:³⁶⁷

- Stage 1 refers to disaster prevention stage from normal operation to the onset of initial failure of an infrastructure component. It focuses on local level impacts. This stage requires critical infrastructures to have **resistant capacity**, i.e. ability to prevent potential hazards and reduce the initial damage level if a hazard occurs. Ouyang et al. propose two measures, “hazard frequency” and “initial damage level” to describe the resistant capacity concept.
- Stage 2 emphasizes system-level effects, translating initial local component failures into system-level consequences and it refers to the damage propagation process after these initial failures. This corresponds to a system’s **absorptive capacity**, i.e. the degree to which it absorbs the impacts of initial damage and minimizes the consequences, such as cascading failures. Ouyang et al. use the maximum impact level as a measure.
- Stage 3 refers to the restoration response and the **restorative capacity** is the ability of the system to be repaired quickly and effectively. Measures chosen by Ouyang et al. include both recovery time and recovery cost.

Francis and Bekera also adopt this notion of resilience (see figure below). They propose a resilience metric that incorporates the three resilience capabilities and the time to recovery, as an additional measure and not as part of restorative capacity. Moreover, while Ouyang et al. 2012 make distinctions

³⁸⁶ McCarthy, J.A. (2007). From protection to resilience: injecting ‘Moxie’ into the infrastructure security continuum. Critical Infrastructure Protection Program at George Mason University School of Law, Arlington, VA.

³⁸⁷ Again, here we observe the two approaches, structure-based vs. performance-based.

³⁸⁸ Francis, R. & Bekera, B. (2014). A metric and frameworks for resilience analysis of engineered and infrastructure systems. *Reliability Engineering & System Safety*, 121 (January), 90–103. <http://dx.doi.org/10.1016/j.res.2013.07.004>.

³⁸⁹ Ouyang M., & Dueñas-Osorio, L. (2014). Multi-dimensional hurricane resilience assessment of electric power systems. *Structural Safety*, 48 (May), 15–24. <http://dx.doi.org/10.1016/j.strusafe.2014.01.001>.

between failure at a component vs. failure at a system level, Francis and Bekera, examine the three capacities with a focus on a specific system.³⁶⁹

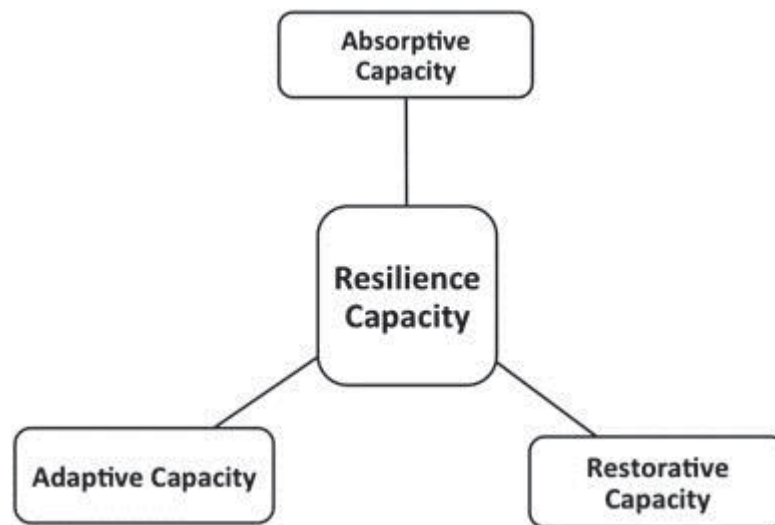


Figure 6.2 The system resilience triangle.³⁶⁶

They define resilience capacities as follows.

- Absorptive capacity refers to the degree to which a system can absorb the impacts of system perturbations and minimize consequences with little effort. In practice, though, it is a management feature depending on configuration, controls, and operational procedures. System robustness and reliability are prototypical pre-disruption characteristics of a resilient system.
- While absorptive capacity is the ability of a system to absorb system perturbations, adaptive capacity is the ability of a system to adjust to undesirable situations by undergoing some changes. A system's adaptive capacity is enhanced by its ability to anticipate disruptive events, recognize unanticipated events, re-organize after occurrence of an adverse event, and general preparedness for adverse events.
- Restorative capacity of a resilient system is often characterized by rapidity of return to normal or improved operations and system reliability. This capacity should be assessed against a defined set of requirements derived from a desirable level of service or control.

Ouyang et al. offer several examples of strategies to achieve these three capacities for a critical infrastructure:³⁸⁹

- Resistant capacity
 - Adjust and improve the organisational and administrative structure to increase early-warning awareness, such as ingraining the safety culture awareness in CISs, reinforcing staff training to decrease human errors.
 - Add and update safety constraints to each participant in the CISs so that the frequency of random hazards can be reduced, such as purchasing high-quality equipment and install properly, implementing strict vegetation program, placing barricades or fences.
 - Harden and protect the key CISs or their components, prevent the events enabling to cause large consequences.
 - Learn and improve from previous accidents using accident models, such as the System-Theoretic Accident Model and Processes approach.
 - Establish an observatory network to sense, monitor, and update system states in real time along with state visualizations based on emerging infrastructure modelling techniques, such as Bayesian networks, to assess on-line risk for early warning.
 - Manage consumer behaviours to keep the CISs load at a certain level to reduce the overload-induced hazards.
- Absorptive capacity

- Adjust and improve the organisational and administrative structure to accelerate the emergency decisions, such as sharing information among stakeholders, reinforcing staff training to accelerate the response time, ingraining the interdependency-related culture awareness, adjusting the market structures.
- Optimize and retrofit the topology of each CIS as well as the interface topologies across CISs.
- Design and prepare redundancy, backup and substitution to lower the interdependency impacts.
- Improve the absorptive capacities of some key CISs, such as the transition of the traditional power systems to smart grids.
- Manage or directly control consumer behaviours to adjust the system load in the emergent scenarios to avoid the large-scale cascading failures.
- Improve the robustness and self-configuration of the communication systems to keep the situational awareness for rapid emergency decisions.
- Restorative capacity
 - Adjust and improve the organisational and administrative structure to accelerate restoration decisions and coordination, such as sharing information among stakeholders, establishing the fusion center to coordinate the participants during emergency scenarios.
 - Design advanced decision support platform to quickly find the restoration sequences and priorities, optimum resource allocation strategies.
 - Improve the restorative capacities for key CISs, such as electric power systems, communication systems.
 - Increase the variety and robustness of communication channels

6.2. CIR and other resilience concepts

A critical infrastructure is a socio-technical system and a part of a complex community system. Bea et al. argue that no matter how much physical science and technology are involved in a complex system; no system is ever solely physical or technical.³⁹⁰ Therefore, the resilience concepts which are applicable relate to both the critical infrastructure itself and the community where it exists and functions within. This is described as essential in the research literature, but it is slowly appearing in recent publications of the field.³⁹¹

Labaka et al. focus on major industrial accidents which have been defined as crises that start in one CI and spread through a network of CI, affecting also the society.³⁹² For this purpose, two resilience types are defined: (a) the resilience level of the CI where the triggering event occurs (internal resilience) and (b) the resilience level of the rest of the external involved agents (external resilience). They propose a CIR framework which links CIR to several resilience concepts, i.e. technical resilience, organisational resilience, economic resilience and ultimately social resilience. Their framework is shown in the figure that follows. Each dimension is linked to a resilience policy, which refers to areas of controls and actions that can be implemented in order to increase the various aspects of resilience.

³⁹⁰ Bea, R., Mitroff, I., Farber, D., Foster, H., & Roberts, K. H. (2009). A new approach to risk: The implications of E3. *Risk Management*, 11 (1), 30–43. <http://dx.doi.org/10.1057/rm.2008.12>.

³⁹¹ Leveson, N., Dulac, N., Marais, K., & Carroll, J. (2009). Moving beyond normal accidents and high reliability organisations: a systems approach to safety in complex systems. *Organisation Studies*, 30(2–3), 227–249. <http://dx.doi.org/10.1177/0170840608101478>.

³⁹² Labaka, L., Hernantes, J., & Sarriegi, J. M. (2015). Resilience framework for critical infrastructures: An empirical study in a nuclear plant. *Reliability Engineering & System Safety*, 141, 92–105. <http://dx.doi.org/10.1016/j.res.2015.03.009>.

Table 6.1 Resilience framework: resilience types, resilience dimensions, and resilience policies and sub-policies.³⁷⁵

Resilience types	Resilience dimensions	Resilience policies	Resilience sub-policies
Internal resilience	Technical resilience	CI safety design and construction	(Required and voluntary) safety systems
			Redundancy
			Simplicity and loose coupling
			(External and internal) audits
		CI maintenance	Preventive maintenance
			Corrective maintenance
		CI data acquisition and monitoring system	Data acquisition equipment
			Information monitoring equipment
		CI crisis response equipment	
	Organisational resilience	CI organisational procedures for crisis management	Crisis management procedures
			Incident management and evaluation
			Coordination procedures with external stakeholders
		CI top management commitment	Top manager commitment and situation awareness
			Activities to promote resilience-based culture
		CI crisis manager preparation	Crisis manager training
			Crisis manager situation awareness and commitment
		CI operator preparation	Operator training
			Operator situation awareness and commitment
	Economic resilience	CI crisis response budget	
External resilience	Technical resilience	External crisis response equipment	
	Organisational resilience	First responder preparation	First responder training
			First responder situation awareness and commitment
		Government preparation	Government situation awareness and commitment
			Government training
			Government communication capacity
			Government leadership capacity
			Coordination of the response agents
		Trusted network community	Shared information systems and databases
			Trust and engagement of the participants
		Crisis regulation and legislation	Regulation and law revision and update
			Regulation and law compliance level
	Economic resilience	Public crisis response budget	
	Social resilience	Societal situation awareness	Societal situation awareness and commitment
			Societal training

Similarly, Alsubaie et al. propose a resilience framework for critical infrastructures which encompasses static and dynamic attributes of an infrastructure, as well as organisational ones, linking CIR to organisational resilience.³⁸⁵ They refer to the attribute ‘systems structure’, as a measure of the physical static parameters of the infrastructure (design and topology of each system), as well as

International Survey

structural interdependencies between infrastructures. The second attribute is called ‘Systems dynamic’ and refers to the dynamic behavior of the infrastructure systems. Measures include emergency preparedness, response management, and recovery activities. Finally, ‘Human and Organisational capacities’ are used to measure the human and organisational factors whose contributions are essential to the overall infrastructure resilience.

In their approach, Alsubaie et al.³⁸⁵ recognize that it is important to take into account the inherent **interdependencies**³⁹³ that exist among most of the modern CIs³⁹⁴. In this respect, proposed resilience concepts and measures need to incorporate CI interdependencies, considering the cascade of a failure through multiple CIs, which offer different services to the community. This dependency of resilience between communities and infrastructure has been widely recognised in the scientific literature. In particular, Jackson notes that to create resilient organisations, one must combine capabilities, culture, and infrastructure.³⁹⁵ Jackson also recognises that the people and organisational infrastructure surrounding the technological systems also are involved in ensuring system resilience.³⁹⁶

Community resilience and CIR are also linked in a third way which is that following a disaster, the needs of a community are likely to change, which can also place new demands on surviving infrastructure – for example, following floods in the UK the affected communities required new locations to meet and socialise after their local community centres were destroyed and other facilities were adopted as substitute community centres.

The Australian strategy is important as it links several aspects of resilience, in the same framework (see Figure 6.3).

³⁹³ In general, CI (inter)dependencies can be classified into four categories, i.e. physical, cyber, geographic and logical (Rinaldi et al. 2001).

³⁹⁴ Ouyang, M. (2014). Review on modeling and simulation of interdependent critical infrastructure systems. *Reliability Engineering & System Safety*, 121 (January), 43–60. <http://dx.doi.org/10.1016/j.ress.2013.06.040>.

³⁹⁵ Jackson, S. (2007b). System resilience: capabilities, culture, and infrastructure, *Proceedings of the Seventeenth Annual International Symposium of the International Council on Systems Engineering*, San Diego, California.

³⁹⁶ Jackson, S. (2007). A multidisciplinary framework for resilience to disasters and disruptions, *Journal of Integrated Design and Process Science*, 11(2), 91– 108.

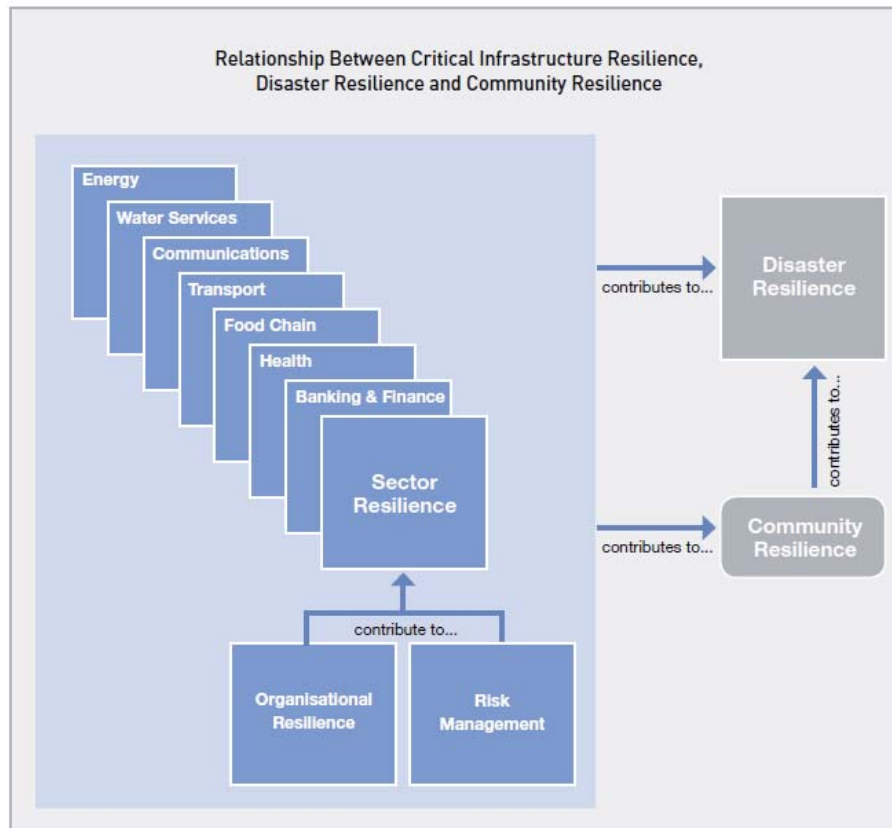


Figure 6.3 Relationship between CIR, disaster resilience & community resilience.³⁶³

Many approaches focus on identifying the optimum restoration strategy. Rochas et al. provide a method for selection of the most effective restoration strategy of a networked infrastructure system and apply it on the district heating pipeline system of Salaspils city (Latvia).³⁹⁷ Ouyang & Wang follow a time-based approach and examine dependency as a factor for restoration.³⁹⁸ Their work adapts an existing resilience framework (Ouyang & Dueñas-Osorio 2012³⁹⁹, 2014³⁸⁹, Ouyang et al. 2012³⁶⁷) for interdependent infrastructure systems and models resilience in order to identify the optimum restoration processes of these systems in the case of an event. They examine power and gas infrastructures and compare five joint restoration strategies (random, interdependent, power first – gas second, gas-aimed, power and gas compromised) with interesting results. Similarly, Reed et al. focus on the operation of the power grid and the effect of its failures on the post-event recovery process.⁴⁰⁰ On an economic approach Jonkeren & Giannopoulos examine recovery paths according to the type of disaster.⁴⁰¹

Economic analysis tools derived from Leontief's input–output approach are widely used to determine how inoperability in a subset of infrastructure systems affects the performance and operability of

³⁹⁷ Rochas, C., Kuzņecova, T., & Romagnoli, F. (2016). The concept of the system resilience within the infrastructure dimension: application to a Latvian case. *Journal of Cleaner Production*, 88 (February), 358–368. <http://dx.doi.org/10.1016/j.jclepro.2014.04.081>.

³⁹⁸ Ouyang, M., & Wang, Z. (2015). Resilience assessment of interdependent infrastructure systems: With a focus on joint restoration modeling and analysis. *Reliability Engineering & System Safety*, 141 (September), 74–82. <http://dx.doi.org/10.1016>.

³⁹⁹ Ouyang M., & Dueñas-Osorio, L. (2012). Time-dependent resilience assessment and improvement of urban infrastructure systems. *Chaos*, 22, 033122. <http://dx.doi.org/10.1063/1.4737204>.

⁴⁰⁰ Reed, D.A., Kapur, K.C., & Christie, R.D. (2009). Methodology for Assessing the Resilience of Networked Infrastructure. *IEEE Systems Journal*, 3(2), 174–180. <http://dx.doi.org/10.1109/JSYST.2009.2017396>.

⁴⁰¹ Jonkeren, O., & Giannopoulos, G. (2014). Analysing Critical Infrastructure Failure With a Resilience Inoperability Input—Output Model, *Economic Systems Research*, 26(1), 39.

International Survey

others. These models are used mainly to depict dependencies between CI sectors (Haimes et al. 2005, Santos 2006, Setola et al. 2009). Furthermore, since the resilience evaluation of a system is highly dependent on the investigated impact, Pant et al. (2014) have proposed a set of metrics for particularly addressing the resilience of CI and industry sectors from an economic perspective. Additionally, it has been shown that infrastructure inoperability in natural hazards can compromise economic recovery, when the public costs orders of magnitude are greater than private utility costs³⁸⁸. Jonkeren & Giannopoulos (2014) apply dynamic inoperability input–output modelling and model the aspect of ‘inventory’ as a resilience measure. Inventory is interpreted in a broad sense here: it can be any resilience measures which enable an infrastructure or economic sector to continue its supply despite being disrupted.⁴⁰¹

During personal interviews with critical infrastructure operators around Europe, we found out that resilience is not a well established concept in the context of critical infrastructure. The concept is implemented and measured indirectly. For example, a former employee of an organisation operating Öresund fixed link claimed that their organisation does not measure resilience due to the fact that it is difficult to define scenarios as there could be an indefinite number of them.³⁸³ A representative from electrical power and distribution company in Norway argued that in their company resilience is measured indirectly. “However, parameters such as robustness, reliability, amount of energy delivered, downtime, recovery time, condition monitoring, maintenance, etc. are used. The term of resilience is new and we do not have direct measures for it”³⁸¹. When asked if their company has a strategy for implementing resilience concept to critical infrastructure, the representative noted that their company has different plans and strategies for that purpose, including:

- “Preparedness regulation, with guidance;
- Strategy to increase robustness of systems and to minimize recovery time;
- Maintenance strategies, continuous process. Increase redundancy on the systems;
- Preparedness plans in crises;
- Common preparedness center for many power distribution companies – easier to get spare parts and equipment in crises, big economic benefit as well;
- Risk and vulnerability analysis performed for all new investments.”³⁸¹

A former employee of an organisation operating Öresund fixed link informed us that their organisation had different plans in case of emergency, however, “the main challenge is to collect and utilize this knowledge quickly in case of an incident. This is actually both an organisational and technological challenge, since there is also a lot of data stored electronically.

Plans for preparedness: at the opening special education for train drivers and first responders was arranged.

Technological concepts to achieve a resilient design include:

- Procedures for closing down the bridge at high wind speed, even though the structure itself is designed for much higher winds;
- Having the cables far from the road to avoid any interference with them;
- Cables are being replaced quickly while the bridge is in operation;
- Pylons designed for ship collision;
- Planes not flying over the bridge, etc.

Financial resilience was meant to be achieved by taking out insurance for downtime, but it was too expensive.”³⁸³

A representative of a major supplier of fuel to the Norwegian market noted that instead of measuring resilience, their company measures redundancy.⁴⁰² The company tries to implement resilience concept in the form of risk evaluation. They use **process maps**, **risk analyses**, **vulnerability analyses** and **reduced-service studies**. However, the company does not use the term resilience in their daily work.

Local supplier of potable water and waste water management noted that their company implements concept of resilience by implementing “good maintenance and operation management plans based on the quality of the systems (not age). 15 year plans – strategy for upgrading vulnerable parts of the systems. Preparedness plans, robust systems and services, continuous/stable operations. Analysis of previous events to improve routines.”⁴⁰³

Resilience expert working in one of the universities in Sweden argued that “in many CI sectors, regulators have different indicators for measuring the performance of the operators. For example, in the power sector the regulator in Sweden has a number of metrics of performance included in the legislation. These include the frequency of failure of different parts of the grid, or the average duration of individual power outages for average customers.

While historical data is often used as an indicator of past performance, this does not give a good indication of how a system will bounce back in the future. Risk analysis methods try to provide more information than data based on historical incidents and could give an indication of resilience given exposure to different scenarios.

A general indicator of resilience is how much strain an organisation or infrastructure could handle. In any case, it's important to understand the limits of different indicators and to determine the correct scenarios to use them in relation to and whether or not they always hold true.”³⁸⁴

“To measure resilience we need to be able to measure **performance**. However, in different critical infrastructure sectors, different indicators exist. Even within one sector several functions might exist with various indicators of each functional performance. Therefore the indicators of resilience will be different in different across sectors and functions. A major challenge is how to compare and/or combine them. A possible solution is to assign weights, importance factors, etc. to each indicator”.⁴⁰⁴ The representative of a major supplier of fuel to the Norwegian market argued that without specifically speaking in terms of ‘resilience’, their company take into account three factors:

- Risk analyses;
- Reduced service analyses;
- Alternative means of conformance (in order to have back-up alternatives).⁴⁰²

The operator of electrical power production and distribution company in Norway argued that **quantitative indicators** are easiest to use and give the best indication of resilience. “Downtime is the most descriptive way to measure critical infrastructure resilience. One could also measure lifetime, condition, maintenance and criticality”.³⁸¹ Similar opinion was expressed by the former employee of an organisation operating Öresund fixed link who informed that resilience should be measured in terms of the downtime of a facility. “It is basically downtime here. The link is either “on” or “off”. It is measured in hours/days/weeks, but so far it was only hours.”³⁸³

The representative of potable water and waste water management company in Norway informed that in their company “resilience is measured indirectly with parameters such as deliverance certainty, resistance against unwanted events, surveillance, condition monitoring, number of unwanted events,

⁴⁰² Personal interview, representative from a major supplier of fuel to the Norwegian market, 22 April 2016.

⁴⁰³ Personal interview, local supplier of potable water and waste water management, Norway, 22 April 2016.

International Survey

downtime, analysts of previous events, redundancy in the systems, etc.”⁴⁰³ The company is using quantitative indicators for measuring facility’s resilience towards disasters.

During the IMPROVER workshop that took place in Copenhagen on the 25th of September, 2015, all the participants agreed that interdependency is a big problem when talking about CIR.⁴⁰⁴ To address this problem, the representative from electrical power and distribution company in Norway stated that their company tries to highlight the services and infrastructures that they are dependent on. They also conduct exercises that reveals of suppliers and infrastructure the company depends on function well during the time of crisis and what is the level of interdependency.³⁸¹ The representative of a major supplier of fuel to the Norwegian market noted that their company has taken into account the dependency on the terminal for supply and distribution, but he could not provide any further details.⁴⁰² The representative of potable water and waste water management company said that their company tries to have good cooperation with other suppliers/operators, as for example power distributor. The power distribution company warns them if probability of power distribution breakdown is high. “Good routine if other infrastructures fail is to have our own alternative solutions, such as for example emergency generators, etc.”⁴⁰³

Interdependencies also pose a huge challenge to organisations operating CI facilities in different countries. “In case of an accident, for example, different organisations are in charge on the two sides of the strait. In Denmark it is the police, in Sweden it is the fire department. There is an agreement that all 4 (both police and fire on both sides) departments are notified if something happens. This collaboration works quite well”³⁸³.

6.3. Risk Management

Some authors study resilience as an extension of the risk assessment problem. McCarthy observes that when one affects elements in the risk chain (such as threat likelihood, impact, etc.), resilience can also be positively impacted.³⁸⁶ The most common example used is increasing redundancy in communication links and networks.

Francis and Bekera analyse the relationship between risk management and resilience assessment.³⁸⁸ They distinguish resilience assessment from risk assessment in the following way:

- Principally, conventional risk assessment methods are used to determine the negative consequences (impact) of incidents and crises, and to mitigate the organisation's exposure to those undesirable outcomes. Risk is measured as the likelihood of a hazard and the consequences caused to the critical infrastructure and the society.
- In contrast, resilience is an endowed or enriched property of a system that is capable of effectively combating (absorbing, adapting to or rapidly recovering from) disruptive events.

This duality of objectives has been identified in a recent study on risk assessment methodologies for CIs⁴⁰⁵. The report observes that resilience seems to be the missing element in most methodologies, or at least it is only implicitly addressed. Operators, asset managers, policy makers tend to identify threats and vulnerabilities within their domain of responsibility, which means that they tend to protect themselves from risk relevant only within their scope and context, often by considering worst case scenarios, and thus applying disproportional risk mitigation measures. From the risk assessment point of view this approach is effective but it narrows down the possibilities for a cost-effective approach.

⁴⁰⁴ IMPROVER workshop, 25th September 2015 Copenhagen, Denmark. Group discussions with CI operators and resilience experts.

⁴⁰⁵ Giannopoulos, G., Filippini, R., & Schimmer, M. (2012). Risk assessment methodologies for Critical Infrastructure Protection. Part I: A state of the art. Publications Office of the European Union, JRC Scientific and Policy Reports, ISBN: 978-92-79-23839-0. <http://dx.doi.org/10.2788/22260>.

Suter identifies three main perspectives on the relationship between risk management and resilience in recent CIP policies.⁴⁰⁶ They identify three perspectives and conclude to the following observations:

- resilience as *the new goal of risk management in CIP*. If resilience is used as a broader concept to integrate rather than replace the traditional protection policies, then there is indeed little need for changing existing risk management strategies.
- resilience as *an alternative to risk management*. This perspective is more radical, but it remains immature, due to the lack of operative standards for resilience management.
- resilience as *part of risk management*. This is the more pragmatic approach and it views resilience as a complementary method to traditional risk management, which could allow practitioners to deal with residual risks, which the traditional approaches fail to address.

6.4. Standards

Finally, standardisation in the field is slowly evolving, with several related standards being released or under development. For example, ANSI is developing a series of resilience standards to address the risks of disruptive events, focused on adaptive, proactive, and reactive strategies, towards risk and resilience management⁴⁰⁷. In the UK, British Standards Institution has released in 2014, the BS 65000:2014 - Guidance on organisational resilience. Moreover, the ISO 223xx family of standards on “Societal Security”, coupled with ISO 28002:201156 on supply chain resilience⁴⁰⁸, cover some relevant to CI resilience concepts. Despite these efforts, critical infrastructure resilience is not implicitly addressed.

During the personal interview, Rasmus Dahlberg, PhD-fellow at the University of Copenhagen, argued that “[...] before standardisation in the field can be realised, much more transdisciplinary work needs to be done, developing theories of the concept from multiple approaches”¹⁴⁶. Resilience expert from Norway argued that “it would be possible to standardise the methodology. For example, standardised questionnaires and similar to force rethinking”¹⁴⁷. “An obstacle for standardization is the strategic process to standardisation. Different infrastructures have different approaches and different needs and therefore there needs to be some flexibility in the field.”³⁸⁴

Gilles Teneau, a researcher working at the Centre d’investigation et de Recherches Expérimentales en Résilience Organisationnelle, noted that standardisation in the field of resilience is inevitable. “There are definitely opportunities to standardise resilience and we will end up with a standardised form of resilience. There is already a norm that exists, the ISO 65000. However it is on engineering resilience and mostly covers things like business continuity plans.”⁴⁰⁹

Further sections of the report will discuss on the implementation of resilience concepts in Europe, Africa, Asia, Canada, Oceania, South America, and the United States of America. For the purpose of the current research, it will focus on critical infrastructure and organisational dimensions of resilience.

⁴⁰⁶ Suter, M. (2011). Focal Report 7: CIP Resilience and Risk Management in Critical Infrastructure Protection Policy. Exploring the Relationship and Comparing its Use. Center for Security Studies (CSS), ETH Zurich.

⁴⁰⁷ Published standards include:

1. Organisational Resilience: Security Preparedness and Continuity Management Systems - Requirements with Guidance for Use (2009) - SPC.1
2. Auditing Management System for Security, Preparedness and Continuity Management with Guidance for Application (2014) - SPC.2
3. Organisational Resilience Maturity Model—Phased Implementation (2012) - SPC.4

Moreover, the following ones are under development:

- Resilience in the Supply Chain (201x) - SPC.3

Community Resilience: Guidance on Capacity Building and Public-Private Partnerships (201x) - SPC.5

⁴⁰⁸ ISO 28002:2011 - Security management systems for the supply chain -- Development of resilience in the supply chain -- Requirements with guidance for use.

⁴⁰⁹ Personal interview, Gilles Teneau, researcher at the Centre d’investigation et de Recherches Expérimentales en Résilience Organisationnelle, also researcher associated with LEMNA (Université de Nantes), France, 18 April 2016.

International Survey

Analysis of social and economic dimensions of resilience will also be provided. As it is beyond the focus of current research to discuss the implementation of ecological resilience, this dimension of the concept will be not touched upon.

7. Case Studies

The section provides a **summary** of information collected on **definition, implementation** and **assessment** of resilience concepts in Europe, Africa, Asia, Oceania, North and South America. Table 7.1 provides an overview of the information on resilience definitions and implementation, and Table 7.2 discusses resilience assessment tools and models that are or could be used in the context of critical infrastructure.

7.1. Methodology and Overview

In order to collect information on existing definitions, implementation and assessment of resilience concepts, the consortium members conducted an extensive international survey covering six continents (Europe, Africa, Asia, Oceania, North and South America). Information was collected by reviewing available region and state-level official documents, scientific papers containing any relevant region or state related information, conducting interviews with resilience experts in a specific region or country (see an overview of resilience concepts in Oceania).

Information was collected using the following structure:

- Disasters in the region/country;
- History and definitions of resilience in the region/country;
- Institutional framework for delivering resilience in the region/country;
- Definition and implementation of CI resilience and technical resilience;
- Definition and implementation of organisational resilience;
- Definition and implementation of social/societal resilience;
- Definition and implementation of economic resilience;
- State or region level official documents related to resilience.

The quality and quantity of the collected information varies in different regions due to the fact that in some of them the concept and practice of resilience are in a rather early stage of development. Therefore, case studies on Africa and South America provide little information that could be used for the purposes of current project. In both regions, the concept and of resilience are driven by the efforts of international and regional organisations and lacks implementation efforts. On the other hand, case studies on Asia (particularly Japan), Oceania (particularly Australia and New Zealand), and the United States of America provide a rich information on the concepts of resilience, as well as their implementation and assessment.

The members of the consortium chose to conduct different number of case studies in different regions depending on the existence and availability of relevant information. For example, the report on resilience concepts in Oceania consists of 12 case studies due to the fact that there is a lot of continent specific and project relevant information; and the report on resilience concepts in Africa does not consist of any specific country-level analyses due to the lack of information on the subject in the continent.

- Report on resilience concepts in **EU/EEA** consists of the following case studies: Norway, Sweden, the United Kingdom, Denmark.
- Report on resilience concepts in **Asia** consists of the following case studies: China, Japan, Indonesia, Philippines.
- Report of resilience concepts in **Canada** includes a case study on Ontario.

- Report on resilience concepts in **Oceania** consists of the following case studies: Australia, New Zealand, Fiji, Kiribati, The Republic of the Marshall Islands, Federal States of Micronesia, Nauru, Palau, Papua New Guinea, Samoa, Solomon Islands, Vanuatu.
- Report on resilience concepts in **South America** consists of the following case studies: Brazil, Chile, and Argentina.
- Report on resilience concepts in the **United States of America** consists of the following case studies: Massachusetts, Texas, Idaho, and Illinois.

Detailed and **comprehensive** information on the topics is provided in the Appendices 3-9:

Appendix 3: C. Pursiainen (UiT), B. Rød (UiT), P. Gattinesi (JRC). *Resilience Concepts in EU/EEA*.

Appendix 4: I. Ioannou (UCL). *Resilience Concepts in Africa*.

Appendix 5: L. Melkunaite (DBI), J. Kinscher, M. AL Heib, R. Salmon (INERIS). *Resilience Concepts in Asia*.

Appendix 6: G. Baker (SPFR). *Resilience Concepts in Canada*.

Appendix 7: L. Petersen (EMSC), K. Eriksson, D. Honfi, D. Lange (SP). *Resilience Concepts in Oceania*.

Appendix 8: A. Utkin, C. Gaspar, R. Carreira, G. Cadete (INOV). *Resilience Concepts in South America*.

Appendix 9: P.J. Reilly, R. Stevenson (University of Sheffield), L. Melkunaite (DBI). *Resilience Concepts in the United States of America*.

7.2. Resilience Definitions and Implementation

Table 7.1 provides a summary of resilience definitions and implementation in different regions. Information on definitions of resilience will serve as an input for extending the Lexicon of definitions.

Table 7.1 Resilience definitions and implementation.

Region/Country	Concept of Resilience	CI Resilience and Technical Resilience	Organisational Resilience	Social/Societal Resilience	Economic Resilience
Norway <i>Appendix 3</i>	Resilience entails the ability to adapt, and not the ability to withstand.	Focus on CI protection. NORSOK standards to ensure adequate safety, value adding and cost effectiveness for petroleum industry developments and operations; DNV-RP-G101 : Risk-based inspection (RBI) of offshore topsides static mechanical equipment – a decision-making technique for inspection planning based on risk.		Ability to adapt to changing conditions during and after extraordinary stress and strain. The properties that characterize resilient societies are robustness, redundancy and the ability to respond rapidly.	
The United Kingdom <i>Appendix 3</i>	The ability of a system or organisation to withstand and recover from adversity. National Resilience Capabilities Programme - core framework through which the UK Government seeks to build resilience across the UK to meet the generic consequences of a wide range of civil emergencies, including catastrophic impact attacks. In particular, guidance is offered on: 1) Infrastructure resilience; 2) Community resilience; 3) Business Continuity; 4) Corporate	Infrastructure Resilience programme - to enable public and private sector organisations to build the resilience of their infrastructure, supply and distribution systems to disruption from all risks (hazards and threats).	A resilient organisation is one that is still able to achieve its core objectives in the face of adversity through a combination of measures. Emphasis on BCM . BCM is defined as a process that helps manage risks to the smooth running of an organisation or delivery of a service, ensuring continuity of critical functions in the event of a disruption, and effective recovery afterwards. British business continuity	Community (societal) resilience - communities using local resources and knowledge to help themselves during an emergency in a way that complements the local emergency services. The guidance ' <i>Resilience in society: infrastructure, communities and businesses</i> ' encourages communities to become better prepared to cope with emergencies, and makes available to communities various tools, including: 1) Strategic national framework on community resilience; 2) Preparing for emergencies: guide for communities; 3) Community	Local Enterprise Partnerships (LEPs).

Region/Country	Concept of Resilience	CI Resilience and Technical Resilience	Organisational Resilience	Social/Societal Resilience	Economic Resilience
	resilience: small/medium enterprises (SME) resilience strategy.		management standard (BS25999) is a code of practice that establishes the process, principles and terminology of business continuity management (BCM), providing a basis for understanding, developing and implementing business continuity within an organisation.	emergency plan toolkit; 4) Community emergency plan template.	
Africa <i>Appendix 4</i>	The ability of countries, communities, and households to cope and manage change, by maintaining or transforming living standards in the face of droughts without compromising their long-term prospects (IGAD). The capacity of vulnerable households, families, communities and system to face uncertainty and the risk of shocks, to withstand and respond effectively to shocks, as well as to recover and adapt in a sustainable manner (AGIR).	Community Infrastructural Upgrading Programme to assist the local authorities to improve the overall resilience of the city by upgrading the infrastructure.	Study for building resilience in the Malawian co-operative movement (2014) evaluated organisational resilience by assessing four dimensions: 5 membership which share the same values such as self-help and equality; 6 ability to develop collective skills; 7 ability to establish networks among other co-operatives and among external agencies; 8 ability for innovation which improves existing goods and enables to access credit.	Different international and regional programs aimed at building social/societal resilience, especially regarding societies' vulnerability towards food deprivation.	Different programs initiated by International Monetary Fund and the African Development Bank Group aimed at increasing economic resilience of local society.
China <i>Appendix 5</i>	Focus on disaster risk management and reduction by implementing disaster monitoring, early warning and forecast systems, civil engineering measures, emergency response, recovery and reconstruction, etc.	Focus on disaster defence and resistance. Earthquake-proof evaluation management system. Cross-country constructions of disaster resilience infrastructures: drainage tunnel in Northern Hong Kong Island, Huangpu river	Business continuity and resilience concepts are relatively new in the country.	Different initiatives aimed at increasing social/societal resilience of local communities, such as: 5 disaster reduction education; 6 disaster emergency response and relief contingency plans; 7 community disaster risk and hidden danger inspection; 8 self-aid and mutual aid for disaster prevention and reduction; 9 installation of flood warning	The country is part of a macroeconomic surveillance initiated by the Macroeconomic Research Office and examines regional economic situations helping governments to detect and reduce financial risks.

International Survey

Region/Country	Concept of Resilience	CI Resilience and Technical Resilience	Organisational Resilience	Social/Societal Resilience	Economic Resilience
Indonesia <i>Appendix 5</i>	Focus on disaster risk reduction .	levee, seawalls, advanced flood information control system in Shanghai. Protection and strengthening of critical public infrastructures; Mainstreaming disaster risks into planning procedures for key infrastructure projects; Principle of “building back better”.		systems. Focus on enhancing the emergency response capacity of people; Disaster education in schools; Introduction of early warning systems, spatial plan regulation, repair of evacuation roads; Extensive risk mapping, evacuation planning, contingency planning, emergency response training and disaster simulations; Sister Village program.	The country is part of a macroeconomic surveillance initiated by the Macroeconomic Research Office and examines regional economic situations helping governments to detect and reduce financial risks.
Japan <i>Appendix 5</i>	Resilience is defined as disaster prevention and mitigation, swift recovery and reconstruction from disasters and enhancement of Japan’s international competitiveness. Instead of avoiding looking at possible natural threats, Japan should “face them squarely”. Resilience is secure social and economic systems that will never become dysfunctional in any event, secure lives and property of local residents, [protected] industrial competitiveness and economic growth, and at the same time ability of both the national and local governments and the private sector to enhance their capacity to address changes in circumstances and increase their	Resilient infrastructure is defined using four qualities: resistance, reliability, redundancy, response and recovery. Focus on early anomaly detection to increase critical infrastructure resilience. This is implemented by making use of technologies including sensor, robot and non-destructive testing to grasp, accumulate and use data of damages, etc. of various infrastructures such as critical infrastructure for life, public infrastructure and industrial infrastructure. Emphasis of the importance of sharing of information about system failures, cyber-	Organisational resilience is closely linked to the concepts of BCM and BCP. Japanese companies are encouraged to establish four plans: 1. Business Continuity Plan 2. Plan for Implementing Proactive Measures 3. Plan for Implementing Education and Training 4. Plan for Implementing Review and Improvement. Business Continuity Guidelines enables enterprises to check their good practices in business continuity in accordance with the Guidelines (for a detailed checklist see Appendix 5).	Citizens are encouraged to be actively involved in the process of building national resilience; At the center of social resilience paradigm in Japan is the importance of information sharing and public awareness; Japan implements disaster prevention education at schools; Government works with the private sector, non-profit organisations and citizens to conduct annual preparedness exercises; Citizens are encouraged to maintain a week’s reserve of food, water and medication.	Economic paradigm is based on National Resilience. In the aftermath of 2011 disaster, building resilience in Japan in both the private and public sectors has become explicitly and powerfully linked to renewable energy systems and their enabling storage and transmission technologies. Other private sector investments include earthquake-proofing of buildings and equipment, reinforcement of transport systems (roads and railroads), disaster-relief robotics, communication resilience, and training of special leadership. Moreover, Japan earns from exporting resilient infrastructures and services to other countries.

Region/Country	Concept of Resilience	CI Resilience and Technical Resilience	Organisational Resilience	Social/Societal Resilience	Economic Resilience
	productivity and efficiency.	attacks, threats and vulnerabilities between critical infrastructure operators and CEPTOAR.			
Philippines <i>Appendix 5</i>	Ability of a system, community or society exposed to hazards to resist, absorb, accommodate and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions.	Resilient infrastructure is able to absorb a disturbance or disaster and still retain its structural capacity and its ability to perform its basic function. Resilient infrastructures depend on structural and non-structural measures and systems that in their totality allow continued operation or use of the structure in the event of a natural disaster. Focus on retrofitting guidelines that allow for a certain level of damage to be acceptable and make strengthening possible and cost effective (as compared to rebuilding) for as many structures as possible. In the guidelines, the Life Safety (LS) structural performance level is used for evaluating existing buildings. The LS performance level implies significant damage to the structure is expected to occur, given a particular level of ground shaking, but some margin against either partial or total structural collapse		Disaster risk reduction and management education in the school curricula of secondary and tertiary level of education. Various disaster risk reduction and management activities, such as organising quick response groups, particularly in identified disaster-prone areas. Nationwide earthquake drills, search and rescue exercises.	

International Survey

Region/Country	Concept of Resilience	CI Resilience and Technical Resilience	Organisational Resilience	Social/Societal Resilience	Economic Resilience
Canada <i>Appendix 6</i>	Resilience is defined as the capacity of a system, community or society potentially exposed to hazards to adapt, by resisting or changing in order to reach and maintain an acceptable level of functioning and structure. Resilient capacity is built through a process of empowering citizens, responders, organisations, communities, governments, systems and society to share the responsibility to keep hazards from becoming disasters.	remains. Principle of “building back better”. National Strategy for Critical Infrastructure, an Action Plan for Critical Infrastructure lists a number of initiatives: 1. The establishment of sector networks covering the ten CI sectors nominated in the national strategy document; 2. The establishment of a National Cross-Sector Forum to promote collaboration across the sector networks; 3. The establishment of a Federal/Provincial/Territorial (FPT) CI Working Group as a standing forum for FPT government collaboration on matters of CI resiliency; 4. The establishment of an information sharing framework to accelerate sharing, and improve quality and protection of CI information; 5. Conduct risk assessments of CI in cooperation with governments and the private sector; 6. The development of sector specific work plans to address CI risks; 7. Conduct collaborative national exercises in support of a common approach to enhancing resiliency of CI; 8. Collaborate to monitor	Emergency management governance structure that can be applied either at a federal, or a provincial/territorial level of government. Privacy Emergency Kit to provide guidance to organisations to help enhance the timeliness and content of communications during an emergency while giving people confidence that their personal information will be handled appropriately.	There is ongoing academic research in Canada in the field of societal resilience. The most prominent is the Successful Societies Programme (SSP) of the Canadian Institute for Advanced Research. Individual citizens are responsible for being prepared for disasters. As a part of preparing citizens for disasters and enabling them to be self-sufficient for at least 72 hours after a disaster takes place. The National Public Alerting System (NPAS) is a multi-channel federal/provincial/territorial (FPT) all-hazards system. Cross-Cultural Roundtable on Security is another government initiative that was created to engage Canadians and the Government of Canada in a long-term dialogue on matters related to national security. Other resilience implementation measures: Hazard mapping; Adoption and enforcement of land use and zoning practices; Implementing and enforcing building codes; Flood plain mapping; Reinforced tornado safe rooms; Burying of electrical cables to prevent ice build-up; Raising of homes in flood-prone areas; Disaster mitigation public awareness programs; Insurance programs.	Key measures of economic resilience: 1. Job creation; 2. Economic growth; 3. Stability of financial sector; 4. Low public debt. A resilient financial system is dependent on close collaboration between financial institutions, and to facilitate collaboration, the Canadian Cyber Incident Response Centre (CCIRC) was established.

Region/Country	Concept of Resilience	CI Resilience and Technical Resilience	Organisational Resilience	Social/Societal Resilience	Economic Resilience
		implementation of the national strategy. Measures to enhance CI resilience: • identify risks to critical infrastructure and interdependencies; • assess and prioritize risks; • take mitigative or protective measures to reduce risks and the potential for disruptions; • conduct exercises to assess measures and identify strengths and areas of improvement; • refine and upgrade critical infrastructure plans in all sectors; • result in swift and more effective response and recovery efforts when disruptions occur.			
Australia <i>Appendix 7</i>	Disaster resilience is defined as the ability of government, communities, businesses and individuals to prepare for, respond to, and manage potential hazards and disasters, thereby minimising impacts and rapidly recovering to emerge stronger and better able to cope with future disaster events. In order to achieve disaster resilience, Australia has developed a disaster resilience strategy, which focuses on	Focus on organisational resilience in order to achieve critical infrastructure resilience and not technical resilience. CIR means coordinated planning across sectors and networks; responsive, flexible and timely recovery measures; and the development of an organisational culture that has the ability to provide a	The Australian Government approach to CIR goes beyond risk management and business continuity planning to also address hazards and risks that are unforeseen or unexpected. The resilience approach builds capacity within organisations to not only effectively respond to a crisis, but also be able to learn and adapt from an event. It is further argued that CIR is achieved undertaking traditional risk management/business	The National Strategy for Disaster Resilience describes disaster resilient communities as communities where: 1. People understand the risks that may affect them and others in their community and they take action to prepare for disasters and are adaptive and flexible to respond appropriately during emergencies; 2. People have taken steps to anticipate disasters and to protect themselves, their assets, and their livelihoods; 3. People work together with local	Resilience is the financial system's capacity to adjust to both the normal business cycle and a severe economic shock. A resilient system does not preclude failure, nor necessarily imply price stability. Rather, a resilient system can adjust to changing circumstances while continuing to provide core economic functions, even during severe but plausible shocks. In a resilient system, individual institutions in distress should be resolvable with

International Survey

Region/Country	Concept of Resilience	CI Resilience and Technical Resilience	Organisational Resilience	Social/Societal Resilience	Economic Resilience
	enhanced partnerships, shared responsibility, understanding risks and disaster impacts, and an adaptive and empowered community.	minimum level of service during interruptions, emergencies and disasters, and return to full operations quickly. The Australian Government takes a non-regulatory approach to critical infrastructure. Based on this approach, the owners and operators of critical infrastructure are best in place to manage risks to their operations and determine the most effective mitigation strategies.	continuity practices and organisational resilience initiatives. Organisational resilience is defined as ability of organisations to absorb event that necessitates change, adapt and continue to maintain competitive edge and profitability. Information sharing is considered to be of key importance to achieving CIR. Trusted Information Sharing Network was established by the Australian Government in 2003 and provides a secure environment in which critical infrastructure owners and operators across seven sector groups meet regularly to share information and cooperate within and across sectors to address security and business continuity challenges. Five core resilience principles: - Resilience needs to be defined not only as an ability to “bounce back” from disaster, but also as an ability to “bounce forward” – i.e. creating positive change after the disaster; - Resilience is dynamic and emerges from the complex interaction between a wide range of organisational attributes;	leaders, using their knowledge and resources to prepare for and deal with disasters, and use existing community networks. Strong social networks that offer support to individuals and families in a time of crisis lead to resilient communities; - Work in partnership with emergency services; - The emergency management volunteer sector is strong; - Businesses have wide reaching business continuity planning; - Land use planning reduces community exposure to known hazards; - And people understand the mechanisms and processes through which recovery assistance may be made available and they appreciate that support is designed to be offered in the first instance to the most vulnerable community members. Common characteristics of resilient communities are: individuals and organisations functioning well while under stress; successful adaptation; self-reliance; and social capacity.	minimal costs to depositors, policy holders, taxpayers and the real economy. The Australian Bureau of Statistics measures the resilience of the Australian economy over time. They use multifactor productivity, which measures growth in output relative to the growth in inputs, as their headline progress indicator for a resilient economy as “an economy with a lower level of productivity is less capable at withstanding and recovering from economic downturns. Other indicators used are flexibility, measured by the average duration of unemployment, stability, measured by consumer price index, and prudent finance measured by total capital base ratio.

Region/Country	Concept of Resilience	CI Resilience and Technical Resilience	Organisational Resilience	Social/Societal Resilience	Economic Resilience
New Zealand Appendix 7	Resilience is how we withstand, adapt and 'bounce back' in response to a disaster. A resilient community is one which expects and is well prepared for an adverse event; they can cope well with the disruption and recover quickly. Everyone has a role to play in creating a resilient community. Resilience is an "adaptive capacity" — that is, society's capability to draw on its individual, collective and institutional resources and competencies to cope with, adapt to and develop from the demands, challenges and changes encountered before, during and after a disaster.	'4Rs' approach to infrastructure, namely risk reduction, readiness, response and recovery. 8 attributes of infrastructure resilience: 1. Service delivery; 2. Adaptation; 3. Community preparedness; 4. Responsibility; 5. Inter-dependencies; 6. Financial strength; 7. Continuous 8. Organisational performance. Implementation of resilience concepts in the context of infrastructure is built upon three principles: better understanding of the services	• Diversity in CI organisations means that different mixes of resilience attributes may be needed to achieve optimal resiliency. This mix is best determined by CI operators and owners; • An all hazards, all threats approach better prepares for unforeseen events; • Resilience in mature organisational systems may require a cultural change and active strategies to develop and foster resilience attributes may be necessary.	Resilient communities are able to plan for, respond to and thrive after a disastrous event. At the heart of a resilient community is a robust set of social networks which help people address the challenges in their day-to-day lives, as well as those that occur in times of extreme stress. Three strategic objectives for increasing social/societal resilience: Build capacity, Increase connectedness, and Foster cooperation. Society is resilient if the following attributes are present before, during and after an emergency event: 1. Communities are connected and work together toward shared goals; 2. Individuals and social structures are engaged and empowered to make a difference; 3. Communities have clear channels of communication to link into	The Economics of Resilient Infrastructure (EoRI) project – a government funded research project which focusses on the cities of Auckland and Christchurch. The objectives of the project are to develop a tool which can be used to quantify the economic impact of infrastructure failure.

International Survey

Region/Country	Concept of Resilience	CI Resilience and Technical Resilience	Organisational Resilience	Social/Societal Resilience	Economic Resilience
		to deliver in the future; improve how we manage our existing assets; and ensure we have the right settings to make better investment decisions in the future		physical and social resources; 4. Communities have realistic expectations of the levels of support available during an event; 5. Communities take actions to reduce the impacts of hazards; 6. Communities have strong and trusting partnerships with each other and with WREMO; 7. Private, public and community sectors are prepared to respond effectively and return to business quickly; 8. The region's local governments have the capacity and capability to effectively manage a large response and recovery while supporting community-driven efforts; 9. People feel a sense of place and belonging in their community. In times of stress people want to stay.	
Brazil Appendix 8	Resilience is often defined as the ability of a person, community, institution, company, or system to adapt and survive, regardless of what kind of stress or adverse condition they might experience.		At the present state of the concept, Organisational resilience in Brazil is restricted to some business continuity management and disaster recovery programs offered by private companies.	During the <i>Rio de Janeiro: Searching for Resilience to Heavy Rains</i> campaign, several actions were implemented in order to achieve resilience of the locals to heavy rains, in line with 5 key priorities defined by the Hyogo Protocol: • Make disaster risk reduction a priority • Assess risk and make decisions • Build self-awareness and self-consciousness • Reduce risk • Be ready to act.	Economic and financial resilience is a capacity to resist or resume the normal functioning after economic recessions or severe downturns of the stock market. This kind of situations might have more or less severe consequences, depending on the ability to adapt to new economic circumstances.
Chile Appendix 8	Resilience is the capacity of a system, community or society, while exposed to a hazardous event, to resist, absorb, adapt and	Chile's building codes require that all new buildings must withstand a 9.0-magnitude earthquake — eventually		Installation of Early Warning and Civil Protection Systems in order to face emergencies such as evacuation of the coastline for tsunami warnings,	Chile has a flexible exchange rate which means that in the case of an important setback in capital flows the national currency <i>peso</i> will

Region/Country	Concept of Resilience	CI Resilience and Technical Resilience	Organisational Resilience	Social/Societal Resilience	Economic Resilience
	recover from its effects in a timely and effective manner, which includes the preservation and restoration of their structures and basic functions. The concept of resilience exists, however is poorly developed, with the most noticeable advances in the area of urban planning and design (earthquake resistant construction techniques and urban planning).	suffering cracking and tilting, but being able not to collapse.		snowfall in the south, etc.	depreciate. The monetary policy is based on a flexible inflation-targeting scheme in a context of low inflation, and the strong position of the financial system provide ample room for such depreciation, as evidenced in 2008-09 during the global financial crisis. Chilean government has ample capacity to borrow abroad if necessary that, in conjunction with the facts mentioned above, this makes Chile little vulnerable to financial crises
Argentina Appendix 8		Technical resilience efforts are mostly canalized in: - providing technical means for - relocation programmes, - assessing the water balance in vulnerable areas, and - climate resistant agriculture - improving drainage and urban planning to facilitate green space development and air movements, - adjusting building designs to a warmer climate.		After 2003 floods in Santa Fe, civil society began to join into groups that supported the regional process of awareness, risk reduction training, development of an emergency plan, and the creation of risk maps for the community.	Economy is primarily connected with the possibility to create a network of local, often barter, markets. During the 2001 economic collapse, these markets self-organized to create a flow of trade of necessary goods and services, when access to standard currency was radically reduced and even ultimately removed from society. Another resilience force is associated with community cooperatives, which must be formed to provide the means for a higher level of local function and, thus, greater regional stability. During an economic crisis, markets and cooperatives must function together to create a culture of mutual cooperation, to decrease tensions and conflict and to safeguard the basic needs of every individual within the community

International Survey

Region/Country	Concept of Resilience	CI Resilience and Technical Resilience	Organisational Resilience	Social/Societal Resilience	Economic Resilience
The United States of America Appendix 9	The ability to adapt to changing conditions and withstand and rapidly recover from disruption due to emergencies. Whether it is resilience towards acts of terrorism, cyber-attacks, pandemics, and catastrophic natural disasters, our national preparedness is the shared responsibility of all levels of government, the private and non-profit sectors, and individual citizens	The ability to reduce the magnitude and/or duration of disruptive events. The effectiveness of a resilient infrastructure or enterprise depends upon its ability to anticipate, absorb, adapt to, and/or rapidly recover from a potentially disruptive event. Critical infrastructure resilience is characterized by three key features: 1. Robustness: the ability to maintain critical operations and functions in the face of crisis; 2. Resourcefulness: the ability to skillfully prepare for, respond to an manage a crisis or disruption as it unfolds; 3. Rapid recovery: the ability to and/or reconstitute normal operations as quickly and efficiently as possible after a disruption. Protection and resilience are not opposing concepts. On the contrary, according to the document they represent complementary and necessary elements for a comprehensive risk management strategy. CIR embedded in the framework of public-private partnerships.	Organisational resilience as the adaptive capacity of an organisation in a complex and changing environment. Resilience is the ability of an organisation to resist being affected by an event or the ability to return to an acceptable level of performance in an acceptable period of time after being affected by an event. Resilience is the capability of a system to maintain its functions and structure in the face of internal and external change and to degrade gracefully when it must. The most important document related to organisational resilience in the US is the ASIS SPC.1-2009 Organisational Resilience Standard. The Standard adopts the Plan-Do-Check-Act (PDCA) model, which is applied to structure the organisational resilience management system processes. The Standard provides recommendations for any type of organisation to identify and develop best practices to assist and foster action in 15 areas. FEMA also helps enhance organisational resilience with its Ready campaign and its preparedness certification programme for business. Launched in February 2003, FEMA's Ready was a national	The terms 'social', 'societal' and 'community' resilience are used interchangeably to refer to the capacity to reduce the negative societal consequences of loss of critical services. Sponsored by FEMA, National Preparedness Month encourages US citizens to take steps to prepare for emergencies. FEMA's Ready campaign disseminates information to help the general public prepare for and respond to emergencies, including natural disasters and potential terrorist attacks. The PrepareAthon! helps to build a more resilient nation by increasing the number of individuals who understand the type of disasters that could happen within their respective communities, sharing information on what measures should be taken in order to mitigate the damage from such incidents and encouraging citizens to participate in community resilience planning. The National Institute of Standards and Technology (NIST) released a draft (which was open for comments until June 26, 2015) of a 'Community resilience planning guide,' which provided a practical and flexible approach to help communities to allocate resources for disaster preparedness and improve their resilience through increased awareness of hazard risks.	Economic resilience is defined as an area's ability to prevent, withstand, and quickly recover from major disruptions (i.e., 'shocks') to its economic base. Thus, the economic resilience concept does not solely focus on the aspect of recovery. The ability to recover quickly from a shock, the ability to withstand a shock and the ability to avoid the shock altogether should all, according to the US Economic Development Administration, be seen as primary attributes of economic resilience. Office of Economic Resilience (OER) helps communities build 'resilient economies' by enhancing quality of place, advancing job creation strategies, reducing housing/transportation/energy consumption costs, promoting clean energy solutions and creating economic opportunities. OER has produced an economic resilience planning evaluation tool to guide communities' and regions' economic development plans.

Region/Country	Concept of Resilience	CI Resilience and Technical Resilience	Organisational Resilience	Social/Societal Resilience	Economic Resilience
			public service advertising campaign designed to educate and empower Americans to prepare for and respond to human-made and natural disasters.		

7.3. Resilience Assessment Tools and Models

Table 7.2 provides an overview of resilience assessment tools and models collected while performing the international survey. This information will serve as an input for the Work Package 2 of the current project.

Table 7.2 Resilience assessment tools and models.

Organisation/Author	Title of the Tool/Model	Dimension(s) of Resilience	Methodology/Description	Indicators
Food and Agriculture Organisation of the United Nations (FAO) (Africa, Appendix 4)	Resilience Index Measurement and Analysis (RIMA) Model	Social/societal resilience	RIMA identifies and weighs factors that make a household resilient to shocks affecting their food security. The RIMA model is an econometric approach that builds on the Resilience Index.	This index weighs the six dimensions that contribute to household resilience: 5 Income and Food Access (IFA); 6 Access to Basic Services (ABS); 7 Assets (AST); 8 Adaptive Capacity (AC); 9 Social Safety Nets (SSN); 10 Sensitivity (S) to shocks.
Resilience African Network (Africa, Appendix 4)	Societal resilience assessment framework	Social/societal resilience	Qualitative	Assesses the resilience of the examined community based on 9 dimensions: 1) wealth, 2) psychosocial, 3) health/health services, 4) natural resources/environments, 5) infrastructure, 6) governance, 7) security/protection/advocacy, 8) human capital, 9) social capital/community networks.
Government of Indonesia (2006). National Action Plan for Disaster Reduction 2006-		Social/societal resilience; Economic resilience; Environmental resilience.	No information available	In the context of resilience against disaster, the success of disaster risk reduction can be measured with the following indicators:

International Survey

Organisation/Author	Title of the Tool/Model	Dimension(s) of Resilience	Methodology/Description	Indicators
2009. (Indonesia, Appendix 5)				(1) Distribution of income levels (2) Level of education (3) Level of use of medical services (4) Level of unemployment (5) Availability and resilience of housing (6) Birth and mortality rates of social groups (7) Quality of life (8) Survival (9) Environmental resilience (10) Local economic resilience.
National Resilience Promotion Headquarters (2013) (Japan, Appendix 5)	Guidelines for Assessment of Vulnerability to Large-scale Natural Disasters	Holistic approach to resilience	- Assess each sector of measures concerning national resilience. Targeted individual sectors of measures are 12: administrative functions/police and fire services; housing and cities; healthcare and welfare; energy; finance; information and communications; industrial structures; transportation and logistics; agriculture, forestry and fisheries; national land conservation; environment; and land use (national land use)); and cross-cutting sectors are three (risk communication; countermeasures for aging infrastructure; and research and development. - Envisage the “worst events that should never happen” and cross-sectorally assess respective countermeasures. Vulnerability assessment is conducted while envisaging the worst events that should never happen. - Assess the required resources to be input, including human resources. - Conduct quantitative assessment in order to monitor the progress of measures. Using indicators to show progress when analysing the problems of each of the individual measures, and to select Key Performance Indicators (KPIs) for respective programs.	No information about KPIs was found.
Australian Government (Australia, Appendix 7)	Critical Infrastructure Protection Modelling and	CI resilience	The CIPMA program aims to improve an insight into the effects, in terms of service	There is no standard format that would be applicable for all the cases; rather each is tailored

Organisation/Author	Title of the Tool/Model Analysis (CIPMA)	Dimension(s) of Resilience	Methodology/Description	Indicators
			disruption, of natural or human-sourced disasters. The outcome of this program is a software tool that combines simulation models, databases, GIS and economic models. CIPMA is restricted to a rather limited range of critical infrastructure sectors, namely Energy, Telecommunications, Banking and Finance. Geographic Information System (GIS) functionality is at the core of CIPMA The methodology is focused on four main areas: 1. CI failure consequences: Economy and population consequences with GIS visualisation of the results, duration of failure, dynamics of critical infrastructure systems; 2. Single points of failure: Identification of particularly vulnerable points that can trigger important cascading effects; 3. Risks: Elaboration of risk maps; 4. Investment and mitigation strategies.	to the purposes of the project. The information needed for modelling and analysis is elicited via workshops.
Australian Government, Resilient Organisations (Australia, Appendix 7)	Organisational Resilience HealthCheck	Organisational resilience	Survey, online tool.	13 indicators divided between the three behavioural attributes to evaluate resilience. They are: • leadership, • employee engagement, • situational awareness, • decision making, • innovation and creativity, • effective partnerships, • leveraging knowledge, • breaking silos, • internal resources, • unity of purpose, • proactive posture, • planning strategies, • and stress testing plans.

International Survey

Organisation/Author	Title of the Tool/Model	Dimension(s) of Resilience	Methodology/Description	Indicators
Government of New Zealand, Resilient Organisations (New Zealand, Appendix 7)	Benchmark Resilience Tool	Organisational resilience	Survey tool. Intended to measure the resilience of an organisation, allowing them to benchmark against other organisations in the same or related industries.	Resilience consists of three interdependent attributes (1) Leadership and Culture ; (2) Networks and (3) Change Ready processes that build Business as Usual (BAU) effectiveness as well as robust and agile response and recovery from crises. 13 indicators divided between the three behavioural attributes to evaluate resilience. They are: • leadership, • employee engagement, • situational awareness, • decision making, • innovation and creativity, • effective partnerships, • leveraging knowledge, • breaking silos, • internal resources, • unity of purpose, • proactive posture, • planning strategies, • and stress testing plans.
Department of Homeland Security (The United States of America, Appendix 9)	Resilience Measurement Index (RMI)	CI resilience; Organisational resilience	Quantitative RMI is a descendant of an earlier index called the Resilience Index (RI). The RMI combines questions that have been developed on the basis of business continuity and resilience standards and specifically draw from following: 1. British Standards Institute 25999 Standard on Business Continuity; 2. NFPA 1600 Standard on Disaster/Emergency Management and Business Continuity Programs; 3. ANSI/ASIS SPC.1-2009 Standard on Organisational Resilience; 4. ISO 22301 Societal Security – Business Continuity Management Systems – Requirements	RMI organises the collected information into four groups (RMI Level 1), namely: preparedness, mitigation measures, response capabilities, and recovery mechanisms. Level 2: • Awareness, • Planning, • Mitigating construction; • Alternate site; • Resources mitigation measures; • Onsite capabilities; • Offsite capabilities;

Organisation/Author	Title of the Tool/Model	Dimension(s) of Resilience	Methodology/Description	Indicators
			15-2012. The Index is based on decision analysis and multi-attribute utility theory (MAUT). This indicator can be used: 1. Alone for addressing the resilience of a specific facility; 2. In combination with PMI and CMI to characterise overall risk; 3. For addressing regional resilience; For guiding decisions for special events and domestic incidents.	• Independent management and command center characteristics; • Restoration agreements; • Recovery time. Level 3 consists of 29 indicators (see Appendix 9)

8. Conclusions

There is no consensus within scientific community about resilience or its correlates. Different authors argue for different definitions of resilience, which indicates how contested and ambiguous the concept is. While analysing the evolution of the concept, three facets of resilience were found in the literature, namely engineering resilience, ecological resilience, and social-ecological resilience. Resilience has been defined in two broad ways: as a desired outcome, or as a process oriented towards a desired outcome. An overview of resilience concepts in six continents allows concluding rather different levels of maturity of the concept in different countries. For example, the concept of resilience is clearly defined in Australia, New Zealand, Japan, or the US. On the other hand it is almost non-existent in Africa or South America.

In resilience literature, the concept of resilience was found to have close links with the concept of vulnerability. However, whether resilience and vulnerability are treated as distinct or closely related concepts depends on how one defined the two terms. Three approaches to this relationship were identified in the literature: resilience and vulnerability are treated as the opposite poles of the same continuum; the two concepts are viewed neither as mutually inclusive, nor mutually exclusive; resilience and vulnerability are treated as distinct notions measuring fundamentally different properties of a system.

Collected information discussing five dimensions (technical, organisational, social/societal, economic, and ecological) of community resilience shows how different components within the same community require different approaches of resilience. As discussed above, each of the dimension contains various and at times contradictory definitions and approaches. Moreover, different authors suggest diverse set of models and indicators aimed at measuring technical, organisational, social/societal, economic, and ecological resilience of communities.

When it comes to the concept of CI resilience, no commonly accepted definition exists. There are also only several existing national, official definitions of the concept. The concept of critical infrastructure is usually associated with the concepts of “system resilience”, “technological resilience”, “technical resilience”, “engineering resilience”, etc. The research field draws heavily from the engineering field and definitions of resilience from the technical or system point of view. However, acknowledging that critical infrastructures do not exist and function in isolation and are rather an integral part of any community, it is crucial to link the concept of critical infrastructure resilience with social, economic and organisational resilience. Therefore, it is one of the goals of the project IMPROVER to establish definitions that are inclusive and transferable across borders, infrastructures, and between the asset level and the policy level.

Implementation and assessment of resilience concepts are also rather complicated. During personal interviews with critical infrastructure operators around Europe, we found out that resilience is not a well established concept in the context of critical infrastructure, and the concept is implemented and measured only indirectly in Europe. While conducting scientific as well as region-based literature overview, we found several tools and models for evaluating and measuring resilience. However, there are a rather limited number of freely available tools, and only limited information about them is publicly available. Moreover, they tend to cover specific concepts of resilience (for example, social/societal or organisational resilience), and are limited to a region/country (for example, Resilience Index Measurement and Analysis Model in Africa). Therefore, it is the goal of the following work packages of the project to design a more complete method to cover the various aspects relevant to CI resilience.

Appendix 1

A summary of the resilience indicators used in Relative Overall Resilience model. Source: McManus 2008, pp. 134. Attribute	Resilience Indicator		Description
Situation Awareness	Roles & Responsibilities	SA ₁	Awareness of roles and responsibilities of staff internally in an organisation and the roles and responsibilities of the organisation to its community of stakeholders.
	Hazards & Consequences	SA ₂	Awareness of the range of hazard types and their consequences (positive and negative) that the organisation may be exposed to.
	Connectivity Awareness	SA ₃	Awareness of the links between the organisation and its entire community of stakeholders, internally (staff) and externally (customers, local authorities, consultants, competitors etc.).
	Insurance	SA ₄	Awareness of the obligations and limitations in relation to business interruption insurance and other insurance packages that the organisation may have or have available.
	Recovery Priorities	SA ₅	Awareness of the minimum operations requirements and the priorities involved in meeting those requirements, together with expectations of key stakeholders.
Keystone Vulnerabilities	Planning	KV ₁	The extent to which the organisation has participated in planning activities including risk management, business continuity and emergency management planning
	Exercises	KV ₂	The extent to which the organisation has been involved in external emergency exercises or created exercises internally for staff and stakeholders.
	Internal Resources	KV ₃	The capability and capacity of physical, human and process related resources to meet expected minimum operating requirements in a crisis. Includes economic strengths, succession and structural integrity of buildings.
	External Resources	KV ₄	The expectations of the organisation for the availability and effectiveness of external resources to assist the organisation in a crisis.
	Connectivity	KV ₅	The extent to which the organisation has become involved with other critical organisation to ensure the availability of expertise and resources in the event of a crisis.
Adaptive Capacity	Silo Mentality Management	AC ₁	The degree to which the organisation experiences the negative impacts of silo mentality and the occurrence of strategies in place for mitigating them.
	Communications & Relationships	AC ₂	The effectiveness of communication pathways and relationships with all stakeholders, both internally and externally in day-to-day and crisis situations.
	Strategic Vision	AC ₃	The extent to which the organisation has developed a strategic vision for the future operations and the degree to which that is successfully articulated through the organisation.

International Survey

	Information & Knowledge	AC ₄	The degree to which information and knowledge is acquired, retained and transferred throughout the organisation and between linked organisations.
	Leadership & Management	AC ₅	The degree to which leadership and management encourage flexibility and creativity in the organisation and how successful decision making is in times of crisis.

Summary of interview prompt questions. McManus 2008, A-1/A-2.

- What level of knowledge do staff have of their own individual roles and responsibilities in the organisation?
- What level of knowledge do staff have of other's roles and responsibilities in the organisation?
- How much flexibility do staff have in their roles and responsibilities in the organisation?
- What sort of hazards do you think this organisation is exposed to?
- What do you think the consequences of these events would be on the organisation?
- How well can you manage these events and what level of control do you think the organisation has over this?
- What degree of connection does this organisation have with its wider community of stakeholders?
- How well does the organisation engage with and seek to understand its staff?
- What level of business interruption insurance or external aid is available to the organisation?
- How suitable is this for the expected range of hazards and their consequences on the organisation?
- How well do you understand what the wider community is likely to expect of this organisation in a crisis situation?
- How well do you think that other organisations will be able to meet your requirements and demands in the aftermath of various crises?
- How well do you understand this organisation's importance to the community in the aftermath of a disaster relative to other organisations?
- Does this organisation engage in:
 - Risk management planning
 - Business continuity planning
 - Crisis management planning
- And is this from an all-hazards or a hazard specific perspective?
- How well integrated are existing planning strategies in the organisation?
- Who or what primarily drives this type of planning in the organisation?
- What does, or should, an emergency management plan look like for this organisation?
- What level of emergency management exercises does this organisation engage in? How frequently?
- What are the principle barriers to participation in exercises in this organisation?
- Are there any plans for alternative offices/space if your main premises are not able to be used?
- How well equipped is your emergency management office if you have one set up?
- How well prepared is this organisation for the loss of internal services such as power, telecommunications, water, sewerage etc.?
- How easy/difficult is it likely to be to engage/retain/recruit or support staff in the aftermath of a crisis?
- How well prepared is this organisation for the impacts on staff during and following a major crisis?
- How easy/difficult is it to retain/recruit staff at present?
- To what extent does this organisation engage in succession planning?

- How well prepared are staff for an emergency where day-to-day operations must continue while the crisis is dealt with?
- To what extent does the organisation have effective organisation wide systems and procedures?
- How do staff feel about using these systems and procedures?
- What is the general financial situation of the organisation?
- What sort of relationships does this organisation have with external organisations, including suppliers, service providers, emergency management organisations etc?
- What are the organisation's expectations of these same organisations in a crisis?
- How much has the organisation thought about the loss of external services and also the restoration of these services following any major outages?
- What specific preparations have been made to maintain and develop good relationships with critical stakeholders in this organisation?
- To what extent does this organisation experience the negative impacts of silo mentality and where does it primarily come from?
- How easily can staff communicate upwards and downwards through the organisation?
- How effective are communications and relationships between:
 - departments, business units, regional/national offices etc?
 - External stakeholders?
- Does the organisation have a strategic vision/mission statement?
 - How clearly is this articulated through the organisation?
 - How closely do day-to-day operations reflect this vision/mission
- To what extent is this vision likely to impact on the performance of the organisation during and after a crisis?
- What does recovery mean to the organisation?
- Describe the prominent decision making style in the organisation? How effective is this?
- What drives the decision making style and how successful is this likely to be/has already been in a crisis?

Appendix 2

Demographic and Background Information Questions. Source: Stephenson 2010, pp. 303.

Demographic	Item
Sex	Tick List Format: Are you male or female? – Male, Female
Age	Tick List Format: How old are you? - <20, 21-30, 31-40, 41-50, 51-60, 61+
Organisation Name	Open Format: What is the name of your organisation?
Hierarchical Level	Tick List Format: Which of these levels best describes your position within your organisation? – Senior manager, Middle manager, Team leader/supervisor, Staff
Job Title	Open Format: What is your job title?
Time in Industry	Tick List Format: How long have you worked in your industry? (please tick one) – Less than 1 year, 1-3 years, 4-10 years, 11-20 years, 21+ years
Time in Job	Tick List Format: How long have you worked at your organisation (please tick one) – Less than 1 year, 1-3 years, 4-10 years, 11-20 years, 21+ years
Industry Sector	Tick List Format: Which industry sector is your organisation in? – Accommodation, Administrative and support services, Agriculture forestry and fishing, Arts sports and recreation services, Construction, Education and training, Electricity gas water and waste services, Financial and insurance services, Government public administration and safety, Healthcare and social assistance, Information media and telecommunications, Manufacturing, Mining, Professional scientific and technical services, Rental hiring and real estate services, Retail trade, Transport postal and warehousing, Whole trade, Other (please specify)
Organisation Classification	Tick List Format: Which classification best describes your organisation? – Individual proprietorship, Partnership, Registered limited liability company (non Co-op), Cooperative companies, Joint ventures and consortia, Branches of companies incorporated overseas, Government owner trading entity, Central government, Local authority trading enterprise (LATE), Incorporated and unincorporated societies and associations, Charitable trusts, Trusts/estates, Consulates and foreign embassies, Other (please specify)
Locations	Open format: How many locations or sites does your organisation have?
Number of Staff	Tick List Format: How many full time people work in your organisation? (please tick one) – 1-5, 6-10, 11-50, 51-250, 251-500, 501-2000, 2001+
Crisis Experience	Tick List Format: Has your organisation experienced a crisis or emergency in the last 5 years? (please tick one) – Yes, No, Don't know
Crisis Memory	Open Format: In what year did the crisis occur?
	On the scale shown please rate, how severe your organisation's most recent crisis was for your organisation – We dealt with it as part of business-as-usual, It challenged us but was not overly disruptive, It definitely challenged

	us and was moderately disruptive, It definitely challenged us and was very disruptive, It could have shut us down permanently, Don't know
	Open Format: Please briefly describe what the crisis was, how long it lasted for and what the impact was on your organisation

Organisational resilience measurement. Source: Stephenson 2010, pp. 303-308.

Indicator	Item number	Item
Minimisation of Silos	AC1.1	People are encouraged to move between different departments or try different roles within our organisation to gain experience
	AC1.2	There is an excellent sense of teamwork and camaraderie in our organisation
	AC1.3	In our organisation, it is important that there are no barriers which stop us from working well with each other and with other organisations
	AC2.2	People in our organisation work with whoever they need to work with to get the job done well, regardless of departmental or organisational boundaries
Internal Resources	KV3.1	I believe that our organisation has sufficient internal resources to operate successfully during business-as-usual
	KV3.2	During business-as-usual resources are managed so that we are able to absorb a small amount of unexpected change
	KV3.3	When a problem occurs in our organisation, internal resources become more easily available at short notice and there is less red tape to deal with
Staff Involvement	KV7.2	Most people in our organisation feel responsible for the organisations effectiveness
	KV7.3	People in our organisation typically "own" a problem until it is resolved
Information & Knowledge	AC4.1	In our organisation, it is a priority that people have the information and knowledge they need to respond to unexpected problems that arise
	AC4.2	In our organisation, if something out of the ordinary happens, people know who has the expertise to respond
	AC4.3	In our organisation, we make a conscious effort to ensure that critical information (e.g. staff contact details) is available in a number of different formats and locations
	SA1.3	If key people were unavailable, there are always others who could fill their role

International Survey

	SA7.2	In our organisation, it is generally easy to obtain expert assistance when something comes up that we don't know how to handle
Leadership	AC5.1	I am confident that management would provide good leadership if our organisation was struck by a real crisis
	AC5.2	I believe people would accept decisions made by management about how our organisation should manage a crisis, even if they were developed with little consultation
	AC5.3	Managers constantly monitor staff workloads and reduce them when they become excessive
	AC5.4	Top management think and act strategically to ensure that our organisation is always ahead of the curve
	AC5.5	Top management in our organisation are good examples of professionals that we can aspire to learn from
	AC3.3	In our organisation we regularly take time from our day-to-day work to re-evaluate what it is we are trying to achieve
Innovation & Creativity	AC6.1	Our organisation actively encourages people to challenge and develop themselves through their work
	AC6.2	People in our organisation are known for their ability to use their knowledge in novel ways
	AC6.3	People in our organisation are rewarded for "thinking outside of the box"
Decision Making	AC7.1	Should problems occur, someone with the authority to act is always accessible to people on the front lines
	AC7.2	When we need to, our organisation can make tough decisions quickly
	AC7.3	In this organisation, the people most qualified to make decisions make them regardless of seniority
Situation Monitoring & Reporting	SA6.2	Our organisation proactively monitors what is happening in its industry to have an early warning of emerging issues
	SA6.3	Our organisation is successful at learning lessons from past projects and making sure these lessons are carried through to future projects
	RE1.3	Our organisation has a culture where it is important to make sure that we learn from our mistake and problems
	SA2.1	During an average day, people interact often enough to know what's going on in our organisation
	SA2.2	Managers actively listen for problems in our organisation

		because it helps them to prepare a better response
	SA3.1	In our organisation we are aware of how dependent the success of one area is on the success of another
	SA7.3	If something is not working well, I believe staff from any part of our organisation would feel able to raise the issue with senior management
Planning Strategies	KV1.1	Given our level of importance to our stakeholders I believe that the way we plan for the unexpected is appropriate
	KV1.3	Our organisation currently has people who perform the following roles (tick all that apply) – scored 0-4, 1 point for each of risk management, crisis management, emergency management, business continuity
	KV1.4.1	Does our organisation have a formal written crisis/emergency or business continuity plan?
	KV6.1	People in our organisation understand how quickly we could be affected by unexpected and potentially negative events
Participation in Exercises	KV2.1	Our organisation understands that having a plan for emergencies is not enough and that the plan must be practiced and tested to be effective
	KV2.2	People are generally able to take time off from their day-to-day roles to be involved in practicing how we respond in an emergency
	KV2.3	I believe that our organisation invests sufficient resources in being ready to respond to an emergency of any kind
Proactive Posture	SA1.2	Our organisation is able to shift rapidly from business-as-usual mode to respond to crises
	RE1.1	Our organisation is focused on being able to respond to the unexpected
	SA6.1	Whenever our organisation suffers a close call we use it as a trigger for self evaluation rather than confirmation of our success
	AC2.1	Our organisation is regarded as an active participant in industry and sector groups
	RE2.2	Our organisation is able to collaborate with others in our industry to manage unexpected challenges
External Resources	KV4.2	Our organisation has agreements with other organisations to provide resources in an emergency
	KV4.3	Our organisation has thought about and planned for support that it could provide to the community during an emergency

International Survey

	KV5.2	Our organisation keeps in contact with organisations that it might have to work with in a crisis
	KV5.3	Our organisation understands how it is connected to other organisations in the same industry or locations, and actively manages those links
Recovery Priorities	SA5.1	Our organisation has clearly defined priorities for what is important during and after a crisis
	SA5.2	I believe that our organisation's priorities for recovery from a crisis would be sufficient to provide direction for staff
	SA5.3	Our organisation clearly understands the minimum level of resources it needs to operate successfully
	SA3.3	Our organisation is conscious of how a crisis in our organisation would impact others

Reflective Business Performance Questions. Source: Stephenson 2010, pp. 308.

Indicator	Item
External Directors	Tick List Format: Does your organisation have external directors/trustees on its governing board? Yes, No, Don't know
Staff Satisfaction	Tick List Format: Has your organisation used a staff satisfaction survey or assessment in the last 2 years?
	Open Format: Please describe your score from the most recent staff satisfaction survey that your organisation took part in
Staff Turnover	Tick List Format: What is your organisation's average annual staff turnover over the last 5 years? – 0-5%, 6-10%, 11-20%, 21-40%, 41%+
Senior Management Turnover	Tick List Format: What is your organisation's average annual senior management turnover over the last 5 years? – 0-5%, 6-10%, 11-20%, 21-40%, 41%+
Skip logic question – for profit/not-for-profit organisations were separated from this point	Tick List Format: Which of the following best describes your organisation? – For-profit, Not-for-profit
For-profit Organisations Only	
Sales Growth Rate	Tick List Format: What is your organisation's average annual sales growth rate over the last 5 years? For each year, this is calculated as your organisation's annual increase in sales divided by the previous year's sales. – Less than 0%, 1-10%, 11-30%, 31-100%, 101%+, Don't know
Profit to Sales Ratio	Tick List Format: What is your organisation's average annual profit to sales ratio over the last 5 years? For each year, this is calculated as your organisation's net profit before tax divided by the total sales. – Less than 0%, 0-5%, 6-10%, 11-20%, 21%+, Don't know
Return on Investment	Tick List Format: What is your organisation's average annual return on investment (ROI) over the last 5 years? For each, this is calculated as your organisation's profit after tax, divided by its assets minus its liabilities. – Less than 0%, 0-5%, 6-10%, 11-20%, 21%+, Don't know
Not-for-profit Organisations Only	

Income Budget Increase	Tick List Format: By how much on average, has your organisation's income budget increased each year, over the last 5 years? – Less than 0%, 1-10%, 11-30%, 31-100%, 101%+, Don't know
Operating Surplus	Tick List Format: What is your organisation's average operating surplus as a percentage of its total income over the last 5 years? – 0-5%, 6-10%, 11-20%, 21-40%, 41%+, Don't know

Note: Only one senior manager from each organisation was asked to complete the reflective questions.



IMPROVED RISK EVALUATION AND IMPLEMENTATION OF RESILIENCE CONCEPTS
TO CRITICAL INFRASTRUCTURE

Appendix 3 - Resilience Concepts in EU/EEA

Editor:

L. MELKUNAITE (DBI)

Authors (in alphabetic order)

P. GATTINESI (JRC)

C. PURSIAINEN (UiT)

B. RØD (UiT)

Deliverable Number: D1.1

Date of delivery: May 31, 2016

Month of delivery: M12



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 653390

Coordinator:	David Lange at SP Sveriges Tekniska Forskningsinstitut (SP Technical Research Institute of Sweden)

Table of Contents

1	Executive Summary	98
2	Nomenclature	98
3	Resilience concepts in EU/EEA	99
3.1	EU disaster risk assessment	99
3.2	Concept of resilience in the EU	100
3.2.1	History of the concept of critical infrastructure resilience in the EU	101
3.2.2	Other Official Initiatives on Critical Infrastructure Resilience by the EU	103
3.2.3	Institutional Framework for Delivering Resilience	104
3.2.4	Implementation of Technical, Organisational, Social, Economic Resilience	104
4	Case Studies	105
4.1	Norway	105
4.1.1	Concept of Resilience	106
4.1.2	Institutional Framework for Delivering Resilience	108
4.1.3	Technical, Organisational, Social, Economic Resilience	108
4.1.4	Resilience Related Official Documents	109
4.2	Sweden	109
4.2.1	Concept of Resilience	110
4.2.2	Institutional Framework for Delivering Resilience	111
4.2.3	Technical, Organisational, Social, Economic Resilience	112
4.2.4	Resilience Related Official Documents	112
4.3	The United Kingdom	113
4.3.1	Concept of Resilience	114
4.3.2	Institutional Framework for Delivering Resilience	115
4.3.3	Technical, Organisational, Social, Economic Resilience	115
4.3.4	Resilience Related Official Documents	118
4.4	Denmark	118
4.4.1	Concept of Resilience	119
4.4.2	Institutional Framework for Delivering Resilience	119
4.4.3	Technical, Organisational, Social, Economic Resilience	120
4.4.4	Resilience Related Official Documents	120
5	Conclusions	120

1. Executive Summary

The current survey concerns the status of critical infrastructure resilience as a concept and practice in the European context. It does this by reviewing first the relevant developments in the European Union (including European Economic Area) context. After that, the review zooms in on three selected countries, Norway (EEA), Sweden (EU), the United Kingdom (EU), and Denmark (EU) to see whether this information will add something to the general European level. While the concept of resilience was found to be mature in the United Kingdom, Denmark was found to be the least advanced country in the field compared to other two Nordic countries.

2. Nomenclature

ABC	Automated border control systems
BCM	Business Continuity Management
CBRN-E	Chemical, Biological, Radiological, Nuclear and Explosives
CenCIP	Critical Infrastructure Protection Research
CI	Critical infrastructure
CIP	Critical Infrastructure Protection
CLES	Centre for Local Economic Strategies
CPNI	The Centre for the Protection of National Infrastructure
DEMA	Danish Emergency Management Agency
DG HOME	The Directorate-General for Migration and Home Affairs
DG MOVE	The Directorate-General for Mobility and Transport
DNV	Det Norske Veritas
ECHO	European Commission in order to authorize its Humanitarian Aid and Civil Protection department
EC-RRG	The Electronic Communications, Resilience and Response Group
EEA	The European Economic Area
ENISA	The European Union Agency for Network and Information Security
EPCIP	The European Programme for Critical Infrastructure Protection
ERNICIP	European Reference Network for Critical Infrastructure Protection
EU	European Union
FRONTEX	European Agency for the Management of Operational Cooperation at the External Borders
IACS	Industrial Automation and Control Systems
ICT	Information and Communication Technology
LEP	Local Enterprise Partnerships
LRF	Local Resilience Forums
LRF	Local Resilience Forums
MSB	Swedish Civil Contingencies Agency
NEAT	National Emergency Alert for Telecommunications
NOST	National Operational Staff
NPoCC	National Police Coordination Centre
NRA	National Regulatory Authorities
POC	Points of Contacts
RBI	Risk-based inspection
RDA	Regional Development Agencies
SEMA	Swedish Emergency Management Agency
SME	Small/medium enterprises
SPF	The National Board of Psychological Defence
SRSA	Swedish Rescue Services Agency

TISP The Infrastructure Security Partnership
 UK United Kingdom

3. Resilience concepts in EU/EEA

Critical infrastructure resilience is a relative new concept in the EU context, and no real policy in this field can be found. However, the issue has been indirectly on the EU agenda through other related concepts, such as critical infrastructure protection, civil protection and disaster risk management, as well as external development and humanitarian assistance. While we refer to this indirect discussion, we however concentrate on that part where critical infrastructure is somehow involved.

3.1. EU disaster risk assessment

There exists a considerable amount of EU policies contributing to disaster risk management. One of the most informative in the current context is the Commission document Overview of Natural and Man-made Disaster Risks in the EU, its first version published in April 2014⁴¹⁰. The document is a summary analysis of the national risk assessments of (so far) 18 Member States and associated countries, prepared by following a joint risk assessment methodology provided by the Commission⁴¹¹. Furthermore, the Joint Research Centre of the European Commission provided input to the report with its Overview of Disaster Risks that the EU faces⁴¹².

This April 2014 document starts from the assumption that the information from the national authorities is sufficient to make general conclusions about “the most important disaster risks that a large number of Member States are addressing, focusing in particular on risks with a cross-border dimension.” The guidelines set by the Commission informed that the Member States should consider all significant natural and man-made hazards that would occur “on average once or more every 100 years (i.e. annual probability of 1% or more) and for which the consequences represent significant potential impacts, i.e. number of affected people greater than 50, economic and environmental costs above €100 million, and political/social impact considered significant or very serious.”

On the basis of the national risk assessments, the document identifies twelve most addressed hazards as follows: (Natural hazards:) Floods, Severe weather, Wild/Forest fires, Earthquakes, Pandemics/epidemics, Livestock epidemics; (Man-made hazards:) Industrial accidents, Nuclear/radiological accidents; Transport accidents; Loss of critical infrastructure; Cyber attacks; Terrorist attacks.

In one section, the document discusses also emerging risks. These include climate change related hazards (including migration), space related hazards (space debris, space weather, near earth objectives), and anti-microbial resistance.

⁴¹⁰ European Commission (2014). The post 2015 Hyogo Framework for Action: Managing risks to achieve resilience: Overview of natural and man-made disaster risks in the EU. *Commission Staff Working Document*.
 /* SWD/2014/0134 final */

Available at: <http://eur-lex.europa.eu/legal-content/da/TXT/?uri=CELEX:52014SC0134>. Accessed: 2 May 2016.

⁴¹¹ European Commission (2010). Risk Assessment and Mapping Guidelines for Disaster Management. *Commission Staff Working Paper*. SEC(2010) 1626 final. Available at:
https://ec.europa.eu/echo/files/about/COMM_PDF_SEC_2010_1626_F_staff_working_document_en.pdf Accessed: 2 May 2016.

⁴¹² De Groeve, T. (2013). Overview of Disaster Risks that the EU faces. *Publications Office of the European Union, JRC Scientific and Policy Reports*. EUR 25822 EN.
 Available at: <http://publications.jrc.ec.europa.eu/repository/bitstream/JRC79415/lb-na-25822-en-n.pdf>
 Accessed: 2 May 2016.

International Survey

While all the above hazards could easily trigger critical infrastructure service disruptions, we may notice the loss of critical infrastructure is listed also as a separate category. That part in the document emphasizes the interconnected nature of critical infrastructure systems, especially energy networks, which rapidly cascade from one country to others. In their national risk assessments, the following countries were especially worried about critical infrastructure losses: Czech Republic, Germany, Ireland, the Netherlands, Poland, Sweden, and the United Kingdom.

The current survey concerns the status of critical infrastructure resilience as a concept and practice in the European context. It does this by reviewing first the relevant developments in the European Union (including European Economic Area) context. After that, the review zooms in on four selected countries, Norway (EEA), Sweden (EU), Denmark (EU), and the United Kingdom (EU), to see whether this information will add something to the general European level.

3.2. Concept of resilience in the EU

While there are several national-level definitions of the concept of critical infrastructure resilience in Europe⁴¹³, there is no official EU-level definition of *critical infrastructure resilience* (whereas, by contrast, there exist official definitions for the concepts of critical infrastructure itself as well as the concept of protection⁴¹⁴).

Yet we can find definitions of resilience related to other contexts. In most cases, resilience in the official EU documents refers to societal resilience in the context of EU's *external humanitarian and development assistance* programmes, related to the (already finalized) EU Strategy for Supporting Disaster Risk Reduction in Developing Countries⁴¹⁵.

This resilience-labelled activity takes place mostly under the EU's Climate action. The 2012 document on EU Approach to Resilience: Learning from food crises offers a straightforward generic definition on resilience: "Resilience is the ability of an individual, a household, a community, a country or a region to withstand, to adapt, and to quickly recover from stresses and shocks"⁴¹⁶.

This policy document was followed by an Action Plan. It understands the concept of resilience as the opposite to fragility, and "resilience should be seen as shifting points along a spectrum"⁴¹⁷.

To be sure, a more recent Communication from the Commission, called The post 2015 Hyogo Framework for Action: Managing risks to achieve resilience, takes up the issue of enhancing the EU's own "resilience to crises" alongside with its external assistance to developing countries⁴¹⁸.

⁴¹³ Several European definitions are collected in CIPedia, a wiki-based application develop within the FP7 project CIPRNet, see: <https://publicwiki-01.fraunhofer.de/CIPedia/index.php/Resilience>

⁴¹⁴ Council Directive (2008). Council Directive 2008/114/EC of 8 December 2008 on the identification and designation of European critical infrastructures and the assessment of the need to improve their protection. Available at: <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:32008L0114> Accessed: 2 May 2016.

⁴¹⁵ European Commission (2011). Communication from the Commission to the Council and the European Parliament of 23 February 2009 – EU strategy for supporting disaster risk reduction in developing countries. Brussels, 23.2.2009. COM (2009) 84 final. Available at: <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52009DC0084&from=EN>

⁴¹⁶ European Commission (2012). Communication from the Commission to the European Parliament and the Council. The EU Approach to Resilience: Learning from food security crises. *European Commission*. COM(2012) 586 final. Available at: http://ec.europa.eu/echo/files/policies/resilience/com_2012_586_resilience_en.pdf. Accessed: 2 May 2016. P. 5.

⁴¹⁷ European Commission (2013). Action Plan for Resilience in Crisis Prone Countries 2013-2020. *Commission Staff Working Document*. SWD(2013) 227 final. Available at: http://ec.europa.eu/echo/files/policies/resilience/com_2013_227_ap_crisis_prone_countries_en.pdf. Accessed: 2 May 2016. P. 1.

⁴¹⁸ European Commission (2014). Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. The post 2015 Hyogo Framework for

While related, these documents do not mention critical infrastructure, except a short notion on the importance of critical infrastructure *protection* in the last-mentioned document.

After this general section on resilience, in the following we consider mainly those EU-level actions and policies that are directly relevant to critical infrastructure resilience.

3.2.1. History of the concept of critical infrastructure resilience in the EU⁴¹⁹

The resilience discourse first started appearing in unofficial policy and scientific analyses in the mid-2000s in the context of crisis and disaster management, mostly by U.S. debates⁴²⁰. Regional Disaster Resilience: A Guide for Developing an Action Plan, The American Society of Civil Engineers/The Infrastructure Security Partnership (TISP), June 2006. To be sure, there can be found early examples already from the 1970s, where the concept was used especially in ecological studies and, rarely, in the context of disasters⁴²¹.

Soon, however, the concept also penetrated the field of critical infrastructure. The concept of resilience in the context of critical infrastructure is much less developed in the official EU policies than that of external humanitarian and development aid. The focus has only recently moved from protection to cover also resilience, and this paradigm change is not yet clearly visible or firmly institutionalised in official EU-level policies.

After 9/11 the concept of critical infrastructure *protection* became more widely prevalent in Europe, first in NATO, and soon thereafter also within the EU. After the 2004 Madrid and 2005 London terrorist attacks, the EU debate culminated in the development of the European Programme for Critical Infrastructure Protection (EPCIP) and its corresponding legislation in 2008⁴²² (for a detailed discussion, see Pursiainen 2009). At that time, the concept of *resilience* did not appear in policy documents. While the Green Paper (2005), which launched the EPCIP, recognizes that not all infrastructures can be protected from all threats, its solution is to prioritize the protective measures and protected objects instead of increasing resilience. Similarly, the Council Directive (2008) on CIP is marked by the same approach, and, consequently, by the absence of reference to resilience⁴²³.

However, as was the case with the concept of critical infrastructure protection, the EU followed the US with some years delay in adopting the resilience discourse in the context of critical infrastructure and EPCIP, in the wake of extensive floods in Europe and other effects of severe weather. In the 2012 Commission Staff Working Document on the Review of the EPCIP (of the DG Home), the concept of resilience plays already a rather prominent role. Resilience is here seen as a *cross-sectoral approach*, whereas the original EPCIP was, it is said in the document, based on a

Action: Managing risks to achieve resilience. *European Commission*. COM(2014) 216 final. Available at: http://ec.europa.eu/echo/files/news/post_hyogo_managing_risks_en.pdf. Accessed: 2 May 2016.

⁴¹⁹ This section is largely based on Pursiainen and Gattinesi (2014).

⁴²⁰ ASCE/TISP (2006). Regional Disaster Resilience: A Guide for Developing an Action Plan. *The American Society of Civil Engineers/The Infrastructure Security Partnership (TISP)*. Available at: http://content.asce.org/oldcefi2007/download/Binder_Handouts/Guide_for_an_Action_Plan_to_Develop_Regional_Disaster_Resilience.pdf. Accessed: 2 May 2016.

⁴²¹ Rose, A. Z. (2009). Economic Resilience to Disasters. *University of Southern California, CREATE Research Archive*. Available at: http://create.usc.edu/sites/default/files/publications/economicresiliencetodisasters_2.pdf. Accessed: 2 May 2016.

⁴²² Pursiainen, Christer, 2009. 'The Challenges for European Critical Infrastructure Protection', *Journal of European Integration*, Issue 31/6, November 2009, pp. 721-739

⁴²³ Green Paper (2005). Commission of The European Communities, Green Paper on a European Programme for Critical Infrastructure Protection. Com(2005) 576 Final. Available at: <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A52005DC0576>. Accessed: 2 May 2016.

International Survey

sectoral approach. The document thus exercises some self-criticism and reveals one reason why some Member States' expectations and practices were not completely met in the EPCIP Directive.

“A number of Member States follow system-focused national CIP programmes where the end goal is security and resilience of systems, which may involve activities across multiple sectors. As a result, the sector-focused approach presented a major challenge. Some of these Member States have adopted a ‘service’-oriented approach for analysis. For instance they identify vital services from a national perspective, such as energy supply, and then implement processes and procedures to increase the security and resilience of such services. Hence, they are focused on final outcomes and are not restricted by the sectoral boundaries of the Directive. As regards the issue of energy supply, this would for instance involve the energy, transport, and ICT sectors”⁴²⁴.

The DG Home staff working document makes a reference to two other EU documents in the context of the new found emphasis on resilience. The first one is the Stockholm Programme, i.e. An Open and Secure Europe Serving and Protecting Citizens adopted by the European Council in 2009. This rather general-level security and safety policy programme discusses critical infrastructure resilience only at one instance, where the context is cyber security related threats:

“The European Council invites the Council, the Commission, the European Parliament, where appropriate, and the Member States to: draw up and implement policies to ensure a high level of network and information security throughout the Union and improve measures aimed at protection, security preparedness and resilience of critical infrastructure, including Information and Communication Technology (ICT) and services infrastructure”⁴²⁵.

The other document referred to in the DG Home staff working document is the EU Internal Security Strategy, in particular its objective 5: “Increase Europe's resilience to crises and disasters”⁴²⁶. Resilience in this Commission Communication is however presented vaguely, referring to (again) “cross-sectoral threats” that “call for improvements to long-standing crisis and disaster management practices in terms of efficiency and coherence.”

Sectorally, resilience of critical infrastructure has been discussed in the EU in somewhat more detail in a few policy documents. However, it is not surprising that within the EU context, resilience has *most notably* found its way into the cyber security field. The EU Cybersecurity Strategy from 2013 discusses this issue under the subtitle “Achieving cyber resilience”, and the strategy notes rather optimistically that “Member States should have, either already today or as a result of this strategy, structures to deal with cyber resilience.” This document suggests that resilience is promoted when both the authorities and private sector have more *capabilities, capacities, resources and processes to prevent, detect and handle cyber security incidents*. In doing so, the EU Cybersecurity Strategy notes, voluntary cooperation is needed but also new legislation, establishing common minimum requirements at *national* level. The EU Cybersecurity strategy goes further however by stating that one function of new (national) legislation would be to overcome the fact that private actors still lack effective incentives to provide *reliable data on the existence or impact of incidents*, to embrace a risk management culture or to invest in security solutions. This, it is said, is especially important in a

⁴²⁴ European Commission (2012). Commission Staff Working Document on the Review of the EPCIP. *European Commission*. SWD(2012) 190 final. Available at: <http://register.consilium.europa.eu/doc/srv?l=EN&f=ST%2011887%202012%20INIT>. Accessed: 2 May 2016. P. 8.

⁴²⁵ European Council (2009). The Stockholm Programme – An Open and Secure Europe Serving and Protecting Citizens. *European Council*. (2010/C 115/01). Available at: <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:C:2010:115:0001:0038:en:PDF>. Accessed: 2 May 2016.

⁴²⁶ European Commission (2010). Communication from the Commission to the European Parliament and the Council. The EU Internal Security Strategy in Action: Five steps towards a more secure Europe. *European Commission*. COM(2010) 673 final. Available at: <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52010DC0673>. Accessed: 2 May 2016.

number of key areas: energy, transport, banking, stock exchanges, and enablers of key internet services, as well as public administrations⁴²⁷.

3.2.2. Other Official Initiatives on Critical Infrastructure Resilience by the EU

The Institute for the Protection and the Security of the Citizen of the Joint Research Centre of the European Commission set up the European Reference Network for Critical Infrastructure Protection (ERNICIP) project in 2009. This took place under the mandate of the DG Home, in the context of EPCIP, and with the agreement of Member States. The preparatory phase was successfully completed in November 2010 and the project started its implementation phase in February 2011. As with EPCIP, ERNICIP's general objective was to improve the *protection* of critical infrastructures in the EU, both national and those defined as European critical infrastructure, in close cooperation with all stakeholders, focusing particularly on the technical protective security solutions. The specific mission of ERNICIP is to "To foster the emergence of innovative, qualified, efficient and competitive security solutions, through networking of European experimental capabilities". In order to achieve this, ERNICIP puts its efforts in maintaining an online inventory of experimental capabilities in Europe, and in developing networks of experts to identify and promote good test practices to form the basis of common European testing standards, aiming at harmonisation of test methodologies and test protocols, where practical⁴²⁸. Lately, ERNICIP has become more active also in the field of critical infrastructure *resilience*, and in practice, resilience is already included in its activities.

The EU has financed several other projects related to critical infrastructure. Under the CIPS-programme (Prevention, Preparedness and Consequence Management of Terrorism and other Security Related Risks), run by DG Home 2007-2013, some projects considered critical infrastructure resilience (alongside with protection) from early on. Also already in FP7, critical infrastructure resilience was addressed in some calls.⁴²⁹ With Horizon 2020, critical infrastructure resilience has become one of the main call themes under Secure Societies calls⁴³⁰. These include DRS-07-2014 call on Crises and disaster resilience, operationalizing resilience concepts, DRS-14-2015 on Critical Infrastructure resilience indicator, analysis and development of methods for assessing resilience, as well as CIP-01-2016-2017: Prevention, detection, response and mitigation of the combination of physical and cyber threats to the critical infrastructure of Europe. Consequently, several EU-funded projects on critical infrastructure resilience are in progress, and one may wait for the first tangible results within a few years.

One should also mention the European Commission mandate M/487⁴³¹, although it is not directly related to critical infrastructure resilience. This is a standardization activity under the European standardization organizations CEN, CENELEC and ETSI, focusing on three selected security sectors to support EU policy on security: Chemical, Biological, Radiological, Nuclear and Explosives (CBRN-E), Border Security – automated border control systems (ABC), as well as biometric identifiers, and Crisis Management/Civil Protection, especially communication interoperability and

⁴²⁷ EU Cybersecurity Strategy (2013). Joint Communication to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Cybersecurity Strategy of the European Union: An Open, Safe and Secure Cyberspace. *EU Cybersecurity Strategy*. JOIN(2013) 1 final. Available at: http://eeas.europa.eu/policies/eu-cyber-security/cybsec_comm_en.pdf. Accessed: 2 May 2016. P. 12.

⁴²⁸ Gattinesi, P., Pursiainen, P. (2013). European Reference Network for Critical Infrastructure Protection: Thematic Areas. State of the Art. *JRC Scientific and Policy Reports*. JRC82093. Available at: <http://publications.jrc.ec.europa.eu/repository/bitstream/JRC82093/lbna26017enn.pdf>. Accessed: 2 May 2016.

⁴²⁹ E.g. the still ongoing project Critical Infrastructures Preparedness and Resilience Research Network www.ciprnet.eu

⁴³⁰ For H2020 Secure Society Programme, see <https://ec.europa.eu/programmes/horizon2020/en/h2020-section/secure-societies-%E2%80%93-protecting-freedom-and-security-europe-and-its-citizens>

⁴³¹ For M/487, see <http://ec.europa.eu/growth/tools-databases/mandates/index.cfm?fuseaction=search.detail&id=472>

International Survey

interoperability of command and control. By enhancing these areas one indirectly also enhances critical infrastructure protection and resilience.

3.2.3. Institutional Framework for Delivering Resilience

Critical infrastructure, similarly to civil protection, belongs to the sovereignty of the Member States in the EU. While the Directive, created within EPCIP, is in principle binding, it only asks the countries voluntarily to inform about their critical infrastructure they consider as “European”. While the list of such European critical infrastructure is secret, the cases when Member States have voluntarily announced parts of its critical infrastructure to be “European” and thus belonging under soft regulation by the Commission are very few.

EPCIP has however functioned as an interface for national critical infrastructure policies to find joint approaches and mutually agreeable solutions. To this effect, the Member States have nominated Points of Contacts (so-called POCs) that meet once or twice a year to discuss these issues.

Within the European institutions, there is a rather strict division of labor within the field of critical infrastructure but also a lot of coordination and cooperation, with the aim of avoiding overlaps. When EPCIP started, it was put under the responsibility of European Commission DG HOME, for budget reasons and as the main threat was seeing that of terrorism. As civil protection is located under DG ECHO, this created first some coordination problems when the so-called all-hazard approach was adopted in EPCIP. Similarly, when the issue is, for instance, aviation security, one has to involve DG MOVE, and so forth. Currently it seems that the inter-DG coordination is more or less working, DG HOME still having main responsibility. Perhaps this organizational architecture has however had some influence in constructing how critical infrastructure protection and resilience is managed within the Commission. Lately, the focus of DG HOME has been much more on malicious CBRNE threats than on the idea of critical infrastructure resilience on all-hazard basis.

One should also mention that there are several EU agencies that play a role in critical infrastructure related matters. In cybersecurity, this is first and foremost ENISA, in border control issues FRONTEX, to name the two most important agencies in this context.

3.2.4. Implementation of Technical, Organisational, Social, Economic Resilience

While there cannot be found any so detailed official EU-level approaches that differentiate between different domains or dimensions of resilience, the relevant FP7 and Horizon 2020 projects, already mentioned above, often include a dimension of technological resilience. This dimension is materialized in conceptual treatments, guidelines and, sometimes, technological applications. The latter are currently usually limited to the (H2020) technological readiness level of TRL4, namely a small-scale prototype that has been tested in laboratory context, and in limited cases to the TRL5 products demonstrated within the systems project industrial or critical infrastructure operator partners.

These technological solutions are typically protection-related sensors and detectors, or software applications for decision-support systems such as interdependency analysis, and the kind. The contemporary challenge is to get these technological innovations to the market, agree on their standardization and/or certification.

We should also mention the ERNCIP Thematic Groups⁴³², whose activities are relevant not only to protection, but also resilience. Currently there are eight active groups, while three groups have finished their work.

⁴³² For ERNCIP TGs, see <https://erncip-project.jrc.ec.europa.eu/>

For instance, the Thematic Group on Chemical & Biological Risks in the Water Sector deals with the use of innovative techniques (probes, sensors, etc.) and enabling technologies for online measurement of the water quality in drinking water distribution networks, and rapid identification and quantification of chemical and biological contaminations in drinking water. These are clearly activities, if implemented, enhancing technological resilience of water networks.

The one ERNCIP Thematic Group that could be positioned under technological resilience is the current work on IACS, i.e. the European IACS Components Cyber-security Compliance and Certification Scheme. Industrial Automation and Control Systems (IACS) increasingly constitute a target for cyber-attacks aimed at disturbing Member States' economies, at disabling our critical infrastructures or at taking advantage of our people. Such hostile acts take place in a context of geostrategic tensions, for the satisfaction of organized crime's purposes, or else in support of possible activist causes.

Within ERNCIP, a dedicated Thematic Group (Case Studies for the Cyber-Security of IACS) has already considered the issue and proposed a European IACS Components Cyber-security Compliance and Certification Scheme. The work for its 2015/2016's lifecycle will build on the ERNCIP deliverables ('European IACS Components Cyber-Security Compliance and Certification Scheme' and 'Use cases in IACS') produced in 2014 by the previous thematic group, using informal surveys and interviews and discussions within expert groups. Subject to approval, this new Thematic Group should work on the plan proposed for the implementation of the European IACS components Cyber-Security Compliance & Certification Scheme into a set of several actions to be run over the 2016-20 period.

Both ERNCIP and many of the FP7 and H2020 projects organize training activities for critical infrastructure operators. The CIPRNet master classes and the ERNCIP annual CI operator workshop are cases to the point. Recently, within ERNCIP there has been developed a training programme for operators, waiting to be implemented.

Naturally, in EU civil protection exercises, organized under the auspices of DG ECHO but in practice by Member States, the scenarios often include critical infrastructure related scenarios. There has been an effort to analyse the lessons learnt from these exercises⁴³³.

4. Case Studies

While to some extent coordinated by the EU, critical infrastructure protection and resilience remains the responsibility of Member States. In the following, we take a closer look at the concept and practices related to critical infrastructure resilience in three selected countries, which seem on the fore in this field.

4.1. Norway

Norway, an EEA country, can be regarded as one of the forerunners in critical infrastructure protection. As its Nordic neighbors, also Norway chooses to speak about critical societal functions rather than mere critical infrastructures. While its critical infrastructure protection policies took shape already in 2006, resilience is a much more recent concept and has not been fully established yet in Norway⁴³⁴.

⁴³³ Theocharidou, M. (2014) CIP Scenarios: Lessons learnt from EU Exercises. *European CIIP Newsletter*. Volume 8, Issue 2.

⁴³⁴ Pursiainen, C. (2007). Towards a Baltic Sea Region Strategy in Critical Infrastructure Protection. *Nordregio Report*. Available at: <http://www.straz.gov.pl/download/1121>. Accessed: 2 May 2016. P. 23-24.

International Survey

Norway has been part of the EU risk assessment efforts, described above, but in fact, it became active in this field before and independently of the EU coordination. According to Royal Decree of 24 June 2005 shall The Norwegian Directorate for Civil Protection prepare a vulnerability and preparedness rapport, which is the baseline for further safety and preparedness investigation across sectors and departments⁴³⁵ (Ministry of Justice and Public Security 2005). From 2006, the mentioned reports have been made, and from 2012 onwards, it bears the name “National Risk Analysis”. The report from 2014 is used here to describe the different disasters the region is prone to⁴³⁶.

National risk analysis divide different hazard into natural events, major accidents and malicious events, where each category are divided into risk areas with associated scenarios⁴³⁶. The six most probable scenarios are all natural events, including extreme weather, forest fire, epidemic, avalanches, and space weather. The risk areas, which have highest consequences to society, are security policy crises, earthquakes, extreme weather, nuclear accidents, epidemic, cyber space, and avalanches. The scenarios with highest risk are carefully evaluated and they are related to epidemic, earthquakes, nuclear accidents, extreme weather and avalanche. As seen from this, natural events are considered not only as more likely but also as more risky.

Some recent emergencies should be mentioned. In December 2011, the extreme weather “Dagmar” struck wester part of Norway. Many places the wind was over hurricane intensity, and led to a high amount of failures on every level in the power distribution system. Immediately after the weather struck, a very large part of the population where affected. The main reason was a tree falling over the lines, but also major conductor lines in the central and regional grid were put out of operation due to the weather. The recovery of all the damage was delayed due to strong wind, high amount of failure, darkness, and the fact that many roads were closed⁴³⁷.

Without saying, the most serious emergency in modern Norway’s history took place on 22 July in 2011, when the government building in central Oslo was bombed, first, and in the aftermath 77 persons were killed in a massacre at the island Utøya, outside Oslo. One single person executed all the actions. The risk management system was thoroughly evaluated after the event.⁴³⁸ (NOU, 2012)

4.1.1. Concept of Resilience

The National Risk Analysis from 2013 mentions development of resilient societies, referring to Global Risks 2013 as a “strategy for continuously identifying new hazards and threats through risk analyses and the preparation of plans to meet these risks”, and that it is a “strategy for meeting events of which we have little knowledge and do not know the probability or consequence thereof. They are events with which a great deal of uncertainty is associated”^{439,440}.

The report states further, using the definition of Norris et al. “Resilience is a characteristic of the actual society. Resilient societies are characterized by being able to adapt to changing conditions

⁴³⁵ Ministry of Justice and Public Security (2005). Royal Decree of 24 June 2005: "Direktoratet for samfunnsikkerhet og beredskap - det generelle koordineringsansvaret for koordinering av tilsyn med aktiviteter, objekter og virksomheter med potensial for store ulykker". *The Norwegian Directorate for Civil Protection*, http://www.dsb.no/Global/Publikasjoner/2008/Andre/koordinering_storulykker.pdf

⁴³⁶ DSB (2014). National Risk Analysis 2014. *The Norwegian Directorate for Civil Protection*. Available at: <http://www.dsbinfo.no/DSBno/2015/Andre/NationalRiskAnalysis2014/>. Accessed: 2 May 2016.

⁴³⁷ NVE (2012). Vinden som blåste i fjor - Report 41:2012. *Norwegian Water Resources and Energy Directorate*. Available at: http://publikasjoner.nve.no/rapport/2012/rapport2012_41.pdf. Accessed: 2 May 2016.

⁴³⁸ NOU (2012). Report from the 22th of July commission. *NOU - Norwegian Public Investigations*. Available at :

⁴³⁹ DSB (2013). National Risk Analysis 2013. *The Norwegian Directorate for Civil Protection*. Available at: http://www.dsb.no/Global/Publikasjoner/2013/Tema/NRB_2013_english.pdf. Accessed: 2 May 2016.

⁴⁴⁰ World Economic Forum (2013). Global Risks 2013 - Eighth Edition. World Economic Forum. Available at: http://opim.wharton.upenn.edu/risk/library/Global_Risks_2013.pdf. Accessed: 2 May 2016.

during and after extraordinary stress and strain. The properties that characterize resilient societies are robustness, redundancy and the ability to respond rapidly”⁴⁴¹

DSB stresses that resilience entails the ability to adapt, and not the ability to withstand. It also makes a clear distinction between robustness, redundancy, and resilience, which is somehow contradictory from the definition of Norris et al. ⁴⁴¹. The report highlights further that “Resilience means that a society is prepared for the occurrence of disasters even if the causes and consequences are new and unknown. Alternative means of meeting essential needs and performing important functions have been thought and prepared - regardless of what happens.” In their final remarks, the report notes that the less the knowledge of and the greater the uncertainty of a type of risk, the more obvious resilience becomes a strategy.

DSB concludes in their National Risk Analysis report in 2013 that resilient *societies* is a relatively new concept in civil protection. However, the report emphasizes that the concept is becoming more and more important: “The analysis of the selected events in the National Risk Analysis illustrate the complex relationships and mutual dependencies, and point to the fact that resilience may become an even more important strategy for the efforts to strengthen civil protection in the future”⁴³⁹.

After the 22th of July-attack in 2011, the Norwegian Ministry of Justice and Public Security released in June 2012 a report to the Norwegian Parliament concerning Public Security, approved by the State Council⁴⁴² (Ministry of Justice and Public Safety 2012). The concept of resilience is not discussed in the report. However, terms like robustness, critical infrastructure, and vulnerability are mentioned. The report stresses that the government wishes to make a new guideline concerning the department’s work with public security and preparedness, the department’s coordination role, and central crisis management. The guideline, admitted 15 June 2012, states that the departments, on basis of overview of risk and vulnerability in own sector and DSB’s national risk picture, shall evaluate risk, vulnerability and robustness in critical infrastructure in own sector, which will be the basis for continuity and preparedness planning, and advantageous training⁴⁴³. The instructions for public security in the ministries, Royal Decree of 15. June 2012, state that risk and vulnerability analysis will give the basis for identification of scenarios and crisis that the different departments must be prepared to manage. The evaluation shall include the ability to maintain or recover important “societal functions” under the strain an unwanted event will entail. Further, the resolution states that different departments shall consider carrying out preventive and preparedness related measures to strengthen robustness in critical infrastructure and important society functions⁴⁴³.

The resolution also mentions that the different departments shall document accomplished measures performed to mitigate lack of robustness in critical infrastructure and functions of the respective department. In the report to the Parliament in 2012, the government propose to strengthen the identification and protection of critical infrastructure⁴⁴⁴. With a reference to EPCIP, it is mentioned that DSB’s mission is to develop a model to identify the Norwegian critical infrastructures.

⁴⁴¹ Norris, F. H. et al. (2008). Community resilience as a metaphor, theory, set of capacities, and strategy for disaster readiness. *Am J Community Psychol.*, 41(1-2), P. 127.

⁴⁴² Reserved for (Ministry of Justice and Public Safety 2012). Report to the Storting 29 (2011-2012) <https://www.regjeringen.no/no/dokumenter/meld-st-29-20112012/id685578/?ch=1&q=>.

⁴⁴³ Ministry of Justice and Public Safety (2012). Instruks for departementenes arbeid med samfunnssikkerhet og beredskap, Justis- og beredskapsdepartementets samordningsrolle, tilsynsfunksjon og sentral krisehåndtering. *Norwegian Directorate for Civil Protection*. Available at: <https://lovdata.no/dokument/INS/forskrift/2012-06-15-535>. Accessed: 2 May 2016.

⁴⁴⁴ Ministry of Justice and Public Safety (2012). Samfunnssikkerhet. Report to the Storting 29 (2011-2012).

4.1.2. Institutional Framework for Delivering Resilience

The instructions for public security in the ministries, Royal Decree of 15. June 2012 state that the ministries “based on an overview of the risk and vulnerabilities in their own sectors and on DSB's National Risk Analysis, [must] assess the risk, vulnerabilities and robustness of critical social functions in their own sectors as a basis for continuity and emergency planning.”⁴⁴⁵

The act related to Municipal Emergency Preparedness which entered into force 1 January 2011, states that the “municipalities are required to survey the disruptive events that may occur in the municipalities, assess the probability of these events occurring and how their possible occurrence may affect the municipalities. The results of this work must be assessed and collated in a comprehensive risk and vulnerability analysis.”⁴⁴⁶

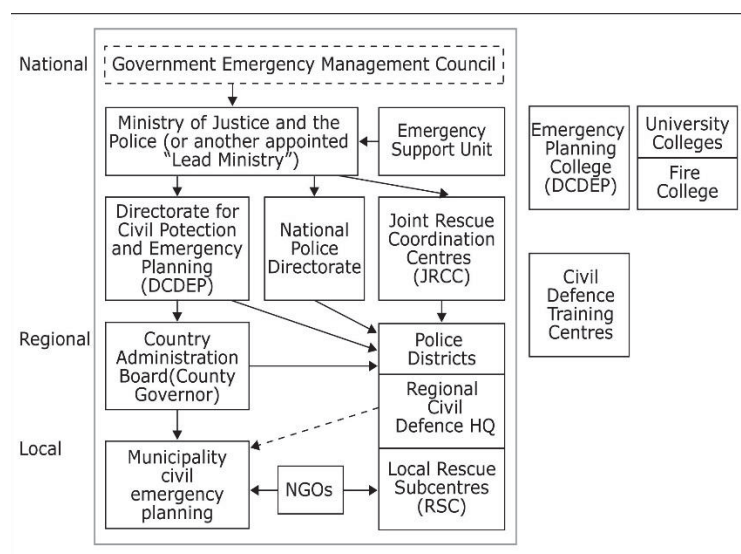


Figure 4.1 Organisational Chart, Disaster Management Structure.⁴⁴⁷

4.1.3. Technical, Organisational, Social, Economic Resilience

In a report from the Norwegian Directorate of Civil Protection from 2012⁴⁴⁸, critical infrastructure is defined, according to Norwegian Official Report No. 6 from 2006⁴⁴⁹, as “(...) is those facilities and systems that are necessary to maintain society’s critical functions, which covers society’s basic needs and the population’s safety.” The report also stresses, referring to Report no. 22 to the Parliament from 2007-2008⁴⁵⁰, that “Owner and operator of critical infrastructure are responsible for protection of critical infrastructure, according to the responsible of the sector (the principle of responsibility and

⁴⁴⁵ Ministry of Justice and Public Safety, 2012. Royal Decree of 15 June 2012: Instruks for departementenes arbeid med samfunnssikkerhet.....” http://www.dsb.no/Global/Publikasjoner/2012/Andre/Kongelig_resolusjon_15_06_2012.pdf.

⁴⁴⁶ Ministry of Justice and Public Security 2010. Lov om kommunal beredskapsplikt, sivile beskyttelsestiltak og Siviltforsvaret. https://lovdata.no/dokument/NL/lov/2010-06-25-45#KAPITTEL_5.

⁴⁴⁷ http://ec.europa.eu/echo/files/civil_protection/vademecum/se/2-se.html

⁴⁴⁸ DSB (2012). Sikkerhet i kritisk infrastruktur og kritiske samfunnsfunksjoner - modell for overordnet risikostyring. *Norwegian Directorate of Civil Protection*. Available at: <http://www.dsbinfo.no/DSBno/2012/Rapport/KIKS/>. Accessed: 2 May 2016.

⁴⁴⁹ Department of Justice and Public Security (2006). Norwegian Official Report: Når sikkerhet er viktigst - Beskyttelse av landets kritiske infrastrukturer og kritiske samfunnsfunksjoner. *Department of Justice and Public Security*. NOU 2006:6. Available at: <https://www.regjeringen.no/contentassets/c8b710be1a284bab8aea8fd955b39fa0/no/pdfs/nou200620060006000dddpdfs.pdf>. Accessed: 2 May 2016.

⁴⁵⁰ Department of Justice and Public Security (2008). Samfunnssikkerhet. Samvirke og samordning. *Department of Justice and Public Security*.

closeness). “ Further, the report highlights that: “Every public authority shall put down clear requirements, carry out effective monitoring and ensure good preparedness. At the same time, must each individual enterprise be aware of its responsibility for safety. Every one of us is also responsible to be prepared for disruption in the deliverance of important services and goods”

In the oil and gas industry, there are a number of standards and regulations to ensure that safety is maintained on a high level. The NORSOK standards are example of this. As stated on their webpage, “is the NORSOK standards developed by the Norwegian petroleum industry to ensure adequate safety, value adding and cost effectiveness for petroleum industry developments and operations. Furthermore, NORSOK standards are as far as possible intended to replace oil company specifications and serves as references in the authorities’ regulations.”⁴⁵¹ For example., NORSOK Z-013 has the purpose to “establish requirements for effective planning and executive risk and/or emergency preparedness assessment. This NORSOK standard has emphasis on requirements related to ensuring that the process of conducting such assessments is suitable for their intended purposes, rather than detailed requirements related to how the assessment and the various hazards typically included in such assessment should be analyzed”⁴⁵².

Det Norske Veritas (DNV), an international certification body, has developed several standards and recommended practices, which are used in the oil industry in Norway. One example of this is DNV-RP-G101: Risk-based inspection (RBI) of offshore topsides static mechanical equipment. RBI is a decision-making technique for inspection planning based on risk. The combination of probability of failure and consequence of failure forms the risk picture of the given component. In an ideal situation, RBI leads to an optimized inspection plan, in addition to monitoring and testing plans for the system. The main motivation for focusing on inspection, integrity management and maintenance has been to reduce the consequences of a system failure⁴⁵³.

As to organizational and societal resilience, all municipalities are obliged to have an emergency preparedness plan, and full-scale exercises are organized in cooperation of all relevant authorities and non-governmental organisations (such as the Norwegian Red Cross).

4.1.4. Resilience Related Official Documents

In addition to the above-discussed documents, there are several other relevant documents that could be mentioned here. The most notable are: 1) The Fire Protection Act of 8 December 2000, implemented as of 1 January 2001; 2) The Fire and Explosion Prevention Act of 14 June 2002; 2) Act on Municipal Responsibility for Sectoral Risk, Vulnerability Assessment and Emergency Plan, Implemented on 1 January 2010; 4) and The Act of Social and Health Preparedness of 23 June 2000.

4.2. Sweden

Sweden is definitely one of the countries where critical infrastructure protection discourse not only started early but where this topic was already embedded in the Cold War total defence concept before anyone spoke about critical infrastructure as such. When the concept of critical infrastructure became popular in Europe, Sweden preferred to use the concept of critical functions instead of critical

⁴⁵¹ NORSOK 2015. <http://www.standard.no/en/sectors/energi-og-klima/petroleum/norsok-standards/#.VynhSISLRhE>.

⁴⁵² NORSOK (2010). Z-013 Risk and emergency preparedness assessment. Norsok Standard. Available at: <http://www.standard.no/pagefiles/955/z-013.pdf>. Accessed: 2 May 2016.

⁴⁵³ DNV (2010). Recommended practice DNV-RP-G101: Risk-based inspection of offshore topsides static mechanical equipment. Det Norske Veritas. Availalbe at: <https://rules.dnvgl.com/docs/pdf/DNV/codes/docs/2010-10/RP-G101.pdf>. Accessed: 2 May 2016.

International Survey

infrastructure, in order to emphasise the broadness of the definition. The whole spirit of the Swedish approach was from early on more about resilience than mere protection⁴³⁴.

In 2011, the Swedish Civil Contingencies Agency (MSB), commissioned by The Government of Sweden, began its work of producing national risk assessment. In the National Risk Assessment from 2012, as stated in the report, MSB “identified 27 particularly serious national events, which was derived from the more than 200 events identified in the agencies’ risk and vulnerability analyses of 2010-2011”⁴⁵⁴. Among the 27 events was events like “disruption in fuel, food and electricity supply”, “flooding of water sources”, “contaminated drinking water supply”, “heat wave”, “pandemic”, “landslide”, “storm”, and so on. Further, eleven scenarios were developed⁴⁵⁵, while seven were analysed and assessed. Of the seven events, “a school shooting” and “a prolonged heat wave” were considered as most likely to occur. “A major fire in a cruise ship”, “disruption in the food supply due to fuel shortage and “the failure of a large dam on a river” were evaluated to have the greatest impact. The events with greatest risk were “fuel shortage leading to disruption in the food supply”, “failure of a large dam on a river” and “prolonged heat wave”.

According to the Europeans Commissions Vademecum⁴⁵⁶ concerning humanitarian aid and civil protection, Sweden is prone to disasters like flooding, winter storms, landslides, forest fires, and ice floes. The commission also lists recent disasters in the country, and since 2000 are all the mentioned disasters related to natural disasters like storm, flooding, and forest fires.

4.2.1. Concept of Resilience

In 2011, commissioned by The Swedish Government, MSB published a national strategy for protection of important public services⁴⁵⁷. In the introduction, it is stated that the purpose of the strategy is to develop a more resilient society. In that context, resilient is defined as “the capacity the society has to withstand and recover from a disruption”.

In 2013, MSB published a report with the title “Resilience – the concepts different meanings and utilization areas”. The report state in the abstract, that the mission for the report is to contribute with knowledge on how the term resilience is used across different sectors, rather than suggesting how and where MSB shall use the term *resilience*. The report gives describes a number of different definitions from different organizations. Furthermore, the report stresses that the term resilience will be subject to further development and that MSB will follow this development⁴⁵⁸.

The Swedish Civil Contingencies Agency (MSB) was established in 2008 exactly with the aim to of building resilience across sectors and levels of government⁴⁵⁹. As a direct result of Government Bill 2007/08:92⁴⁶⁰, MSB replaced the Swedish Rescue Services Agency (SRSA), the Swedish Emergency Management Agency (SEMA), and the National Board of Psychological Defence (SPF). According to Lindberg & Sundelius (2013), the goal was to “give coordinated support to society in the area of civil

⁴⁵⁴ MSB (2012). Swedish National Risk Assessment 2012. *Swedish Civil Contingencies Agency*. Available at: <https://www.msb.se/RibData/Filer/pdf/26621.pdf>. Accessed: 2 May 2016.

⁴⁵⁵ MSB states in the National Risk Assessment from 2012 that (MSB, 2012) : «MSB does not consider the seven scenarios analyzed in 2012 to represent the greatest risks facing Sweden as a country. They should, instead, be viewed as in-depth studies of a selection of the 27 events which were considered to be particularly serious in the risk identification phase.”

⁴⁵⁶ http://ec.europa.eu/echo/files/civil_protection/vademecum/se/2-se.html

⁴⁵⁷ MSB (2011). Ett fungerande samhälle i en föränderlig värld: Nationell strategi för skydd av samhällsviktig verksamhet. *Swedish Civil Contingencies Agency*. Available at: <https://www.msb.se/RibData/Filer/pdf/26083.pdf>. Accessed: 2 May 2016.

⁴⁵⁸ MSB (2013). Resiliens: Begreppets olika betydelser och användningsområden. *Swedish Civil Contingencies Agency*. Available at: <https://www.msb.se/RibData/Filer/pdf/27199.pdf>. Accessed: 2 May 2016.

⁴⁵⁹ Lindberg, H., Sundelius, B. (2013). Whole-Of-Society Disaster Resilience: The Swedish Way.

⁴⁶⁰ Government Bill (2008). Stärkt krisberedskap - för säkerhets skull, Prop. 2007/08:92.

National legislation. Available at: <http://www.regeringen.se/rattsdokument/proposition/2008/03/prop.-20070892/>. Accessed: 2 May 2016.

contingency management leading to enhanced emergency management capability at home and abroad by harnessing efficiency and effectiveness synergies”⁴⁵⁹. Furthermore, “MSB’s mandate is a concrete expression of widened policy field for crisis and disaster management, integrating across sectors, across the internal and the external divide, the risk and the threats, as well as the different management phases, before, during and after incidents”.

The Swedish Government gave on 14 April 2010 MSB the mission to develop a national strategy for protection of important public services. In December 2011, the strategy was published, with the main goal to develop a society with good capability to withstand and recover from serious disturbances in important public services⁴⁵⁷. In 2013, commissioned by The Swedish Government, based on the national strategy, MSB developed an Action plan to protect important public services⁴⁶¹. The Action plan is based on the principles from the national strategy and the prioritized activities and acts in collaboration between other agencies, municipalities, parliament, country administrative boards, and the private sector⁴⁶¹. The goal for the plan is to concretize the national strategy by initiating actions and activities that integrate a systematic safety awareness in all important functions in the society, on both local, regional and national level, by 2020⁴⁶¹. The purpose is also to develop a resilient society with a better capability to withstand and recover from serious disturbances.

MSB has decided a research strategy for 2014 to 2018. The strategy includes, among other things, the two areas *continuity* and *resilience* in the society, where the main issue is protection of important public services, risk and vulnerability analysis, and resilience⁴⁶¹. In 2015, MSB established Centre for Critical Infrastructure Protection Research (CenCIP), based in Lund University⁴⁶².

4.2.2. Institutional Framework for Delivering Resilience

Three levels of governance handle civil emergency planning in Sweden: national, regional and local. At national level, whoever is responsible for an activity under normal conditions will also have the responsibility during emergencies. The Ministry of Defence used to have the overall political responsibility in Swedish civil emergency planning, but this was changed recently and today MSB works under the ministry of Justice. The Crisis Management Coordination Secretariat at the Swedish Government Offices is responsible for everyday management. Public authorities, like MSB, are represented at each coordination area. As reported to the European Commission Vademecum on MSB’s role, “their task are to coordinate activities to reduce vulnerability and enhance the emergency management capabilities of the respective areas and, as consequence their own sector. They are also expected to ensure coordination with the business sector, the municipalities and the country administrative boards”. It is stated further, that at regional level, “the county administrative boards are responsible for coordinating civil emergency planning activities, such as exercises, risk and vulnerability analyses, and acting as a clearing house between public and private partners. (...) County administrative boards coordinate the relevant actors to maintain the level of responsibility during crisis and have the overall responsibility for reporting the need for host nation support in the event of major emergency”⁴⁶³. The 290 municipalities in Sweden have also an important role in civil defence, civil emergency planning and preparedness, and accident prevention work. They do this through safety in land use planning and accident prevention. The European Commission states that, “the municipalities receive continuous support and assistance from the county administrative board in fields of contingency planning, exercises and training”. The organizational chart Sweden’s disaster management structure is illustrated in Figure 2.

⁴⁶¹ MSB (2013). Handlingsplan för skydd av samhällsviktig verksamhet. *Swedish Civil Contingencies Agency*. Available at: <https://www.msb.se/RibData/Filer/pdf/27271.pdf>. Accessed: 2 May 2016.

⁴⁶² MSB (2015). Nytt forskningscentrum om skydd av samhällsviktig verksamhet. *Swedish Civil Contingencies Agency*. Available at: <https://www.msb.se/sv/Kunskapsbank/Forskningsresultat/Resiliens-och-samhallsviktig-verksamhet/Skydd-av-samhallsviktig-verksamhet/>. Accessed: 2 May 2016.

⁴⁶³ For EU Vademecum – Civil protection, see http://ec.europa.eu/echo/files/civil_protection/vademecum/se/2-se.html

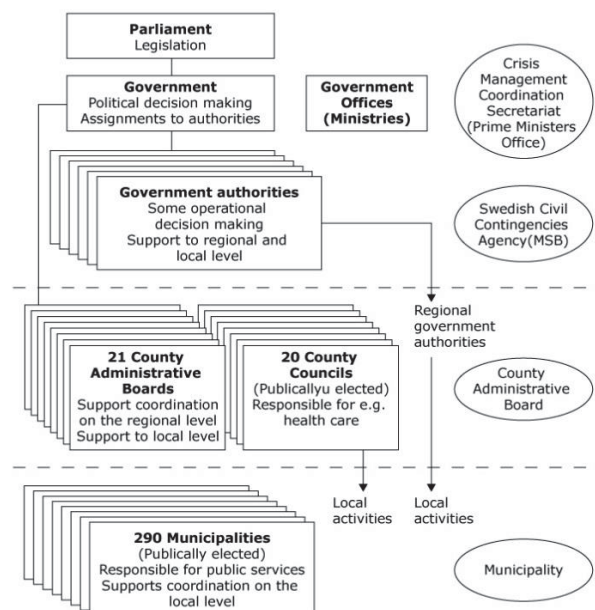


Figure 4.2 Sweden disaster management structure (European Commission 2014).

4.2.3. Technical, Organisational, Social, Economic Resilience

No official documents about implementation of resilience are easily available. However, one could mention the following ones where one partially discusses this issue: 1) MSB, 2011: Ett fungerande samhälle i en förenad värld: Nationell strategi för skydd av samhällsviktig verksamhet. Swedish Civil Contingencies Agency. 2) MSB, 2013: Handlingsplan för skydd av samhällsviktig verksamhet. Swedish Civil Contingencies Agency. 3) MSB, 2011: Ett fungerande samhälle i en förenad värld: Nationell strategi för skydd av samhällsviktig verksamhet. Swedish Civil Contingencies Agency. 4) MSB, 2013: Handlingsplan för skydd av samhällsviktig verksamhet. Swedish Civil Contingencies Agency.

As to organizational and societal resilience, all municipalities are obliged to have an emergency preparedness plan, and full-scale exercises are organized in cooperation of all relevant authorities and non-governmental organizations (such as the Swedish Red Cross).

Swedish Civil Contingencies Agency published in December 2015 a report to demonstrate how to systematic work with protection of society important functions (samhällsviktig verksamhet), which will support the work with risk management, continuity management and crisis management⁴⁶². It is stated, that the goal with the report is to create a more resilient society with better ability withstand and recover from serious disruptions. The report shall help to reach the goals stated in the strategies and planning acts developed by MSB in, respectively, 2011 and 2013^{461 457}. The overall goal with the planning act from 2013, is to facilitate so that all society important functions have implemented systematic work by 2020.

4.2.4. Resilience Related Official Documents

Beside the above mentioned documents, one should mention the following ones: 1) The Swedish 'Civil Protection Act', government bill 2002/03:119. 2) The 'Act of Measures to be taken by Municipalities and County Council in Preparedness for and during Extraordinary Incident during Peacetime and Periods of Heightened Alert', Government bill 2006:54. 3) Government Bill 2008: Stärkt krisberedskap – för säkerhets skull, Prop. 2007/08:92. 4) MSB, 2011: Ett fungerande samhälle i en förenad värld: Nationell strategi för skydd av samhällsviktig verksamhet. Swedish Civil

Contingencies Agency. 5) MSB, 2012: Swedish National Risk Assessment 2012. Swedish Civil Contingencies Agency. 6) MSB, 2013: Handlingsplan för skydd av samhällsviktig verksamhet. Swedish Contingencies Agency. 7) MSB, 2013: “Resiliens: Begreppets olika betydelser och användningsområden”. 8) Swedish Civil Contingencies Agency. The emergency Preparedness and Heightened Alert Ordinance, 2006.

4.3. The United Kingdom

The UK is probably one of the most advanced countries in Europe when it was implement critical infrastructure protection policies and now when the focus is perhaps more on resilience policies. It is therefore useful to review the UK experience so far.

Since 2008, the UK Cabinet Office has been producing the National Risk Assessment, as a part of the UK Government's National Security Strategy. Dividing the risks into three main categories (natural events, major accidents and malicious attacks), the National Risk Assessment provides an official government assessment of the most significant risks to the United Kingdom. It evaluates a number of risks in each category, rated by relative impact and relative likelihood, and discusses the measures currently in place to deal with each of these. The full report is therefore classified, although an unclassified summary known as the National Risk Register of Civil Emergencies is publically available.

The latest update of the National Risk Register shows that the highest risk to the UK is from pandemic influenza, with coastal flooding as the highest risk from a natural hazard, alongside widespread electricity failure resulting from severe weather, in particular a combination of strong winds and lightning causing technical failures⁴⁶⁴.

Coastal flooding has the potential to have the most widespread impact to the UK in a single event. The last significant event of this type to seriously affect the UK was in January 1953 when the east coast of England suffered one of the biggest environmental disasters ever to have occurred in the UK. Flood defences were breached by a combination of high tides, storm surge and large waves. Over 600km² of land were flooded, 307 people died and 200 industrial facilities were damaged by floodwater. A month after the flooding, the estimated cost was £40–50 million, the equivalent of around £1 billion today.

More recently, stormy weather experienced across the UK from late October 2013 through to February 2014 resulted in a number of coastal flooding incidents. The worst tidal surge in 60 years was experienced on England's east coast in December 2013, leading to 2,800 flooded homes, significant coastal erosion and evacuation of thousands of people. However, the consequences of this storm surge were less serious even though sea levels were higher than in 1953, due to the investment made in coastal flood defences and flood warnings.

The frequency of inland flooding is increasing; this is evidenced by several examples of river and surface water floods in 2007, 2009, 2010, 2012, 2013 and 2014. Of these, the events of summer 2007 were the most widespread. In June–July 2007, severe rainfall during an extremely wet summer led to the flooding of 48,000 households and 7,300 businesses across England. Businesses as well as homes were inaccessible for many months while buildings dried out and damage was repaired. The flooding in Cumbria in November 2009 caused six bridges to collapse, severing the road network and cutting off communities.

⁴⁶⁴ UK Cabinet Office (2015). National Risk Register of Civil Emergencies, 2015 edition. *Cabinet Office*. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/419549/2015-NRR-WA_Final.pdf. Accessed: 2 May 2016.

International Survey

The winter storms experienced from October 2013 to February 2014 also resulted in serious inland flooding. In the wettest winter since records began, south-east, central, southern and south-west England experienced thousands of flooded properties and disruption to rail, road, air and energy infrastructure. Extensive flooding was experienced on the Somerset Levels, where some homes and businesses were under water from January to March 2014.

The most significant storms in recent decades were those of 16 October 1987 and 25 January 1990. The first brought down an estimated 15 million trees in the south-east of England. By contrast, the 1990 storm was more extensive and had higher peak wind speeds. The net effect was a much higher death toll but less damage to trees and property.

More recently, on 28 October 2013, a severe storm travelled across southern England. The timing of the storm meant that trees were still in full leaf and vulnerable to strong winds. Falling trees were the main cause of disruption, killing four people, and contributing to widespread transport disruption and power outages, with more than 660,000 homes left without power.

The UK has experienced major loss of life in industrial accidents such as the Flixborough chemical plant explosion (1974) and the Piper Alpha oil platform fire (1988). In December 2005, the largest peacetime fire in Europe occurred at the Buncefield Oil Storage Terminal in Hemel Hempstead.

4.3.1. Concept of Resilience

In the UK's Critical Infrastructure Resilience Programme, resilience is defined as "the ability of a system or organisation to withstand and recover from adversity". A resilient organisation is one that is still able to achieve its core objectives in the face of adversity through a combination of measures.

Physical protection may make up an important part of resilience, but it is not the only factor. Resilience is also underpinned by good design of infrastructure networks, effective emergency response, business continuity planning, and recovery arrangements⁴⁶⁵.

The concept of resilience is now highly developed in the UK, at local, national and critical national infrastructure levels. The main driver for this at national government level seems to have been the passing of the Civil Contingencies Act 2004, which had the requirement for the formation of Local Resilience Forums. These are forums formed in each police area by key emergency responders and specific supporting agencies.

In 2008, the government published, for the first time, a National Risk Register, fulfilling a commitment made in the National Security Strategy. This was the first step in providing advice on how people and businesses can better prepare for civil emergencies. Subsequent editions have been published in 2010, 2012, 2013 and 2015. This includes the planning assumptions which are used to set the parameters for the UK Resilience Capabilities Programme which co-ordinates planning and capability building for resilience across the UK. These were specifically stated as being aimed at the government departments and agencies who lead on improving the resilience of the country to particular types of emergency⁴⁶⁶ (UK Cabinet Office 2011).

⁴⁶⁵ UK Cabinet Office (2011). National Emergency Plan for the Telecommunications Sector, *Cabinet Office*. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/61807/emergency-plan-telecomms-sector.pdf. Accessed: 2 May 2016.

⁴⁶⁶ UK Cabinet Office (2011). National Risk Register: A Summary of the Sector Resilience Plans for Critical Infrastructure 2010/2011. Available at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/271345/sector-resilience-plan-2011.pdf

The National Resilience Capabilities Programme, led by the Cabinet Office, is the core framework through which the UK Government seeks to build resilience across the UK to meet the generic consequences of a wide range of civil emergencies, including catastrophic impact attacks. In particular, guidance is offered on: 1) Infrastructure resilience; 2) Community resilience; 3) Business Continuity; 4) Corporate resilience: small/medium enterprises (SME) resilience strategy.

The Infrastructure Resilience programme, led by the Cabinet Office, was established in March 2011 to enable public and private sector organisations to build the resilience of their infrastructure, supply and distribution systems to disruption from all risks (hazards and threats) as set out in the National Risk Assessment.

4.3.2. Institutional Framework for Delivering Resilience

The National Resilience Capabilities Programme, led by the Cabinet Office, is the core framework through which the UK Government seeks to build resilience across the UK to meet the generic consequences of a wide range of civil emergencies, including catastrophic impact attacks.

The Centre for the Protection of National Infrastructure (CPNI), part of the UK's Security Service, aims to protect national security against malicious acts by providing advice on protective security to the organisations that make up the UK's critical national infrastructure covering physical, personnel and cyber security.

The Civil Contingencies Secretariat within the Cabinet Office has developed a cross-sector Critical Infrastructure Resilience Programme with the aim of improving the resilience of critical infrastructure and essential services to severe disruption from natural hazards.

As most emergencies are best managed at the local level by local emergency responders and emergency planners, the Civil Contingencies Act 2004 provides a common framework for emergency planning, putting a duty on emergency planners and responders to identify and assess the risks of emergencies affecting the area in which they operate. The work of identifying potential risks and preparing plans for either preventing or mitigating the impact of incidents locally is coordinated through Local Resilience Forums (LRFs). LRFs are multi-agency partnerships made up of representatives from local public services, including the emergency services, local authorities, the NHS and the Environment Agency. LRFs are supported by other organisations such as the Highways Agency and public utility companies. In Scotland, the role of LRFs is fulfilled by Regional Resilience Partnerships.

The UK Government provides guidance on the planning and preparing work coordinated by LRFs based on the NRA, as does the Scottish Government in respect of matters devolved to the Scottish Parliament. Many local communities also plan for emergencies and are encouraged to produce their own local risk register as part of their Community Emergency Plan.

Contingency planning in the private sector is usually undertaken as part of business continuity planning. In some cases, it falls within the obligations placed on some essential services, such as the emergency services, by the Civil Contingencies Act (2004) ⁴⁶⁴.

4.3.3. Technical, Organisational, Social, Economic Resilience

The UK's security strategy includes the requirement for government organisations to have well-tested plans, policies and procedures to reduce their vulnerability to security incidents, including the need to have: 1) Business continuity arrangements aligned to industry standards, to maintain key business

International Survey

services, building resilience and security to facilitate a rapid and effective response to recover from incidents; 2) Processes in place to regularly conduct risk and vulnerability assessments and review resilience planning for critical assets, particularly those identified as Critical National Infrastructure⁴⁶⁷.

The advice provided by the Centre for the Protection of National Infrastructure (CPNI) is primarily aimed at security managers of infrastructure organisations. For the more important locations, advice is provided by security specialists, but CPNI also makes available general advice through its web site. This includes a document '*Resilience and Cyber Security of Technology in the Built Environment*' which states that from a resilience perspective, the greatest threat to a building is likely to come from single points of failure, which may be the building fabric or structure, utilities, infrastructure, systems or processes⁴⁶⁸. According to this, the resilience of systems, whether IT or building systems, is generally considered in terms of redundancy and the system availability under both fault and maintenance conditions. The paper sets out a four-tier classification mechanism that can be used for data centres and industrial plants. Tier 1 buildings will have minimal resilience, with single points of failure in critical systems, while Tier 4 buildings will have a high degree of fault tolerance and might be used by an organisation delivering critical national infrastructure services.

The UK telecommunications sector is seen to be inherently resilient due to the underlying structure and historic investment made by the large telecoms providers (UK Cabinet Office 2015). The industry has extensive and well-practised plans in place for managing emergencies and these plans involve a high level of cooperation between companies. It is therefore commonly accepted that the likelihood of a widespread telecoms emergency is low – in recent years there have been some relatively minor issues, mainly derived from severe weather, which can result in access issues for network repairs, or from power loss which can have an impact on telecoms. Core networks are very resilient although there can be issues in the access network (the connection point between the customer and the exchange/core network) as this is usually the oldest part of the network.

The Electronic Communications, Resilience and Response Group (EC-RRG) plays a key role in terms of the telecoms sector's resilience. EC-RRG is an industry-run group, supported by the Department for Business, Innovation and Skills, which acts to raise awareness of telecommunications resilience and to disseminate best practice. EC-RRG owns and manages the National Emergency Plan for Telecoms and facilitates a response to major incidents through the NEAT (National Emergency Alert for Telecommunications) protocol⁴⁶⁵.

The Cabinet Office guide '*Resilience in society: infrastructure, communities and businesses*' sets out advice to infrastructure operators, business, and small/medium enterprises (SMEs), as well as to communities⁴⁶⁹.

This includes encouragement on the use Business Continuity Management (BCM), defined as a process that helps manage risks to the smooth running of an organisation or delivery of a service, ensuring continuity of critical functions in the event of a disruption, and effective recovery afterwards. The UK government aims to ensure all organisations have a clear understanding of BCM. The British business continuity management standard (BS25999) is a code of practice that establishes the process,

⁴⁶⁷ UK Cabinet Office (2014). HMG Security Policy Framework *Cabinet Office*. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/316182/Security_Policy_Framework_-_web_-_April_2014.pdf. Accessed: 2 May 2016.

⁴⁶⁸ Boyes, H. (2013). Resilience and Cyber Security of Technology in the Built Environment, *The Institution of Engineering and Technology*, Available at: <http://timreview.ca/article/888>. Accessed: 2 May 2016.

⁴⁶⁹ UK Cabinet Office (2014). Resilience in society: infrastructure, communities and businesses. Available at: <https://www.gov.uk/guidance/resilience-in-society-infrastructure-communities-and-businesses>. Accessed: 2 May 2016.

principles and terminology of business continuity management (BCM), providing a basis for understanding, developing and implementing business continuity within an organisation⁴⁷⁰.

The Corporate Resilience Strategy aims to promote effective but inexpensive ways to enable SMEs to build resilience to all kinds of hazards and threats⁴⁶⁹.

In the UK, community (societal) resilience is seen as communities using local resources and knowledge to help themselves during an emergency in a way that complements the local emergency services. The guidance '*Resilience in society: infrastructure, communities and businesses*' encourages communities to become better prepared to cope with emergencies, and makes available to communities various tools, including: 1) Strategic national framework on community resilience; 2) Preparing for emergencies: guide for communities; 3) Community emergency plan toolkit; 4) Community emergency plan template⁴⁶⁹.

In the UK, civil protection arrangements are designed to be flexible and scalable to adapt to any circumstances. For example, when a public order incident has the potential to place pressure on one police force, the newly enhanced National Police Coordination Centre (NPoCC) will support forces in England and Wales and liaise with Police Scotland and the Police Service of Northern Ireland, ensuring that they receive the assistance needed to respond effectively. NPoCC also works to ensure policing resilience during major events and in an emergency that requires a UK police response⁴⁶⁴.

In 2010, the UK Coalition Government set out a plan for local economic growth in the White Paper *Local growth: realising every place's potential*. This White Paper aimed to shift powers to local communities and businesses: principally through the closure of the Regional Development Agencies (RDAs) and the introduction of Local Enterprise Partnerships (LEPs)⁴⁷¹.

With the rationale they cover natural economic areas, and not be limited to existing administrative boundaries, LEPs have had the freedom to develop growth plans that address the narrow concepts of productivity growth and the wider issues of local economic resilience.

Studies analysing the performance of LEPs in addressing issues of local economic resilience seem to indicate a large variation in the nature of the strategic economic plans and growth plans. Broadbridge and Raikes (2015) identified that most LEPs have at least one area of resilience in which they demonstrate some good planning, with performance generally best around those resilience measures which align more closely with traditional economic growth drivers⁴⁷².

McInroy, Neil and Jackson Matthew (2014) of the Centre for Local Economic Strategies (CLES) analysed the LEPs and LEP areas which are resilient in relation to CLES' thinking around "whole place". Using two factors of composition and social strategy, and economic performance and associated indicators, they have portrayed an initial picture of resilience, and recommended that the policy agenda for LEPs needs to shift from an overarching emphasis upon business and predominantly large business being the driver of LEPs to an emphasis which reflects the balanced nature of economics, social growth and wider place resilience⁴⁷³.

⁴⁷⁰ BS252999 has recently been superseded by ISO 22301 (requirements) and ISO 22313 (guidance).

⁴⁷¹ UK Department for Business, Innovation & Skills (2010). *Local growth: realising every place's potential*. UK Department for Business, Innovation & Skills. Available at: <https://www.gov.uk/government/publications/local-growth-realising-every-places-potential-hc-7961>. Accessed: 2 May 2016.

⁴⁷² Broadbridge, A., Raikes, L. (2015). *Developing resilient local economies: Good practice among local enterprise partnerships, IPPR North*. Available at: <http://www.ippr.org/publications/developing-resilient-local-economies-good-practice-among-local-enterprise-partnerships>. Accessed: 2 May 2016.

⁴⁷³ McInroy, N., Matthew J. (2014). *Developing Local Economic Resilience - The Role of Local Enterprise Partnerships (LEPs), Centre for Local Economic Strategies*. Available at: <http://www.cles.org.uk/publications/the-local-economic-resilience-of-leps/>. Accessed: 2 May 2016.

International Survey

4.3.4. Resilience Related Official Documents

Sector resilience plans set out the resilience of the UK's most important infrastructures to the relevant risks identified in the National Risk Assessment. The sectors covered are: 1) Emergency services; 2) Energy; 3) Finance; 4) Food; 5) Government; 6) Hazardous sites; 7) Health; 8) Civil nuclear; 9) Transport; 10) Water.

Produced annually, these sector plans alert the relevant government ministers to the perceived vulnerabilities, with a programme of measures to improve resilience where necessary. Individual sector plans are classified, but the Cabinet Office summarises each sector plan in a published summary document⁴⁷⁴.

The National Risk Assessment, which provides the official government assessment of the most significant risks to the United Kingdom, is classified, with an unclassified summary, the National Risk Register of Civil Emergencies, publically available.

To support the Local Resilience Forums (LRF) in England and Wales, the UK Government publishes guidance that sets out the role of LRFs, highlighting compliance with the Regulations and suggests issues, processes, systems and activities to consider when establishing effective mechanisms for civil contingencies, emergency preparedness and elements of response and recovery⁴⁷⁵ (UK Cabinet Office 2013). For Scotland, the Scottish Government publishes similar guidance⁴⁷⁶.

4.4. Denmark

Denmark has a well-developed societal safety and security system and respective research. However, when it comes to resilience or critical infrastructure resilience, it is not as well argued as in the country's Scandinavian neighbours.

In 2013, the Danish Emergency Management Agency (DEMA) published its first National Risk Profile⁴⁷⁷. The report divides incidents into *man-made* and *natural* incidents, where natural incidents are divided into *extreme weather phenomena* and *serious contagious diseases*, and man-made incidents is divided into two sub categories: *accidents* and *security threats*. DEMA has chosen 10 incidents that were further investigated⁴⁷⁸. The incidents were hurricanes, strong storm and storm surges (1), heavy rain and cloudburst (2), pandemic influenza (3), animal diseases and zoonosis (4), transport accidents (5), accident with dangerous substances on land (6), marine pollution accidents (7), nuclear accidents (8), terrorist acts (9), and cyber-attacks (10).

In December 1999, a hurricane hit Denmark, described as the biggest in recent times. Seven people were killed and almost 1000 people were seriously injured. The power distribution system was down for long periods, and approximately 400,000 homes lost electricity during and after the hurricane. In July 2011, a big cloudburst hit greater Copenhagen. No fatalities were caused during the cloudburst, but in

⁴⁷⁴ UK Cabinet Office (2014). A Summary of the 2014 Sector Resilience Plans. *Cabinet Office*. Available at: <https://www.gov.uk/government/publications/sector-resilience-plan-2014>. Accessed: 2 May 2016.

⁴⁷⁵ UK Cabinet Office (2013). The role of Local Resilience Forums: A reference document. *Cabinet Office*. Available at: <https://www.gov.uk/government/publications/the-role-of-local-resilience-forums-a-reference-document>. Accessed: 2 May 2016.

⁴⁷⁶ Scottish Government (2012). Preparing Scotland - Scottish guidance on resilience. *Scottish Government*. Available at: <http://www.gov.scot/Publications/2012/03/2940>. Accessed: 2 May 2016.

⁴⁷⁷ DEMA (2013). National Risk Profile (NRP). *Danish Emergency Management Agency*. Available at: [http://brs.dk/viden/publikationer/Documents/National_Risk_Profile_\(NRP\)_-_English-language_version.pdf](http://brs.dk/viden/publikationer/Documents/National_Risk_Profile_(NRP)_-_English-language_version.pdf) Accessed: 2 May 2016.

⁴⁷⁸ DEMA states, "The National Risk Profile (NRP) is a result of continuous effort to map and analyze risks. The NRP does not cover the whole range of risk confronting society, but concentrates on those which DEMA believes have the greatest claim on the attention of preparedness planners and operators at the moment". (DEMA, 2013)

the days after the event five people were reported to be infected with leptospirosis, were one person died. Research after the event showed that many people exposed to sewage-infected rainwater through their job, had become sick. The event caused enormous material damage due to water and moisture on homes, businesses and public institutions – estimated to be the costliest natural incident since the hurricane in 1999. In addition, there was a widespread breakdown of infrastructure causing high costs to society⁴⁷⁷.

4.4.1. Concept of Resilience

In 2006, DEMA published an introduction and user guide for risk and vulnerability analysis⁴⁷⁹. When describing central concepts of the risk and vulnerability analysis model, they state that resilience is the opposite of vulnerability, by saying that “vulnerability (and its opposite, resilience) expresses a given system’s general ability to function and achieve its goals when faced with threats. A system is vulnerable when it lacks or has reduced capacity to plan for, prevent, respond to or recover from a realized threat. Vulnerability assessment is carried out comparing threats against existing capacities, as well as the preferred degree of protection”. As said, it is however difficult to find exact official definitions of the concept of resilience.

In 2005, as a part of Denmark’s continuing vulnerability assessment, implemented the same year, DEMA published its first national vulnerability report. The goal with the report is to “promote preparedness culture in both private and public sector. Bigger incidents and disasters do occur in every sector. Despite being caused by technology, nature and human, society should be able handle the situation quick and in an effective manner. A coordination effort from all parts of society is a precondition for a robust society”⁴⁸⁰. From 2005 to 2010, the agency published vulnerability reports yearly. The term resilience is not mentioned in the reports. However, it can be argued that the concept of resilience is covered, considering used terms like robustness, vulnerability and recovery, which are keywords in the concept of resilience. In 2013, DEMA published its first National Risk Picture (NRP). In the introduction it is stated that the society must be robust and prepared for accidents and disasters.

The Danish Emergency Agency (DEMA), is as of today, part of the EU-read project Resilience Capacities Assessment for Critical Infrastructure Disruption, where resilience is investigated in situations with disruptions and failure in critical infrastructure.

4.4.2. Institutional Framework for Delivering Resilience

The civil protection structure in Denmark is divided into three levels: central, regional and municipal. At national level, the ministries are responsible for their own sector, which includes planning and taking the necessary measures for civil protection. The Ministry of Defence is the head of civil preparedness planning, and is responsible for implementing the necessary measures⁴⁸¹. The Danish Emergency Agency is organized under the Ministry of Defence, and has the purpose, as stated in the report from 2015, “to ensure a robust society by developing and strengthening preparedness, in order to prevent and respond to major accidents and disasters”. It is further stated on their web page that “their mission is to cushion the effects of accidents and disasters on society and to prevent harm to people, property and the environment”. DEMA has a number of operational, supervisory and regulatory functions concerning management and preparedness, which includes five regional centre’s for national rescue preparedness. The regional centre’s assists the municipal rescue preparedness when

⁴⁷⁹ DEMA (2006). Introduction and User Guide - DEMA’s Model for Risk and Vulnerability Analysis . *Danish Emergency Management Agency*. Available at:

http://brs.dk/eng/inspection/contingency_planning/rva/Pages/vulnerability_analysis_model.aspx. Accessed: 2 May 2016.

⁴⁸⁰ DEMA (2005). National Sårbarhedsrapport 2005. *Danish Emergency Management Agency*. Available at: http://brs.dk/viden/publikationer/Documents/National_Saarbarhedsrapport_2005.pdf. Accessed: 2 May 2016.

⁴⁸¹ European Commission, 2014. http://ec.europa.eu/echo/files/civil_protection/vademecum/dk/2-dk-1.html#over.

International Survey

it is needed. Each municipality prepare contingency plans for all tasks they are responsible for in peacetime and in periods of crisis and war. In addition, has a National Operational Staff (NOST) been established in Denmark. NOST play a coordinate role in case of major incidents, disasters and security threats. The Centre for Resilience and Contingency Planning advises and guides national, regional and local authorities in contingency planning and strategic crisis planning. The centre also develops tools and methods that can support the work with preparedness in all sectors, both private and public⁴⁸².

4.4.3. Technical, Organisational, Social, Economic Resilience

In the report “Crisis Management in Denmark” from 2015, DEMA refers to the National Crisis Management System. This management system is applicable to any kind of accident or disaster. The authorities can, as stated in the report, “activate the national crisis management systems, or parts of it, if it is assessed that a given incident cannot be managed effectively, or sufficiently fast, by ordinary measures, or when a cross-sectoral coordination and mutual orientation is necessary”⁴⁸³. The main objective of the management system is to limit the consequences of major accidents and disasters in a way that society quickly can return to normal state. The national crisis management system is described in the National Crisis Management Plan. The plan establishes framework and procedures which applies for authorities when many different actors cooperate to manage major disasters and accidents. Further, according to chapter 5 in the Danish Emergency Management Act, “all authorities are required, within their sectors, to plan for continuity and maintenance of vital societal functions in case of a major accidents and disasters. This includes the development of preparedness plans”. The term critical or vital societal functions is by the agency referred to as activities, commodities, services, etc., that underpin society’s general ability to function⁴⁷⁷.

4.4.4. Resilience Related Official Documents

Since DEMA was formed in 1992, it has published a number of reports. From 2005 to 2010 it published yearly national vulnerability reports. In 2013, it published Denmark’s first National Risk Profile, according to the guidelines of the European Commission. Other public documents published of DEMA worth mentioning are the DEMA’s Model for Risk and Vulnerability Analysis. There exists a number of legislative frameworks for civil protection: 1) Emergency Management Act, 2) Act of Shelters, and 3) Act of Safety and Environmental Control of Nuclear Installations, among others. At ministerial level, 1) Order of the Ministry of Environment No 1156 of 18 November 2005 on the control of major accidents involving accidents involving dangerous substances, 2) Order of the Ministry of Defence no 765 of 3 August 2005 regarding risk-based municipal fire and rescue service as amended by Order no 872 of 6 July 2007, and 3) The National Crisis Management Plan - which is produced and revised according to the Emergency Management act - is worth mentioning.

5. Conclusions

Critical infrastructure resilience was found to be a relatively new concept on the EU context, and no real policy in this field was found. While several national-level definitions of the concept of critical infrastructure resilience in Europe can be found, there is no official EU-level definition of critical infrastructure resilience.

⁴⁸² DEMA (2014). About DEMA. *Danish Emergency Management Agency*. Available at: <http://brs.dk/omstyrelsen/opgaver/styrelsen/default/Pages/Enheder.aspx#CBK> Accessed: 27 October 2015.

⁴⁸³ DEMA (2015). Danish national crisis management. *The Danish Emergency Management Agency*. Available at: http://brs.dk/eng/emergency_management/national_emergency_management_organisation/Pages/national_emergency_management_organisation.aspx. Accessed: 2 May 2016.

Norway was found to be one of the forerunners in critical infrastructure protection, taking into account critical societal functions and not only mere critical infrastructures. However, the country does not have an official concept of critical infrastructure resilience.

Sweden also focuses on critical infrastructure protection rather than resilience. However, in its national strategy for protection of important public services, the Swedish Government set a goal of developing a more resilient society.

The UK was found to have an official state-level concept of critical infrastructure resilience. The concept of resilience is highly developed at local, national and critical national infrastructure levels.

The concept of resilience is in its early stages of development in Denmark.



IMPROVED RISK EVALUATION AND IMPLEMENTATION OF RESILIENCE CONCEPTS
TO CRITICAL INFRASTRUCTURE

Appendix 4 - Resilience Concepts in Africa

Editor:

L. MELKUNAITE (DBI)

Author:

I. IOANNOU (UCL)

Deliverable Number: D1.1

Date of delivery: May 31, 2016

Month of delivery: M12



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 653390

Coordinator:	David Lange at SP Sveriges Tekniska Forskningsinstitut (SP Technical Research Institute of Sweden)

Table of Contents

1	Executive Summary	124
2	Nomenclature	124
3	Resilience concepts in Africa	125
3.1.	Concept of Resilience	127
3.2.	Institutional Framework for Delivering Resilience	132
3.3.	Critical Infrastructure and Technical Resilience	132
3.4.	Organisational resilience	134
3.5.	Social resilience	135
3.6.	Economic resilience	136
3.7.	Additional attempts to build resilience in Africa	137
3.8.	Resilience Related Official Documents	140
4	Conclusions	140

1. Executive Summary

Africa is a poor continent which suffers from recurrent disasters caused by conflict, drought and flood. These disasters hinder the economic development and the eradication of poverty in Africa. In recent years, the political commitment of the African leaders to reduce the risk of disaster led to fruitful collaboration with the international community aiming to build economic, technical, organisational, societal and ecological resilience of fragility states and eco-system as well as vulnerable communities and organisations. Emphasis is given to the development of strategies which will improve the capacity of the urban and rural poor mostly in Sub-Saharan Africa to survive and thrive during shocks and stresses. With regard to the physical infrastructure, which is of particular interest to IMROVER, although its resilience is considered essential to the sustainable development of Africa, limited attention is given to the improvement of its resilience using a robust resilience framework.

2. Nomenclature

AGIR	Global Alliance for Resilience
AU SAFGRAD	African Union through the Semi-Arid Food Grain Research and Development
CILSS	Permanent Interstates Committee for Drought Control in the Sahel
CIUP	Community Infrastructural Upgrading Programme
CPIA	the Country Policy and Institutional Assessment
CSO	Civil Society's Organization
DRR	Disaster risk reduction
ECOWAS	Economic Community Of West African States
FAO	Food and Agriculture Organization of the United Nations
IDDRSI	Drought Disaster Resilience and Sustainability Initiative
IGAD	Inter-governmental Authority on Development
IMF	International Monetary Fund
INTRAC	International NGO Training and Research Centre
NGO	Non-government organisations
OECD	Organization for Economic Cooperation and Development
RAN	Resilient Africa Network
SWAC	Sahel and West Africa Club Secretariat
UEMOA	West African Economic and Monetary Union
UNDP	United Nations Development Programme
UNICEF	United Nations Children's Fund
UNISDR	United Nations International Strategy for Disaster Reduction
WEF	World Economic Forum
WFP	The World Food Programme

3. Resilience concepts in Africa

Africa has 1.1 billion inhabitants living in 55 recognized states. It is the second largest and the second most populated continent after Asia. Africa remains the poorest continent with \$1,576 Gross Domestic Product per capita as opposed to \$39,052 of the richest Oceania. Nigeria, Egypt and South Africa are the three strongest African economies and Sub-Saharan countries represent the poorest areas on the planet despite the very large (over 4%) growth rates experiences in the past two decades. Africa relies on agriculture, which supports 80% of its population and provides employment for the 60% of the economically active Africans. This widespread poverty makes the African continent vulnerable to a number of natural as well as human-induced hazards, which often lead to disasters. In recent years, the African states appear, at least in principle, to be politically committed to collaborate with the international community in order to reduce the risk of disaster and strengthen their resilience. This report presents a brief introduction to the main hazards in Africa, a historical background of the resilience research. The definition of the resilience by existing literature follows and the report concludes with a review of studies which propose strategies to build economic, technical, organizational and societal resilience in Africa.

Africa suffers from a number of natural (e.g., droughts) and human-induced (e.g., civil war) hazards. Most of these hazards lead to disasters due to the highly vulnerable African communities which suffer from poverty, unemployment, and chronic under-development, rapid expansion of the cities and unsustainable use of the natural resources.

The natural hazards can be divided into four sub-groups, namely: climatological, hydrological meteorological, geophysical, biological and astrophysical (see Appendix 1). The disasters caused by the first four sub-groups of hazards have been systematically monitored^{484,485,486,487,488}. Since 2000, Africa appears to have suffered on average 59 disasters per year caused by the first four sub-groups hazards (see Figure 3.). This represents the 17% of the total number of annual disaster occurring globally by these sub-group of hazards, which caused 10% of the global annual number of victims and caused 0.6% of the global annual economic loss. The small percentage of the loss can be attributed to the underreporting of the losses and the poor state of infrastructure networks in Africa. The disaggregation of the data according to hazard sub-groups shows that Africa is affected mostly by hydrological and climatological hazards. In particular, droughts and floods cause the highest number of losses and victims respectively. Both hazards are recurrent phenomena which are expected to intensify in the future due to the climate change. The Global Risks 2015⁴⁸⁹ commissioned by the World Economic Forum identified water scarcity as major risks for North Africa. Biological hazards, such as the HIV/AIDS, malaria or Ebola infections, also represent natural hazards associated with high

⁴⁸⁴ Guha-Sapir D., Hoyois P., Below R. (2012). Annual disaster statistical review 2011: The numbers and trends. *Centre for Research on the Epidemiology of Disasters*, Brussels, Belgium. Available at: http://www.cred.be/sites/default/files/ADSR_2011.pdf. Accessed: 25 April 2016.

⁴⁸⁵ Guha-Sapir D., Hoyois P., Below R. (2013). Annual disaster statistical review 2012: The numbers and trends. *Centre for Research on the Epidemiology of Disasters*, Brussels, Belgium. Available at: http://www.cred.be/sites/default/files/ADSR_2012.pdf. Accessed: 25 April 2016.

⁴⁸⁶ Guha-Sapir D., Hoyois P., Below R. (2014). Annual disaster statistical review 2013: The numbers and trends. *Centre for Research on the Epidemiology of Disasters*, Brussels, Belgium. Available at: http://www.cred.be/sites/default/files/ADSR_2013.pdf. Accessed: 25 April 2016.

⁴⁸⁷ Guha-Sapir D., Hoyois P., Below R. (2015). Annual disaster statistical review 2014: The numbers and trends. *Centre for Research on the Epidemiology of Disasters*, Brussels, Belgium. Available at: http://www.cred.be/sites/default/files/ADSR_2014.pdf. Accessed: 25 April 2016.

⁴⁸⁸ Scheuren J-M., Polain de Waroux O., Below R., Guda-Sapir D., Ponserrre S. (2008). Annual disaster statistical review 2007: The numbers and trends. *Centre for Research on the Epidemiology of Disasters*, Brussels, Belgium. Available at: http://www.cred.be/sites/default/files/ADSR_2007.pdf. Accessed: 25 April 2016.

⁴⁸⁹ WEF, (2015). Global risks 2015, 10th edition. *World Economic Forum*, Geneva, Switzerland. Available at: http://www3.weforum.org/docs/WEF_Global_Risks_2015_Report15.pdf. Accessed 25 April 2016.

International Survey

disaster risk. According to Mulugeta G. et al.⁴⁹⁰, they represent the 36% of all disasters in Africa and have been identified as a major challenge for Sub-Saharan⁴⁸⁹.

Many African countries have also been affected by social and political instability as well as long and bitter conflicts, which jeopardize their development. The Global Risks 2015 Report identified that political and unemployment as the main challenges faced by North and Sub-Saharan Africa, respectively⁴⁸⁹. The study of conflicts in Africa found that exploitation of scarce renewable resources such as land, grazing areas and water, is likely to lead to localized conflicts⁴⁹¹. By contrast, the control of extractive resources such as oil, gas and minerals can fuel national and international conflicts. It was also found that countries that were recovering from conflicts related to the extraction resources were more likely to relapse to conflict than countries that were recovering from other types of conflict.

⁴⁹⁰ Mulugeta G., Ayonghe S. et al.(2007). Natural and human-induced hazards and disasters in sub-Saharan Africa. *ICSU Regional Office for Africa*. Republic of Seychelles. Available at: http://www.icsu.org/icsu-africa/publications/reports-and-reviews/icsu-roa-science-plan-on-hazards-disasters/Doc%20SP03.1_ICSU%20ROA%20Science%20Plan%20-%20Hazards%20and%20Disasters.pdf Accessed: 25 April 2016.

⁴⁹¹ Coyle I., Bruch C. (2014/2016). From Fragility to Resilience Managing Natural Resources in Fragile States in Africa. *African Development Bank Group*. Available at: http://www.afdb.org/fileadmin/uploads/afdb/Documents/Publications/From_Fragility_to_Resilience_-_Managing_Natural_Resources_in_Fragile_Situations_in_Africa.pdf. Accessed: 25 April 2016

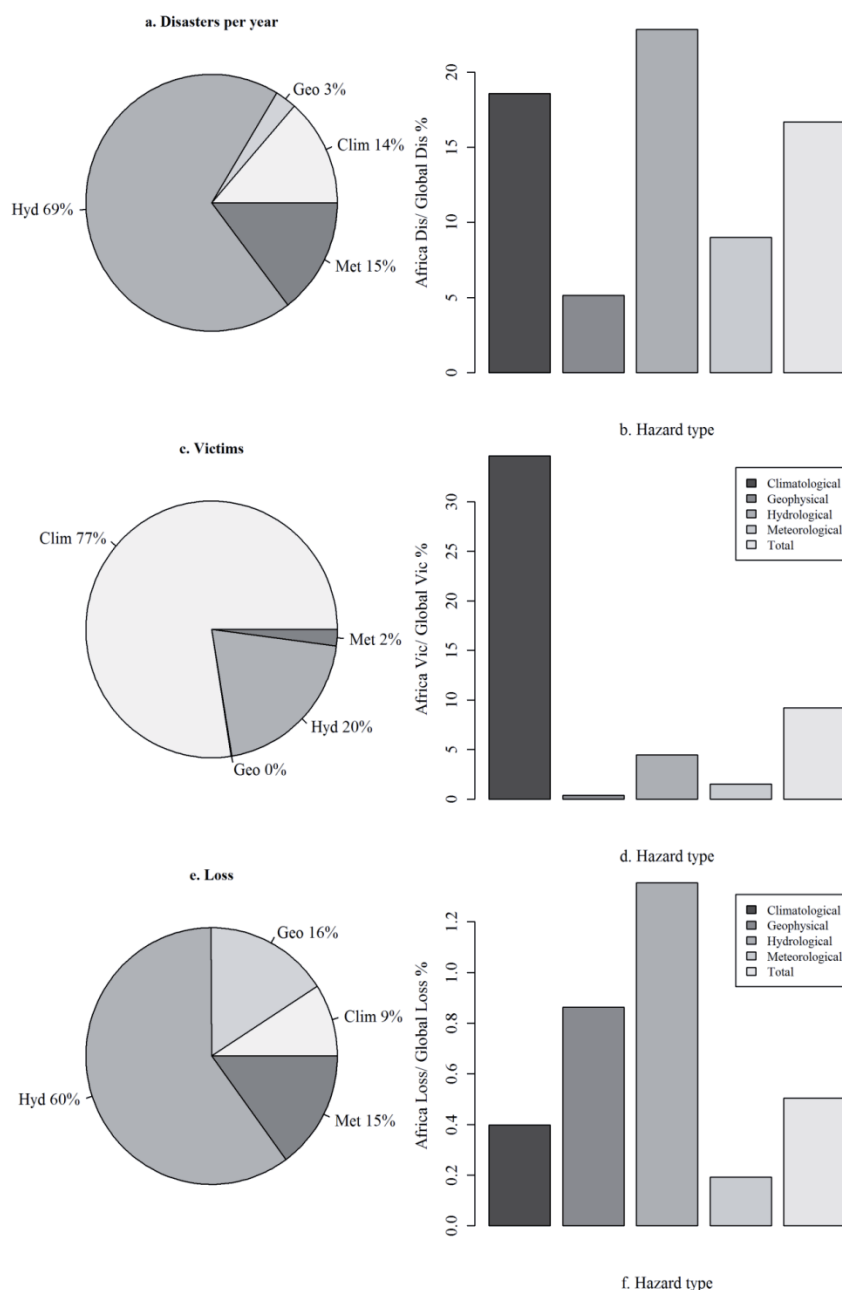


Figure 3.1 Natural hazard disaster statistics^{484,485,486,487,488}.

3.1. Concept of Resilience

Resilience is not a well established concept in Africa. It is rather international and regional organisations that try to introduce the concept of resilience in the continent. For example, IGAD's initiative IDDRSI defined resilience to droughts as "the ability of countries, communities, and households to cope and manage change, by maintaining or transforming living standards in the face of droughts without compromising their long-term prospects"⁴⁹². Similarly, AGIR defined resilience as "the capacity of vulnerable households, families, communities and system to face uncertainty and the

⁴⁹² IGAD (2013). The IGAD drought disaster resilience and sustainability initiative (IDDRSI Strategy). *Intergovernmental Authority On Development*. Available at: http://resilience.igad.int/attachments/article/210/IDDRSI_Strategy_Revised_January_2013.pdf. Accessed: 25 April 2016.

International Survey

risk of shocks, to withstand and respond effectively to shocks, as well as to recover and adapt in a sustainable manner”. Finally, RAN, an African institution, defined social resilience as the “capacity of people and systems to mitigate, adapt to, recover, and learn from shocks and stresses in a manner that reduces vulnerability and increases well-being”⁴⁹³.

IMF defined resilience of the Sub-Saharan states as a “condition where institutional strength, capacity, and social cohesion are sufficiently strong for the state to promote security and development and to respond effectively to shocks”⁴⁹⁴. Resilience of each state is measured by its level of fragility quantified in terms of the Country Policy and Institutional Assessment (CPIA) or whether it has experience a conflict. The CPIA is used to rate states and is based on a set of criteria regarding:

- economic management,
- structural reforms,
- policies for social inclusion and equity,
- public sector management.

In addition, resilience of the co-operatives in Malawi is determined by “its ability to maintain their core functions while responding to shock and stress hazards”⁴⁹⁵.

FAO defined resilience as “the ability to withstand threats or to adapt to new strategies in the face of shocks and crises, in ways that preserve the integrity of individuals, households and communities (while not deepening their vulnerability) with a focus on merging humanitarian and development programming to better address overlapping risks and stresses”⁴⁹⁶. Similarly, the Montpellier Panel defined resilience as “the capacity of agricultural development to withstand or recover from stresses and shocks and thus bounce back to the previous level of growth”⁴⁹⁷.

With regard to the international institutions which focused on the African urban resilience, the UNISDR defined resilience as the “capacity of urban cities to withstand and recover from natural disasters”⁴⁹⁸. Similarly, Arup defined urban resilience as “the capacity of cities to function, so that the people living and working in cities – particularly the poor and vulnerable – survive and thrive no matter what stresses or shocks they encounter”. Finally, according to Strauch et al., social-ecological resilience refers “to the dynamic process of adaptive learning, reorganization and meaning-making demonstrated in linked human, animal, and plant ecosystems often organized in formal and/or informal social institutions, as they anticipate, withstand and/or judiciously engage with adversity while maintaining function without fundamentally losing their identity”⁴⁹⁹.

Different international and regional organisations aim to introduce the concept and practice of resilience in the region. The recurrent disasters in Africa show that strategies limited to immediate emergency response, although necessary, are no longer enough and the long-term recovery of the affected communities should be considered in order to reduce the disaster risk. In 2005, 47 African

⁴⁹³ Cooke, C.G. (2015). The state of African resilience: Understanding dimensions of vulnerability and adaptation. *Resilient Africa Network*.

⁴⁹⁴ Gelbard, E., Deléchat C., et al. (2015). Building resilience in Sub-Saharan Africa’s fragile states. *International Monetary Fund*. Washington D.C. USA. <https://www.imf.org/external/pubs/ft/dp/2015/afr1505.pdf>

⁴⁹⁵ Vicari, S., Borda-Rodriguez A. (2014). Building resilience in the Malawian co-operative movement. *The co-operative college*. <https://coopseurope.coop/development/sites/default/files/building-resilience-in-malawian-co-operative-movement.pdf>

⁴⁹⁶ Lenayapa, L.N. (2012). Programming Framework to End Drought Emergencies in the Horn of Africa - Ending Drought emergencies in Kenya. *Republic of Kenya*.

⁴⁹⁷ The Montpellier Panel. London: Agriculture for Impact; Growth with resilience: Opportunities in African Agriculture.

⁴⁹⁸ UNISDR (2012). City Resilience in Africa: A ten essentials pilot. My city is getting ready! Available at: http://www.unisdr.org/files/29935_cityresilienceinafricansdate.pdf. Accessed: 26 April 2016.

⁴⁹⁹ Resilience Analysis Unit (2015). Resilience context analysis: Resilience to food insecurity and malnutrition in Karamoja, Uganda. Available at: <http://documents.wfp.org/stellent/groups/public/documents/ena/wfp276266.pdf>. Accessed: 26 April 2016.

states member of the African Union agreed to adopt the Hyogo Framework for Action⁵⁰⁰⁵⁰¹. The framework called for actions aiming to account for disaster risk reduction strategies into emergency response and management in national, sub-regional and regional levels. Despite the commitment of the African leaders, the implementation of the plan was found to be weak⁵⁰². They found that although most African states have established a national level disaster management planning, the implementation of this plan is rather weak. For example, Ghana has set up a National Organisation for emergency and disaster response and general disaster preparedness. It involves management committees at national, regional and district level which should collaborate at all levels. However, in Accra the flood risk reduction is not a top priority which means that the impact of floods is not reduced. In Mozambique, a new Master Plan for Prevention and Mitigation of Natural Disasters was approved in March 2006, however it addresses the problems in national level and does not focus on urban areas.

The turning point for the urgent need for the African states to develop climate resilience was the humanitarian crisis in 2011 at the Horn of Africa which affected 13 million people. This crisis forced the member states of the Inter-governmental Authority on Development (IGAD) to establish the Drought Disaster Resilience and Sustainability Initiative (IDDRSI) aiming to put an end to the drought disasters in the Horn of Africa by building resilience of the vulnerable communities through economic development⁴⁹². IGAD proposed a programme for strengthening resilience in the affected countries which included 7 areas⁴⁹⁶:

- Peace and human security
- Humanitarian preparedness
- Infrastructure development
- Human capital
- Sustainable livelihoods
- Coordination
- Drought contingency finance.

Kenya with 36% of the population living in arid or semi-arid areas actively participated in this initiative which lead to concrete steps towards the ending of drought emergencies⁴⁹⁶. This involved the establishing of a National Drought Management Authority and a 10 year budget to fund initiatives related to the 7 aforementioned areas. Most of the budget was assigned to the improvement of infrastructure and ensuring sustainable livelihoods mainly by funding irrigation projects and livestock production. In 2012, the UKAid decided to assist Kenya in building its drought resilience by concentrating on the most marginalised poor people in the arid and semi-arid rural areas of eastern and northern Kenya, and investing in medium and long-term programmes which will increase the ability of the households to withstand environmental, security and market shocks⁵⁰³. However, despite drought management activities, there is still reliance to the short term emergency aid. For this reason, the UKAid through the Development fund for International development provides funding to programmes

⁵⁰⁰ Peace, T.R. (2011) Extended Programme of Action for the Implementation of the Africa Regional Strategy for Disaster Risk Reduction (2006 - 2015) and Declaration of the 2nd African Ministerial Conference on Disaster Risk Reduction 2010. *United Nations International Strategy for Disaster Reduction, African Union Commission*.

⁵⁰¹ UNISDR (2005). Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters. Hyogo, Japan. World Conference on Disaster Reduction.. Available at: http://www.unisdr.org/files/1037_hyogoframeworkforactionenglish.pdf. Accessed: 26 April 2016.

⁵⁰² ActionAid (2006). Climate change, urban flooding and the rights of the urban poor in Africa: Key findings from six African cities. *Action Aid International*. Available at: http://actionaid.org/sites/files/actionaid/climate_change_urban_flooding_and_the_rights_of_the_urban_poor_in_africa.pdf. Accessed: 26 April 2016.

⁵⁰³ Department for International Development (2012). Building resilience in Kenya. *UKAid*. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/191916/Approach_to_disaster_resilience_-_Kenya_case_study.pdf. Accessed: 26 April 2016.

International Survey

aiming to provide income for the worst hit by the droughts, to prevent acute malnutrition, to support the education in arid lands and to extend market access for the poor. UKAid also argued for the need to increase the funding from the building resilience to droughts rather than concentrating to the humanitarian aid by performing a cost-benefit analysis to the cost of humanitarian aid and building drought resilience to Kenya and Ethiopia⁵⁰⁴.

In 2015 IGAD in collaboration with the Food and Agriculture Organization of the United Nations (FAO), United Nations Children's Fund (UNICEF), United Nations Development Programme (UNDP) and the World Food Programme (WFP) tried to identify unique factors which affect resilience of households or community in Karamoja, the least developed area in Uganda⁴⁹⁹.

Climate resilience is also supported by the African Union through the Semi-Arid Food Grain Research and Development (AU SAFGRAD) office which aims to lead, coordinate and facilitate programs aiming to build resilience in rural livelihoods in semi-arid African areas through agricultural research, technology transfer and adoption, management of natural resources and mitigation as well as adaptation to climate change and combating desertification off the soil⁵⁰⁵.

The humanitarian crisis in 2011 also led to a long term political alliance between the European Union, the Economic Community Of West African States (ECOWAS), UEMOA (West African Economic and Monetary Union) and Permanent Interstates Committee for Drought Control in the Sahel (CILSS)⁵⁰⁶. The alliance, called Global Alliance for Resilience (AGIR), was established in 2012 aiming to eradicate hunger in the Sahel and West Africa region in 20 years by addressing the causes of the recurrent food and malnutrition crisis. The Food and Agriculture Organization of the United Nations (FAO) also concentered on building resilience of people living in Africa's drylands and heavily relying on agriculture. These communities tend to be affected the worst when a disaster strikes. These programs focused on:

- Strengthening of the capacity of the institutions in the area focusing on the Regional Economic Communities;
- Monitoring of the risks by mapping the vulnerability and assessing resilience as well as improving early warning systems;
- Building of economic, technical and social resilience;
- Development of emergency response measures.

A subsequent study by the FAO in collaboration with the European Union produced a resilience measurement index which aimed to identify the most vulnerable segments within the African population, their geographic location, the dimension of the resilience which needed strengthening, and the impact that the intervention would have on the most vulnerable⁵⁰⁷. This index was used for the assessment of resilience in 4 countries namely, Senegal⁵⁰⁸, Mali⁵⁰⁹, Niger⁵¹⁰ and Burkina Faso⁵¹¹.

⁵⁰⁴ Venton C.C., Fitzgibbon C., et al. (2012). The Economics of Early Response and Disaster Resilience: Lessons from Kenya and Ethiopia. Department for International Development, UKAid. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/67330/Econ-Ear-Rec-Res-Full-Report_20.pdf Accessed: 26 April 2016.

⁵⁰⁵ African Union Safeguard, Current Programs, UA-Safgard. Available at: <http://www.ua-safgrad.org/programs/current-programs>. Accessed: 26 April 2016.

⁵⁰⁶ SWAC, OECD (2013). AGIR - Global Alliance For resilience - Sahel and West Africa. Available at: <http://www.oecd.org/site/rpca/agir/>. Accessed: 26 April 2016.

⁵⁰⁷ FAO (2014). Resilience Index Measurement and Analysis Model. *Food and Agriculture Organization of the United Nations*. Available at: <http://www.fao.org/3/a-i4102e.pdf>. Accessed: 26 April 2016.

⁵⁰⁸ FAO (2015). Resilience analysis in Senegal. *The Food and Agriculture Organization of the United Nations*. Rome, Italy. Available at <http://www.fao.org/3/a-i4456e.pdf>. Accessed: 26 April 2016.

⁵⁰⁹ FAO (2015). Resilience analysis in Mali. *The Food and Agriculture Organization of the United Nations*. Rome, Italy. Available at: <http://www.fao.org/3/a-i5093e.pdf>. Accessed: 26 April 2016.

In 2012, the FAO in collaboration with UNICEF and the World Food Programme (WFP) initiated a programme in Somalia, a country which suffered the impact of a civil war, aimed at increasing community resilience towards food deprivation⁵¹². The program recognizes that the state is still too weak to take care of the most vulnerable people, and thus it is focused on interventions regarding the strengthening of the productive sectors (both the livestock and the crops), improving the basic social services and establishing safety nets.

Other initiatives come from private funding bodies such as for example the Bill and Melinda Gates Foundation which brings together a number of European and African experts in agriculture, ecology, trade and global development and aims to improve the regional agricultural development and food security of Sub-Saharan Africa⁴⁹⁷. The panel advocated national policies where the farmers can increase productions ensuring that the food is at reasonable prices. The increase of production depends on the use of new and efficient technologies which combat soil and water degradation and provide climate-resilient crops. Finally, the policies ensure that there is a safety social net which ensures that the most vulnerable people have access to adequate food and nutrition during a hazard event.

There are also initiatives aimed at assessing and increasing resilience of African cities. Following the Hyogo framework for action, in 2012 UNISDR launched a global resilient cities campaign aimed at assessing and improving the capacity of African cities to withstand and recover from natural disasters using 10 point checklist of factors that are considered to be fundamental for resilience of urban spaces⁴⁹⁸. The project started with a pilot study for 3 cities, Narok and Kisumu in Kenya and Moshi in Tanzania, and highlighted ways to improve the methodology as well as the causes of the inability of local governments to build effective climate resilience in the three cities. In 2010, The World Bank commissioned a report on building resilience to increasingly frequent extreme weather (i.e., heavy rains and dust storms) among the urban poor in Mombasa, Kenya⁵¹³. In 2014, Arup funded by the Rockefeller foundation produced a framework which could be used by cities to assess their resilience to a number of natural and man-made disasters⁴⁹⁸. The African cities such as Durban (South Africa), Accra (Ghana), Arusha (Tanzania), Dakar (Senegal), Enugu (Nigeria) and Kigali (Rwanda) committed to 'Is your city ready' project run by Arup and the Rockefeller Foundation to improve their resilience to a number of hazards.

There are also a number of initiatives aimed to strengthen resilience of infrastructure, eco-systems and the national economies. In particular, the World Bank proposed ways to strengthen the transport infrastructure in Ethiopia⁵¹⁴, Mozambique⁵¹⁵, Ghana⁵¹⁶ either by short-term maintenance projects or long-term design initiatives. The adopted methodology allowed to estimate the impact of no adaptation

⁵¹⁰ FAO (2015). Resilience analysis in Niger. *The Food and Agriculture Organization of the United Nations*. Rome, Italy. Available at: <http://www.fao.org/3/a-i5045e.pdf>. Accessed: 26 April 2016.

⁵¹¹ FAO (2015). Resilience analysis in Burkina Faso. *The Food and Agriculture Organization of the United Nations*. Rome, Italy. Available at: <http://www.fao.org/3/a-i5044e.pdf>. Accessed: 26 April 2016.

⁵¹² FAO, UNICEF, WFP (2012). A Strategy for Enhancing Resilience in Somalia. Available at: http://www.fao.org/fileadmin/templates/cfs_high_level_forum/documents/Brief-Resilience-JointStrat-FinalDraft.pdf. Accessed: 26 April 2016.

⁵¹³ Moser C., Norton A., et al. (2010). Pro-poor adaptation to climate change in urban centres: Case Studies of Vulnerability and Resilience in Kenya and Nicaragua. *World Bank* Available at: http://siteresources.worldbank.org/EXTSOCIALDEVELOPMENT/Resources/244362-1232059926563/5747581-1239131985528/ESW_propoorurbanadaptationReport4947GLBweb2.pdf. Accessed: 26 April 2016.

⁵¹⁴ World Bank (2010). Making Transport Climate resilient: Country report Ethiopia. Denmark Available at: <https://openknowledge.worldbank.org/bitstream/handle/10986/12889/698920ESW0P1010a0final00120Aug02010.pdf?sequence=1&isAllowed=y>. Accessed: 26 April 2016.

⁵¹⁵ World Bank (2010). Making Transport Climate resilient: Country report Mozambique. Denmark Available at: http://www-wds.worldbank.org/external/default/WDSCContentServer/WDSP/IB/2012/06/14/000425970_20120614113225/Rendered/PDF/693920ESW0P102000monitorinMZ0final00.pdf. Accessed: 26 April 2016.

⁵¹⁶ World Bank (2010). Making Transport Climate resilient: Country report Ghana. Denmark Available at: http://www-wds.worldbank.org/external/default/WDSCContentServer/WDSP/IB/2012/06/14/000425970_20120614132713/Rendered/PDF/695990ESW0P102000final00120Aug02010.pdf. Accessed: 26 April 2016.

in various future scenarios and to estimate the cost of reducing the risk that the investment in infrastructure will be unsuited with the actual future climate. This methodology has also been adopted in order to design hydropower infrastructures (e.g., dams, roads, power stations) in 7 basins located in Congo, Niger, Nile, Orange, Senegal, Volta, and Zambezi⁵¹⁷. Other initiatives aim at building ecological resilience of important lakes, such as for example the Lake Chad^{518,519}. The African Development Bank Group also proposed a framework for the better use of the natural resources⁴⁹¹. The IMF focuses on strategies to build the economic resilience of 26 Sub-Saharan states, which are unable to cover the basic needs and deliver security to their people⁴⁹⁴.

Finally, international initiatives also build networks such as the Resilient Africa Network (RAN), which is funded by USAID and brings together 20 universities in 16 African countries, the Tulane University, Stanford University and its Centre for Strategic and International Studies. RAN developed a methodology to assess societal resilience, which was then applied to develop a strategy of increasing the resilience of a poor district in Zimbabwe with a very high rate of HIV/AIDS infected population⁴⁹³.

3.2. Institutional Framework for Delivering Resilience

There are no official documents where the concept resilience is used.

3.3. Critical Infrastructure and Technical Resilience

No official state level definition of critical infrastructure resilience was found while performing the literature review. It should be mentioned that infrastructures in Sub-Saharan Africa are very poor and require investment of around \$93 billion US dollars for the next ten years⁵¹⁷. Once again, it is the international organisations that aim to build resilience of infrastructures in African states. For example, The World Bank initiated a project to address the coastal risks on three North African cities, namely Alexandria, Tunis and Casablanca, concentrating on the most vulnerable urban illegal settlements⁵²⁰. The report urges to improve urban infrastructures such as coastal defences and drainage systems.

In Alexandria, 1/3 of the population lives in unplanned settlements, which are the most vulnerable and exposed areas in the city⁵²⁰. Until 2030, Alexandria's risk of tsunami/marine submersion, coastal erosion and water scarcity are expected to increase from medium or low to high. The risk of an earthquake and flooding is expected to also increase from low to medium. Overall, the cumulative loss from natural disasters and climate change impacts is expected to be \$1.72 billion in Net Present Value for the period 2010-2030. Based on this risk, the urban plan should ensure that the city does not expand to the areas of highest risk and should establish the density of the population and building heights. The city should also install early-warning systems are proposed for all types of disasters and approve investments on more resilient structures. These structures include the coastal defence, drainage systems and mobile water pumps protection during flooding. Similar recommendations were

⁵¹⁷ Cervigni R., Liden R., et al. (2015). Enhancing the Climate Resilience of Africa's Infrastructure: The Power and Water Sectors. *The World Bank*. Washington D.C. USA. Available at: <http://www.worldbank.org/content/dam/Worldbank/Feature%20Story/Africa/Conference%20Edition%20Enhancing%20Africas%20Infrastructure.pdf>. Accessed: 26 April 2016.

⁵¹⁸ Kafumbata D., Jamu D., et al. (2014). Riparian ecosystem resilience and livelihood strategies under test: lessons from Lake Chilwa in Malawi and other lakes in Africa. *Philosophical Transactions B: Biological Sciences*. P369

⁵¹⁹ Mekonnen, Dawit Tadesse. (2016). The Lake Chad development and climate resilience action plan: Summary. *World Bank Group* Washington D.C USA. Available at: <http://documents.worldbank.org/curated/en/2016/01/25811845/lake-chad-development-climate-resilience-action-plan-summary> Accessed: 26 April 2016.

⁵²⁰ Bigio, A.G. (2011). North African coastal cities: Address natural disasters and climate change. *The World Bank*. Available at: <http://web.worldbank.org/archive/website01418/WEB/IMAGES/ALEXANDR.PDF>. Accessed: 26 April 2016.

also made for Casablanca, another rapidly expanding city with many new settlements in vulnerable locations close to the sea⁵²⁰.

The urban plan for this city involves the creation of model eco-neighbourhoods of sustainable, climate resilient design and construction. Early warning systems should also be included and the physical barriers to physical vulnerability by the coast should be strengthened and houses on the coast should be removed, especially in the areas which already experience coastal erosion and sea storm surges. Finally, Tunis is a more modestly expanding city faced by an increase in the risk of flooding and coast erosion from high to very high over the next 15 years⁵²⁰. It is also faced by an increase in the low risk of water scarcity to medium and increase of the medium risk of earthquake or tsunami to high. Overall, the accumulated loss of natural disasters from 2010-2030 is estimated to a Net Present Value of \$1.05billion. Resilience of the city infrastructures can be increased by upgrading the drainage systems in the areas below the sea level, and constraining the expansion of unplanned settlements in high-risk areas. The zoning of the city should also be revised taking into account highly vulnerable areas. The risk of flooding could be mitigated by reducing the amount of water on the ground by installing green roofs, rainwater storage and other environment friendly constructions. Given the high likelihood of earthquakes and tsunamis, early-warning systems should be put in place.

The World Bank started to implement Community Infrastructural Upgrading Programme (CIUP) in the city of Dar es Salaam in Tanzania⁵²¹. The city has experienced one of the highest growth rates (~8% per year) in recent years. 70% of its 4 million residents live in unplanned, dense settlements which often do not have access to clean water or hygienic sanitation and are prone to floods. Most of these residents are unemployed or under-employed migrants from other parts of Tanzania who came in Dar es Salaam for a better future. The programme aims to assist the local authorities to improve the overall resilience of the city by upgrading the infrastructure, for example building storm water drainage networks and regularising the unplanned settlements, issuing licenses for each property in these settlements. The local authorities identified communities, representing the 20% of the total unplanned settlements of the city, living in poorly built houses, lacking even basic services such as clean water, suffering from the high risk of flooding. The upgrading of the infrastructure is performed by bottom-up planning which involves the collaboration between the technical project staff, the local authorities and the local residents in order to increase the community awareness and participation in the program.

The World Bank also initiated a project aiming to build hydropower infrastructure (e.g., dams, roads, power stations) and this way increase its technical potential in 7 basins located in Congo, Niger, Nile, Orange, Senegal, Volta, and Zambezi⁵¹⁷.

A series of World Bank studies aimed to increase the climate resilience of the transport networks in Ethiopia⁵¹⁴, Mozambique⁵¹⁵, Ghana⁵¹⁶. All three networks are overloaded and missing maintenance and repair. The increase in the amount of rainfall due to changing climate conditions is expected to have a high impact on these transport networks. The study proposed both short and long term strategies aimed at improving the overall design as well as maintenance of the transport networks in the three countries. Long-term initiatives included updating of the design codes with the most recent research regarding the climate and the most effective construction techniques. Short term initiatives focused on maintenance strategies.

⁵²¹ Dickson E., Baker J.L., et al. (2012). Urban Risk Assessment: Understanding disaster and climate risk in cities. *The World Bank*. Washington D.C. USA. Available at: http://www-wds.worldbank.org/external/default/WDSCContentServer/WDSP/IB/2012/07/13/000386194_20120713023320/Rendered/PDF/709820PUB0EPI0067926B09780821389621.pdf. Accessed: 27 April 2016.

3.4. Organisational resilience

No official state document regarding the organisational resilience has been found. However, international and regional organisations implemented quite a few programmes aimed at increasing resilience of community based organisations in African states.

In 2005, the International NGO Training and Research Centre (INTRAC) and PSO Netherlands produced a list of proposals which could assist Civil Society's Organizations (CSOs) which have a large number of AIDS/HIV infected employees in building organisational resilience⁵²². In some Sub-Saharan Africa communities, the AIDS/HIV pandemic has affected the 20%-40% of the adult population⁵²². This seems to have a detrimental effect on the operations of CSOs, such as faith-based organisations, churches, trade unions, pressure groups, community groups, non-government organisations (NGOs), NGO networks and coalitions. These organisations are less resilient in the face of AIDS/HIV pandemic as they tend to employ a small number of employees (11-20 people) and thus are particularly vulnerable to the reduced productivity of individuals due to illness, care responsibilities, grieving etc. They also have limited financial resources to effectively respond to the challenges of the pandemic and they tend to focus on the short term issues instead of developing a long-term strategies to cope with AIDS/HIV. According to proposals made by INTRAC and PSO Netherlands, organisational resilience of CSOs can be improved by a set of internal policies and programs aimed at:

- Raising awareness among staff and help them to reduce the risk of infection and cope better if they get infected;
- Developing policies that address the increasing need for sick leave and recruitment. Policies might include paying for the medical treatment of the infected staff or modify the travel policy of the infected so they don't have to travel away from their families;
- Long-term human resource implications. The CSOs should account for the fact that despite the awareness programs some members of staff will fall ill and planning should assure that the organizational capacity is not compromised. Such strategies include multi training in order for staff to have a wider range of skills, over-recruiting in critical areas in order for the organization to operate at all times, ill staff should be given less responsibilities but should continue to work;
- Financial budgeting and monitoring. It is important for each organization to account for the additional direct and indirect cost of AID/HIV;
- Tackling wider issues regarding AIDS/HIV such as the stigma it carries.

A recent study aimed to assess and increase organisational resilience of the co-operatives in Malawi⁴⁹⁵. In 2013, there were 234 active co-operatives in Malawi. Organisational resilience of the co-operatives was evaluated by assessing four dimensions, namely: membership which share the same values such as self-help and equality; ability to develop collective skills; ability to establish networks among other co-operatives and among external agencies; ability for innovation which improves existing goods and enables to access credit and so on. The study further identified different indicators that help to measure each of the aforementioned dimensions. For example, positive elements of innovation could be an access to commercial banks' and donors' credit, or development of alternative income sources that allows for a certain level of independence from. On the other hand, reluctance of commercial banks to fund co-operatives, lack of woman participation, lack of infrastructure, or high cost of software necessary for effective work are considered to have a negative impact on innovation. Based on this assessment 7 policies have been identified for further building the resilience of the co-operatives,

⁵²² James R. (2005). Praxis paper No.4: Building organizational resilience to HIV/AIDS: Implication to capacity building. *INTRAC*.

including education and training programs, support for further women participation and financial services for the co-operative development.

Ncename and Weeks explored the dimensions of organizational resilience of the South African service sector by interviewing 32 members of management from public services, state-owned companies, and a range of private companies⁵²³. The interviews identified the relationship of organizational resilience with the concepts of sustainability and connection to the market. The interviewed leader stressed the importance of forward planning, awareness of the risks and adaptability to changing conditions as essential contributors to organizational resilience. Nonetheless, it is still not clear how the unpredictable rare events are taken into account in the resilience framework. Finally, the human capital and good leadership and cultural diversity have been identified as important contributors to the organizational resilience of the service sector of South Africa.

3.5. Social resilience

No official state level documents regarding social resilience have been found. Once again it is the international and regional organisations driving the process forward. For example, the Resilience African Network developed a qualitative methodology which helps to assess social resilience of local communities by analysing the impact that different disasters have on them⁴⁹³. It also aims to understand how resilience of these communities can be increased in the future. It assesses resilience based on 9 dimensions:

- wealth,
- psychosocial health,
- health/health services,
- natural resources/environments,
- infrastructure,
- governance,
- security/protection/advocacy,
- human capital,
- social capital/community networks.

Additional dimensions such as knowledge and understanding as well as the communication and access to information were also added.

For example, the model was used to assess resilience of the Beitbridge District in Zimbabwe which relies on its livestock production and has HIV/AIDS rate over 20% of the adult populations is assessed. HIV/AIDS infection is recognized by community members as the most disruptive factor. Their lives are also affected by the drought which forces men to leave their families and go for work in South Africa. In many occasions, they do not send money back which forces the women to resolve to prostitutions to support their families. This increases the rate of sexually transmitted diseases including HIV/AIDS. Members of this community have positively adapted to their problems by selling their livestock, supplementing their diets through communal gardens or pooling resources to pay for children's tuition fees and support those infected by HIV/AIDS. The framework helped identify ways which could improve social resilience by providing better facilities for the community members to be able to sell their livestock, to develop platforms where producers could gather information about prices and introduce farmer business schools.

The World Bank commissioned a report on building resilience to increasingly frequent extreme weather (i.e., heavy rains and dust storms) among the urban poor in Mombasa, Kenya⁵¹³. As part of

⁵²³ Ncename, S.N., Weeks, R.V. (2012). Organizational Resilience in the South African Services Sector. *PICMET'12: Technology Management for Emerging Technologies*.

this study, residents in poor mostly illegal settlements in four communities of Mombasa have been interviewed. These communities are located in flood-prone areas below the sea level and suffer from inadequate drainage and rubbish collection. The extreme weather further exacerbates their vulnerability. For example, heavy rains lead to the loss of learning hours as the children cannot get to school on time or development of water-borne diseases such as malaria and cholera in the stagnant water after a heavy rain. Residents identified housing as the main asset that they want to protect from extreme weather. The interviews also identified a number of self-help groups and NGOs which the residents tend to trust as opposed to the government institutions which are not trusted. The study concluded that the increase of resilience in these communities can also be achieved by sustained funding and the involvement of the self-help groups and the local residents.

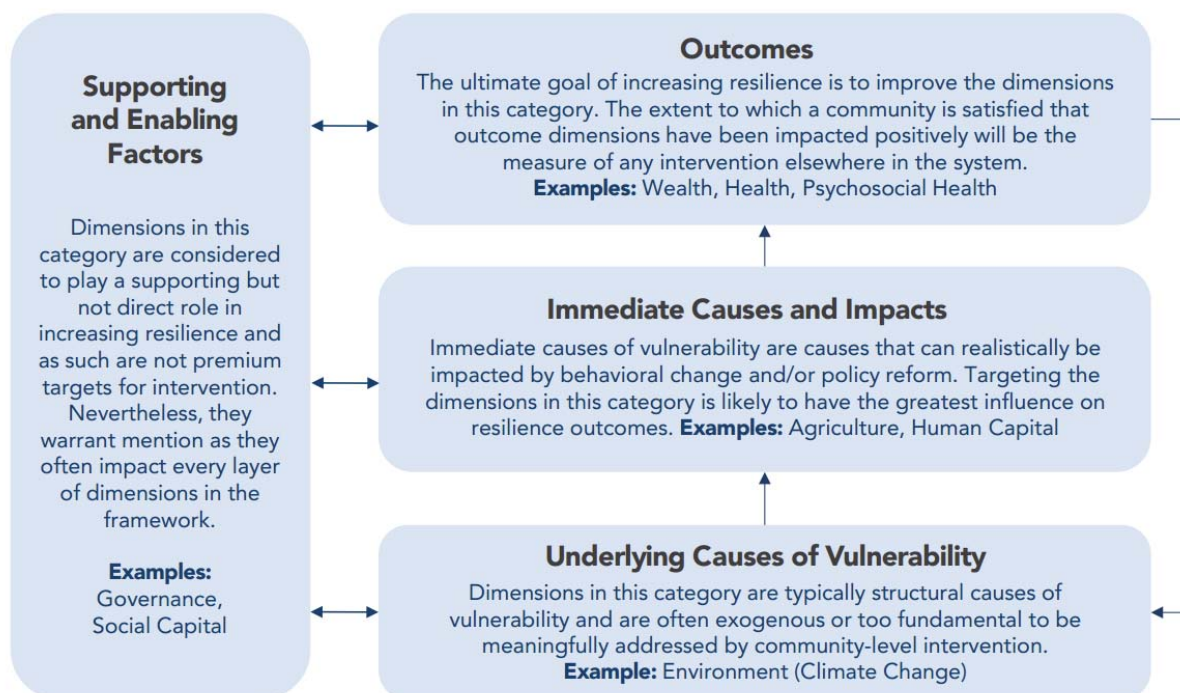


Figure 3.2 Societal resilience assessment framework according to RAN⁴⁹³.

Finally, Straub et al. assessed socio-ecological resilience of the Boumba rural community in Niger which is affected by recurrent famines⁵²⁴. In Niger, wild plant foods are termed ‘famine foods’ and are typically wild plants and are not cultivated. The study observed that these types of foods are part of the tribe’s diet in times of plenty and in times of famine. It was also noted that most famine intervention programs aim to supplement the main calories in many occasions by identifying lesser-known plants and encouraging their cultivation. Straub et al. argue that it is the preservation of this diversity of wild plants instead of the systematic cultivation of one or few of them what is more likely to build the socio-ecological resilience of the system as it allows the tribe a sense of normality without disrupting the eco-system.

3.6. Economic resilience

To the best of our knowledge, there is no existing official definition of economic resilience in African states. The reviewed literature concentrates on building the economic resilience of fragile Sub-Saharan

⁵²⁴ Strauch A.M., Muller J.M., et al. (2008). Exploring the Dynamics of social-ecological resilience in East and West Africa: Preliminary evidence from Tanzania and Niger. *African Health Sciences*. P28-P35

African states which suffered long periods of conflict by developing policies that ensure the post-conflict stabilisation, ensuring food security and better exploitation of natural resources. A number of studies have been produced by African or International Organisations and no official state-report has been found.

A recent IMF report focuses on strategies to build economic resilience in 26 Sub-Saharan states, which are unable to cover the basic needs and deliver security to their people⁴⁹⁴. The main factors behind this fragility are considered to be long years of conflict and political instability, which leads to weak governments and institutions which cannot deliver basic services to the population, underdevelopment, unemployment and lack of education. According to the report, resilience of a fragile state can be slowly built in a 10 year period by ensuring the post-conflict stabilisation. Policies towards this direction should include integrating the combatants back into civilian roles and reforming the tax collection agency which will ensure the flow of revenues at the state. The increase in revenues will allow the state to invest on the economic development and building the welfare state. Policies that improve the governance and the legitimacy of the state should be developed. These policies were found to reduce the debt of each state, increase the public investment and reduce the dependence on foreign aid.

The African Development Bank Group examined strategies that can improve resilience of fragile Sub-Saharan African states that recover from natural resource-type conflicts⁴⁹¹. The report proposed a number of policies that can help fragile states to manage their natural resources better in order to foster their economies and this way build their economic resilience. Policies should include investments in appropriate technology and human capital which can effectively exploit these resources in a sustainable and environmentally friendly way. These countries should do more to ensure the accountability and transparency of these investments by using certified extraction methods and communicate information regarding these investments in order to tackle the corruption.

3.7. Additional attempts to build resilience in Africa

There have been several attempts by international organisations to raise awareness about urban resilience of African cities. For example, the UNISDR concentrated creating a methodology aimed at assessing resilience of different African cities⁴⁹⁸. According to the methodology, urban resilience includes 10 dimensions:

- The presence of institutional and administrative frameworks, which will allow the integration of disaster risk reduction activities into the planning agenda;
- Available financial resources devoted to disaster risk reduction (DRR) policies;
- Multi-hazard risk assessment;
- Infrastructure protection, upgrading and resilience;
- Protection of vital facilities: education and health, food and water supplies;
- Building regulations and land use planning;
- Training, education and public awareness;
- Environmental protection and strengthening of the eco-systems;
- Effective preparedness, early warning and response;
- Recovery and rebuilding communities.

A pilot study was conducted in three cities, namely, Narok and Kisumu in Kenya and Moshi in Tanzania⁴⁹⁸. All three cities were vulnerable to flood and drought, which have been made worse due to rural farming practises, deforestation and charcoal production. It was found that although there is

International Survey

informal capacity for disaster risk mitigation in the three cities, none of the three local governments is sufficiently equipped to deal with a disaster event and the disaster risk reduction planning is missing.

Yet another example of an attempt to assess urban resilience in Africa is a project initiated by the Rockefeller Foundation and Arup⁵²⁵. They developed a framework, according to which resilience of a city is determined by the 12 indicators presented in Figure 3.3. The framework was applied to Cape Town however no report to explicitly discuss the results has been found.

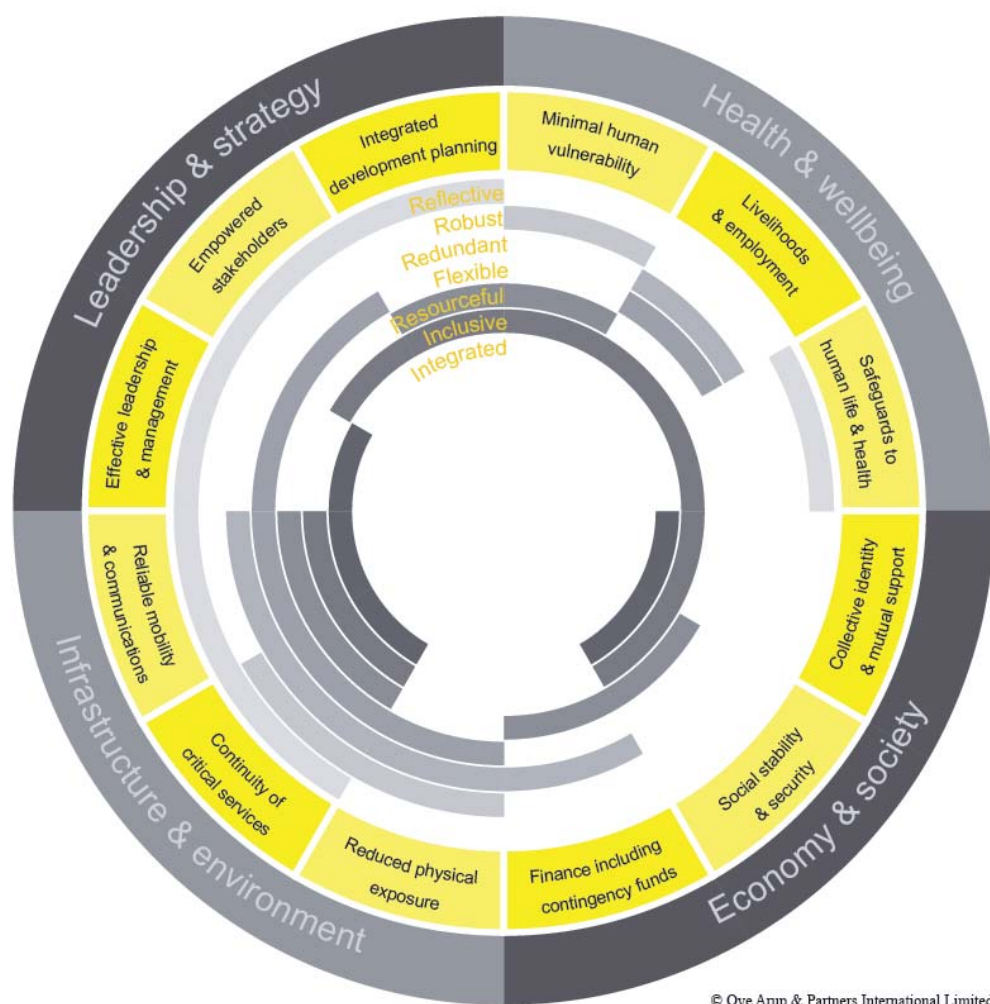


Figure 3.3 Urban resilience framework according to Arup⁵²⁵.

The Montpellier Panel identified resilient agricultural growth as the key component to achieve food and nutritional security in Sub-Saharan Africa⁴⁹⁷. Their study aimed to propose ways to achieve sustainable agricultural growth which would help the most vulnerable people and could withstand multiple shocks and hazards. According to their approach, African governments should concentrate their efforts on building resilience in economic markets, agriculture and people (see Figure). The increase of production depends on the use of new and more efficient technologies which combat soil and water degradation, and provide climate-resilient crops. Finally, the policies ensure that there is a safety social net which ensures that the most vulnerable people have access to adequate food and nutrition during a hazardous event.

⁵²⁵ Silva J.D. (2014). City resilience framework. *Ove Arup, the Rockefeller Foundation*.

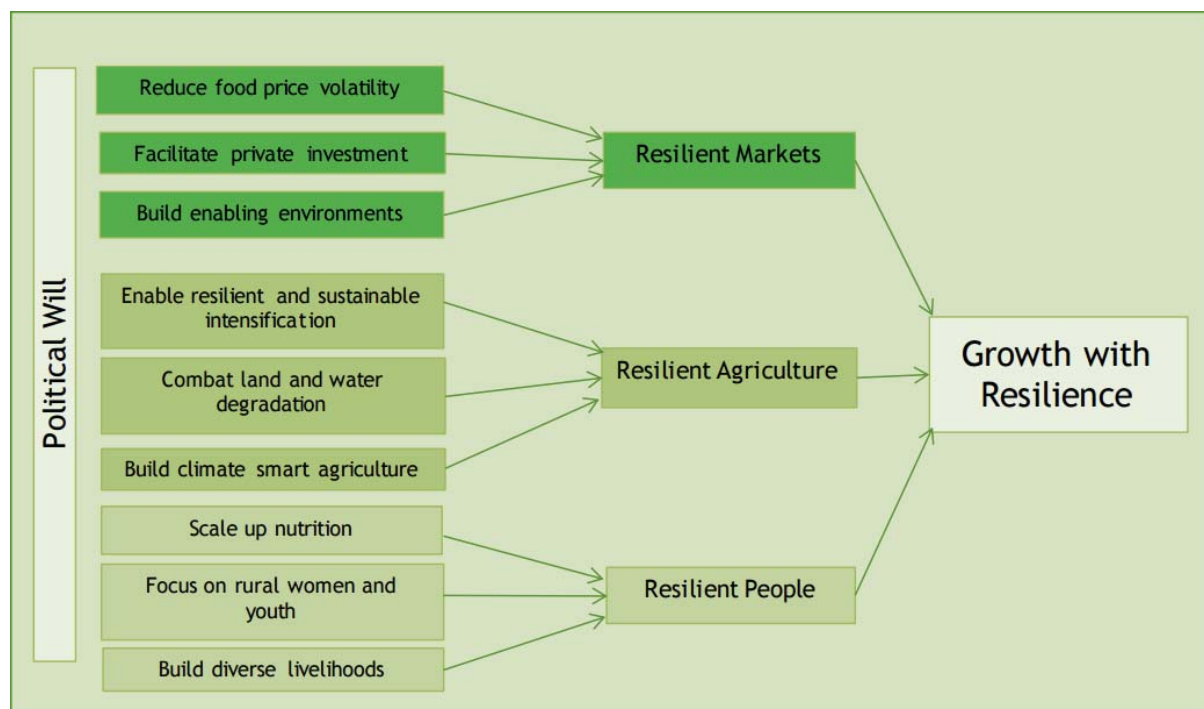


Figure 3.4 The Montpellier Panel framework for growth with resilience in Sub-Saharan Africa⁴⁹⁷.

The food and nutrition security was also the focus of a recent study by RAU, which concentrated on Karamoja, one of the least developed sub-regions in Uganda⁴⁹⁹. Resilience of the region is assessed by a number of indicators using the analytical approach depicted in Figure .

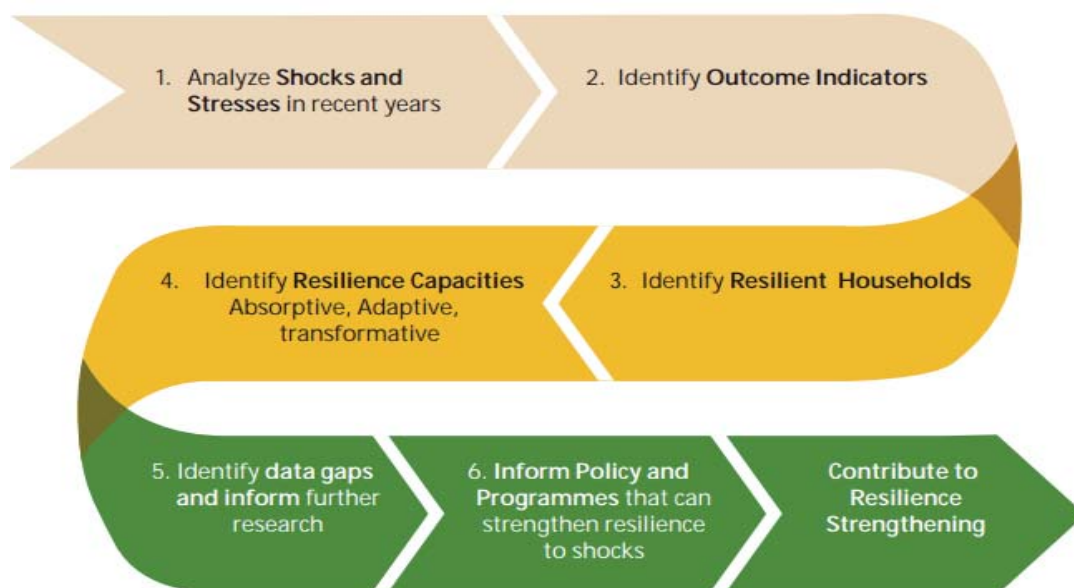


Figure 3.5 Resilience analysis framework⁴⁹⁹.

The first step of the proposed analytical approach requires the identification of multiple shocks and stresses in Karamoja's sub-regions. Karamoja is found to be affected by high food prices, disease of crops and livestock, and limited access to basic social services. Then the capacities of the communities to absorb, adapt and transform due to a hazard event are explored. The absorptive capacity is found to be influenced by factors such as the livestock ownership and informal safety nets. The adaptive capacity is found to be influenced by factors such as the livestock and land diversification and the presence of infrastructure and basic social safety services. Finally it is concluded that the key to the

International Survey

transformative capacity of the local community is the empowerment of youth and women, local leadership and education of the members of each household. The study proposed that local community resilience can be strengthened by new initiatives aiming to support the livelihoods, empower women and youth, increase the access to social protection, provide social safety nets, and persuade local governments to develop disaster risk reduction plans.

The food and nutrition insecurity in Africa is the focus of a recent study funded by FAO in collaboration with the EU⁵⁰⁷. The study developed a resilience measurement index in order to assess resilience of households in sub-Saharan countries and measure the impact of the interventions in each household. The proposed measure has 6 dimensions, namely:

- Income and food access;
- Access to basic services;
- Assets;
- Adaptive capacity;
- Social safety nets;
- Sensitivity to shocks.

The index is used to identify the most vulnerable groups and their geographical location, to highlight the dimension of resilience that needs to be supported and to assess the impact that these interventions have on resilience of the group under investigation. This exercise aimed to inform the National Resilience Priorities of African states. So far, this methodology has been applied to four countries, namely, Senegal, Niger, Mali and Burkina Faso.

3.8. Resilience Related Official Documents

No documents directly related to the concept of resilience were found.

4. Conclusions

The resilience literature for Africa appears to be less than 10 years old and concentrates mainly to assessing and/or building resilience in the most vulnerable rural or urban communities in Sub-Saharan Africa affected by the climate change reflecting the political commitment of African leaders to reduce the risk of disaster and ensure sustainable growth. There is a general understanding of in the reviewed studies recognized that disasters have complex cause and any successful disaster risk reduction plan should include initiatives aiming to strengthen the economic, technical, organizational, societal and ecological resilience to conflict and climate change affected hazards such as droughts and floods which remain the biggest causes of disaster in Africa. The reviewed studies mostly focus on proposing qualitative measures to build the resilience of a studied community, state or organization. A notable exception is the studies commissioned by the World Bank which aims to improve the resilience of the hydropower and transport infrastructure of Sub-Saharan countries and uses a cost-benefit analysis to assess the impact of different choices. Due to the direct impact of this report to the IMROVER's aim to develop a resilience methodology for critical infrastructure, these study should not be further studied.



IMPROVED RISK EVALUATION AND IMPLEMENTATION OF RESILIENCE CONCEPTS
TO CRITICAL INFRASTRUCTURE

Appendix 5 - Resilience Concepts in Asia

Author:

L. MELKUNAITE (DBI)

Contributors

J. KINSCHER (INERIS)

M. AL HEIB (INERIS)

R. SALMON (INERIS)

Deliverable Number: D1.1

Date of delivery: May 31, 2016

Month of delivery: M12



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 653390

Coordinator:	David Lange at SP Sveriges Tekniska Forskningsinstitut (SP Technical Research Institute of Sweden)

Table of Contents

1	Executive Summary	143
2	Nomenclature	143
3	Resilience Concepts in Asia	144
3.1	Regional Overview	147
4	Case Studies	148
4.1.	China	148
4.1.1.	Concept of Resilience	149
4.1.2.	Institutional Framework for Delivering Resilience	150
4.1.3.	Critical Infrastructure and Technical Resilience	151
4.1.4.	Organisational Resilience	152
4.1.5.	Social Resilience	153
4.1.6.	Economic Resilience	154
4.1.7.	Resilience Related Official Documents	154
4.2.	Indonesia	155
4.2.1.	Concept of Resilience	155
4.2.2.	Institutional Framework for Delivering Resilience	157
4.2.3.	Critical Infrastructure and Technical Resilience	158
4.2.4.	Organisational Resilience	159
4.2.5.	Social Resilience	159
4.2.6.	Economic Resilience	161
4.2.7.	Resilience Related Official Documents	161
4.3.	Japan	161
3.3.1	Concept of Resilience	162
3.3.2	Institutional Framework for Delivering Resilience	166
3.3.3	Critical Infrastructure and Technical Resilience	166
3.3.4	Organisational Resilience	171
3.3.5	Social Resilience	172
3.3.6	Economic Resilience	173
3.3.7	Resilience Related Official Documents	174
4.4.	Philippines	174
4.4.1.	Concept of Resilience	175
4.4.2.	Institutional Framework for Delivering Resilience	176
4.4.3.	Critical Infrastructure and Technical Resilience	177
4.4.4.	Organisational Resilience	178
4.4.5.	Social Resilience	178
4.4.6.	Economic Resilience	179
4.4.7.	Resilience Related Official Documents	179
5	Conclusions	179
	Appendix 1	180
	Appendix 2	184
	Appendix 3	186

1. Executive Summary

This report provides an overview of resilience concepts in Asia. Four case studies are performed in order to collect detailed state-level information: China, Indonesia, Japan and Philippines. Case studies represent different maturity level of the concept of resilience. Japan is the most advanced country in Asia regarding the application of resilience practice in different policies. Country has a Fundamental Plan for National Resilience which influences its social and economic policies. Its critical infrastructure resilience policy is built on 4R's approach. The country also puts an emphasis on the principle of early anomaly detection. Other three countries discussed in the report are less advanced in the field compared to Japan, however, recently different policies were initiated to increase resilience of local communities.

2. Nomenclature

ACCCRN	Asian Cities Climate Change Resilience Network
ADB	Asian Development Bank
ADRC	Asian Disaster Reduction Center
AMRO	Macroeconomic Research Office
ARJ	Association for Resilience in Japan
ASEAN+3	Association of Southeast Asian Nations
BAKORNAS PBP	The National Natural Disaster Management Coordinating Board
BCP	Business continuity planning
BMC	Business continuity management
BNPB	The National Agency for Disaster Management
CBDRM	Community-based disaster risk management
CCA	Climate change adaptation
CII	Critical Information Infrastructure
DMO	Disaster Management Office
DRF	Disaster Risk Financing
DRI	Disaster Recovery Index
DRM	Disaster Management Law
DRM	Disaster Risk Management
DRR	Disaster risk reduction
HFA	Hyogo Framework for Action
IEC	Information, Education and Communication
InaSAFE	Indonesia Scenario Assessment for Emergencies
IRG/Engility	The US Department of State, in a partnership with International Resources Group
IRP	The Asian Association of Independent Research Providers
ISSET	The Institute for Social and Environmental Transition-International
JICA	Japan International Cooperation Agency
KPI	Key Performance Indicators
LDCC	Local Disaster Coordinating Council
LRDRMC	Local Disaster Risk Reduction and Management Council
LS	Life Safety
M-BRACE	Mekong-Building Climate Resilience in Asian Cities
NDCC	The National Disaster Coordinating Council

International Survey

NDRRMC	National Disaster Reduction and Management Council
NDRRMF	National Disaster Risk Reduction and Management Framework
NDRRMP	National Disaster Risk Reduction and Management Plan
NISC	National center of Incident readiness and Strategy for Cybersecurity
NRC	National Resilience Council
PPP	Public-Private Partnership
RDRRMC	Regional Disaster Risk Reduction and Management Council
SC-DRR	Safer Communities through Risk Reduction in Development
SNAP	the Strategic National Action Plan
TEPCO	Tokyo Electric Power Company
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
USAID	The United States Agency for International Development
WHO/OCHA	United Nations Office for the Coordination of Humanitarian Affairs

3. Resilience Concepts in Asia

Asia is the most disaster prone region in the world and the most affected in terms of economic impact and size of population involved.⁵²⁶ The most recent examples of devastating disasters are the earthquake and tsunami in Japan in 2011, large-scale floods in Thailand in 2011, and the tropical storm in the Philippines in 2013.⁵²⁷ The number of natural disasters increased since the beginning of their recording. The most recent examples of devastating disasters are the earthquake and tsunami in Japan in 2011, large-scale floods in Thailand in 2011, and the tropical storm in the Philippines in 2013.⁵²⁶ Statistics indicate that the number of natural disasters is growing in Asia (see Figure 3.1).

⁵²⁶ Kim, S.E., David Li, H.M., et al. (2015). Overview of Natural Disasters and their Impacts in Asia and the Pacific, 1970 - 2014. *United Nations Economic and Social Commission for Asia and the Pacific*. ESCAP Technical Paper. Available at: http://www.unescap.org/sites/default/files/Technical%20paper-Overview%20of%20natural%20hazards%20and%20their%20impacts_final.pdf. Accessed 4 February 2016.

⁵²⁷ Jha, A., Baca, A., et al. (2012). Building Urban Resilience. Managing the Risks of Disasters in East Asia and the Pacific. Principles, Tools and Practice. *The World Bank*. Available at: http://www.gfdrr.org/sites/gfdrr/files/publication/EAP_handbook_principles_tools_practice_web.pdf. Accessed 4 February 2016.

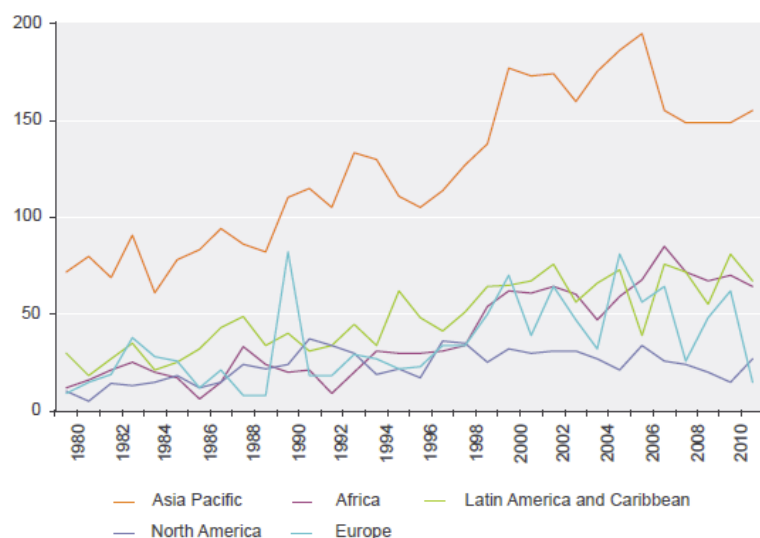


Figure 3.1 The number of natural disasters around the world 1980-2012.⁵²⁸

Between 1970 and 2014, 56.6% of the world-wide fatalities occurred in Asia and were mainly related to earthquakes and tsunamis (Figure 3.2). People affected by disasters in Asia (6 billion) represent 87.6 % of all globally affected people. Asia experiences all types of natural disasters. Some of them can be predicted and thus prepared for. For example, Bangladesh experiences frequent floods and cyclones. Therefore, vulnerability of local communities to such events can be highly reduced by increasing efforts in flood monitoring, forecasting and establishment of early warning systems.⁵²⁸ It is also known that, the major driver of the increasing damages and losses from disasters are related to rapid urbanization and increase of population.⁵²⁷ In East Asia, the urban population is expected to double between 1994 and 2025⁵²⁹. Increasing population and urbanization will itself lead to a future scarcity of fundamental resources such as water and agricultural land. UNESCO estimated that the water deficit in 2030 will be 40%. Some of the long-term risks can be anticipated and reduced by optimal urban planning, including avoidance of settlements in vulnerable zones (flood plains, seismic zones, etc.), as well as sustainable ecosystem management which is part of the resilient behaviour.⁵³⁰

⁵²⁸ Shamika, S., Abe, M. et al. (2013). Building Resilience to Natural Disasters and Major Economic Crisis. *United Nations Economic and Social Commission for Asia and the Pacific*. Available at: <http://www.drrgateway.net/sites/default/files/ThemeStudy2013-full.pdf>. Accessed 4 February 2016.

⁵²⁹ Jha, A., Brecht, H. (2011). Building Urban Resilience in East Asia' An Eye on East Asia and Pacific. *The World Bank*. Available at: http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2012/04/06/000333037_20120406013658/Rendered/PDF/678890BRI00PUB067903B0EYE0on0EA0no8.pdf. Accessed 4 February 2016.

⁵³⁰ UNESCO (2012). Managing Water under Uncertainty and Risk: United Nations World Water Development Report. *United Nations Educational, Scientific and Cultural Organization*. Paris, France. Available at: <http://www.zaragoza.es/contenidos/medioambiente/onu/789-eng-ed4-v3.pdf>. Accessed: 4 February 2016.

International Survey

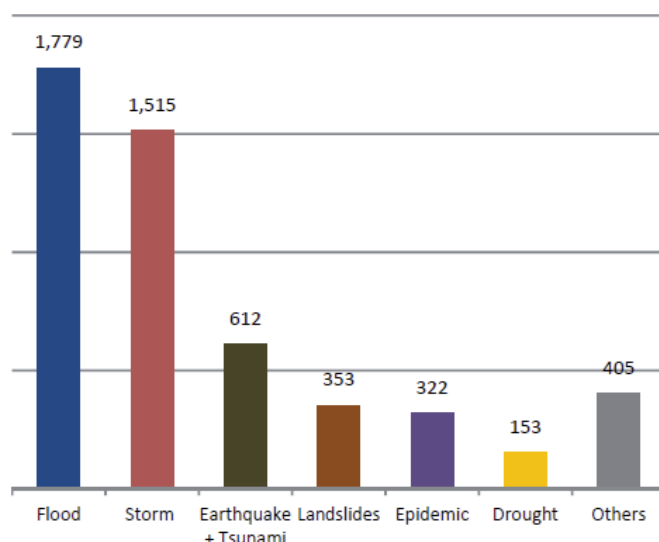


Figure 3.2 Different natural disasters in Asia.⁵²⁶

However, not all disaster could be predicted. Natural disasters such as for example earthquakes and tsunamis are rather difficult to predict and therefore to prepare for. For example, Japan is one of the most developed, however, still extremely disaster prone countries in the world. Kamaishi City had one of the biggest breakwaters in the world (8 meters high and 63 meters deep). However, in 2011 the breakwater collapsed and the tsunami reached 6.9 to 9 meters.⁵³¹ Hence, even advanced technologies and engineering solutions can fail in the face of an extensive natural event.

Another major factor of uncertainty in Asia is climate change which has a highly negative effect on the landscape of risks faced by the region as well as the availability of vital resources. In order to deal with the consequences of climate change, Asian Cities Climate Change Resilience Network (ACCCRN) was created. ACCCRN supports cities in South and Southeast Asia and help them to analyse their vulnerabilities with respect to climate change impacts, and plan as well as implement concrete resilience-building measures to address them. The most important and partially already implemented measures include climate sensitive land use and urban planning, institutional coordination mechanisms and capacity support, drainage, flood and solid waste management, water demand and conservation systems, emergency management and early warning systems, responsive health systems, resilient housing and transport systems, strengthening of ecosystem services, diversification and protection of climate-affected livelihoods, and education and capacity building of citizens (Brown et al. 2012).

Asia has also experienced cascading system failures caused by natural disasters. The best known example occurred after the earthquake in Japan in 2011, when 10-metres high tsunami hit north-eastern Japan damaging the Fukushima power plant, and triggering a third crisis, namely, a nuclear accident.⁵²⁸ This disastrous event underlined the difficulty to prepare for and anticipate crises associated with multiple overlapping events. In addition, some event occurrences that do not seem catastrophic when isolated, can provoke multiple and interrelated shocks. For example, the 2010 floods in Pakistan and the droughts in Russia triggered complex crisis transmitted by the financial and trade systems.⁵²⁸ Another example of interlinked economic and natural disasters occurred in the

⁵³¹ ADRC, IRP (2011). Great East Japan Earthquake: Preliminary Observations. *Asian Disaster Reduction Center and International Recovery Platform*. Available at: <http://www.unisdr.org/we/inform/publications/20537>. Accessed: 4 February 2016.

landslide prone Compostela Valley in the southern island of Mindanao in the Philippines following the economic crisis of 2008.⁵³²

3.1 Regional Overview

There are quite a few international organisations established in Asia and aimed at building community resilience in the region. For example, the Asian Development Bank (ADB) defines resilience as “the magnitude of a disturbance that a system can withstand without crossing a threshold into a new structure or dynamic”.⁵³³ They precise that in “human systems, resilience refers to the ability of communities to withstand and recover from stress, such as environmental change or social, economic, or political upheaval, while for natural systems, it is a measure of how much disturbance (e.g., storms, fire, and pollutants) an ecosystem can handle without shifting into a qualitatively different state.”⁵³³ The report further describes that “social and environmental systems are interlinked, complex, and adaptive process dependent—rather than input dependent—and self-organizing rather than predictable.”⁵³³

In their report *Investing in Resilience: Ensuring a Disaster-Resistant Future*, ADB defines resilience as “the ability of countries, communities, businesses, and individual households to resist, absorb, recover from, and reorganize in response to natural hazard events, without jeopardizing their sustained socioeconomic advancement and development.”⁵³⁴ The term of resilience in this case is used to refer not only to physical resilience of the built environment but also to describe social resilience, organisational resilience, and physical resilience of the natural environment. They further argue that “successful investment in resilience embodies principles of integrated Disaster Risk Management, entailing a systematic set of activities that collectively aims to avoid, lessen, or transfer the potential adverse effects of all hazards, specifically through the integration of CCA (Climate change adaptation), DRF (Disaster Risk Financing), and DRR (Disaster risk reduction) measures.”⁵³⁴ In 2012, the United States Agency for International Development (USAID), and the US Department of State, in a partnership with International Resources Group (IRG/Engility) and the Institute for Social and Environmental Transition (ISET) organised the Adaptation Partnership workshop on resilience in Bangkok, Thailand.⁵³⁵ The workshop had 74 attendees including international and regional climate and adaptation/resilience researchers, city- and regional-level practitioners, and development agencies from over 15 countries, including Thailand, Vietnam, China, Indonesia, India, Nepal, Pakistan, Laos, Malaysia, Australia, South Africa, the United Kingdom, and the United States. During the workshop attendees were asked to write down what does resilience mean for each of them. The sampling of definitions of resilience was as follows:

- Ability to recover from unforeseen events, e.g., bamboo in a storm;
- Ability to deal with pressures and recover from damages;
- Ability to absorb shocks and keep the system intact;
- Well-being of communities and the systems the depend on are secured;
- Withstand and recover from stresses and shocks, bounce back, innovate, learn, move on.

The Institute for Social and Environmental Transition-International (ISET), an organisation working in Vietnam, Thailand, and India, collaborates with local partners to build resilience and catalyse

⁵³² NDRRMC (2012). Update – Situational Report No. 38 regarding effects of Typhoon “Pablo” (Bopha). *Philippines & National Disaster Risk Reduction and Management Council*. Available at: <http://www.ndrrmc.gov.ph/index.php/2-uncategorised/2245-situational-report-re-effects-of-typhoon-pablo-bopha>. Accessed: 4 February 2016.

⁵³³ Asian Development Bank (2009). Building Climate Resilience in the Agriculture Sector of Asia and the Pacific. *Asian Development Bank* Available at: http://www.preventionweb.net/files/11486_BuildingClimateResilienceAgricultur.pdf. Accessed: 4 February 2016. P.6-7.

⁵³⁴ Asian Development Bank (2013). Investing in Resilience: Ensuring a Disaster-Resistant Future. *Asian Development Bank*. Available at: <http://www.adb.org/sites/default/files/publication/30119/investing-resilience.pdf>. Accessed: 4 February 2016. P. 5.

⁵³⁵ See <http://www.adaptationpartnership.org>.

adaptation to social and environmental change.⁵³⁶ ISET defines resilient systems as the ones that are “able to maintain their functions and linkages in the face of stresses and change” (Tyler et al. 2010, 4). A set of characteristics make complex systems more resilient, namely: “flexibility and diversity, which is seen as “the ability to perform essential tasks under a wide range of conditions, and to convert assets or modify structures to introduce new ways of achieving essential goals [...]; redundancy, modularity, perceived as the capacity for contingency situations, to accommodate increasing or extreme/surge pressures/demand; multiple pathways and a variety of options for service delivery, or interacting components composed of similar parts that can replace each other if one, or even many, fail [...]; safe failure, is the ability to absorb shocks and the cumulative effects of slow-onset challenges in ways that avoid catastrophic failure” (ibid.).

Mekong-Building Climate Resilience in Asian Cities (M-BRACE) is a program aimed at strengthening the capacity of city stakeholders of cities in the Mekong region. The program assesses “changing patterns of vulnerability that arise out of the combined influences of urbanization and climate change; and to put in place the institutional processes that would allow city stakeholders to deal with future uncertainties and risks.”⁵³⁷ M-BRACE defines urban resilience as the “the ability to anticipate or respond to specific, expected disturbance, but also on the ability for physical systems, agents and institutions to respond to a wide range of changes and conditions.”⁵³⁷ The program especially aims to make institutions more adaptive, learning-oriented and able to access and generate new knowledge as conditions change.

4. Case Studies

4.1. China

China is a country prone to almost all kinds of natural disasters due to its vast, complex geographical and climatic conditions (Ye 2014). More than 70 percent of Chinese cities and more than 50 percent of Chinese population are living in areas vulnerable to earthquakes, or meteorological, geological or marine disasters. Two thirds of China’s land are threatened by floods.⁵³⁸ In the period between 1990 and 2011, 654 natural disasters occurred in China killing 12 million and affecting 3 billion people. The total estimated economic damage for the period is 350 million US \$ (ibid.). For example the Winchuan earthquake killed 70 000 people. Apart from natural disasters, China is also suffering from disaster related to disaster linked to human activity or error. For example, in December 2015 a landslide on at an industrial site in Shenzhen destroyed 33 buildings and buried dozens of people under dirt and construction waste. This latest disaster in China was linked to country’s rapid industrialization, weak safety regulation and a political system rife with graft.⁵³⁹

⁵³⁶ See <http://i-s-e-t.org/welcome.html>.

⁵³⁷ Institute for Social and Environmental Transition-International, Thailand Environment Institute, Vietnam National Institute for Science and Technology Policy and Strategy Studies. (2014). Urban Vulnerability in Southeast Asia: Summary of Vulnerability Assessments in Mekong-Building Climate Resilience in Asian Cities (M-BRACE). *Institute for Social and Environmental Transition-International* Bangkok, Thailand. Available at: <http://i-s-e-t.org/resources/major-program-reports/urban-vulnerability-southeastasia-summary-assessments-mbrace.html>. Accessed: 4 February 2016. P. 4-5

⁵³⁸ The Information Office of the State Council (2009). China’s Actions for Disaster Prevention and Reduction. *Information Office of the State Council of the People’s Republic of China*. Available at: <http://reliefweb.int/report/china/full-text-chinas-actions-disaster-prevention-and-reduction>. Accessed: 14 March 2016.

⁵³⁹ Goldman, R. (2015). “A Year of Disasters in China”. *The New York Times*. Available at: http://www.nytimes.com/interactive/2015/12/21/world/asia/china-disaster-landslide-ship-coal-mine-explosion.html?_r=0 Accessed: 26 April 2016.

4.1.1. Concept of Resilience

China does not have an official state-level definition of resilience. It could be argued that the discipline of resilience is rather immature in the country. However, the country has published several official state-level documents related to disaster risk management and reduction. In 1998, the government of China issued the National Natural Disaster Reduction Plan of the People's Republic of China (1998-2010), which proposed the guidelines, major tasks and specific measures of national disaster reduction in form of specific plan for the first time.⁵⁴⁰ Although the Plan does not mention the concept of resilience, it calls for reduced disaster risks, sustainable development and prosperity of communities. The document outlines a rather close relationship between disaster reduction and national economic and social development. It is argued that “sustainable stable economic development and social progress are the basis for deepening disaster reduction. On the other hand, continuous strengthening of disaster reduction will provide guarantee for the economic development and social progress.”⁵⁴¹ In the Plan it is argued that it is essential to take a holistic disaster reduction approach and pay more attention to disaster prevention as well as to combine it with resistance and rescue. It also draws attention to the education of disaster reduction aimed at communities. It urges for increased people's knowledge of disaster reduction.⁵⁴⁰

As a response to the Hyogo Framework for Action, in 2006 Chinese government issued the Disaster Reduction Action Plan of the People's Republic of China (2006-2015).⁵⁴² To the best of our knowledge this is the first official state-level Chinese document where the notion of *resilience* was used. The document states that “disaster systems will become more complicated, disaster types more diverse, disaster loss more severe and the prevention, resilience and relief of disasters more difficult.”⁵⁴³ However, the document does not define resilience in any way nor does it provide any further information about the concept. The overall expected outcome of the Plan is to continue to reduce the loss of life and property caused by disasters within the country, and to achieve sustainable development of economy and society. It specifies four strategic goals:

1. To integrate disaster risks into China's 11th five-year development plan and stress the significance of disaster prevention, reduction, and preparedness and of vulnerability reduction.
2. To promote the establishment and capacity building of local disaster reduction organisations and facilitate disaster reduction.
3. To promote community disaster reduction, enhance contingency reserve, responsive measures and restoration plans and carry through in practice.
4. To timely apply various disaster reduction measures to high risk zones.⁵⁴⁴

The document puts an emphasis on disaster monitoring, early warning and forecast systems as means to reduce disaster risks in the future. The Plan outlines that China is performing a large-scale survey about disaster reduction capabilities nationwide with an aim to ascertain the actual situation on disaster reduction capabilities in all regions. The country also has an integrated risk map which is being regularly updated and made public.⁵⁴⁵ It is also emphasized that efficient and timely information sharing is critical in the process of disaster risk reduction. China has disaster information service operating system which interconnects the governments at the central, district and county levels.

⁵⁴⁰ China National Committee for IDNDR (1998). The National Natural Disaster Reduction Plan of the People's Republic of China. China National Committee for IDNDR. Available at: http://www.adrc.asia/management/CHN/china_national_disaster_reduction_plan.html. Accessed: 14 March 2016.

⁵⁴¹ Ibid. P. 10.

⁵⁴² NCDR (2006). Disaster Reduction Action Plan of the People's Republic of China (2006-2015). Office of the China National Committee for Disaster Reduction. Available at: http://www.preventionweb.net/files/30351_chinadisasterreductionactionplan200.pdf. Accessed: 15 March 2016.

⁵⁴³ Ibid. P. 2.

⁵⁴⁴ Ibid. P. 4.

⁵⁴⁵ Ibid. P. 7.

International Survey

In the aftermath of the devastating Wenchuan earthquake in May 2008, the Chinese government decided to make May 12 “Disaster Prevention and Reduction Day” starting in 2009.⁵³⁸ All the activities related to this day will be discussed in the section on social resilience.

In 2009, the Information Office of the State Council published a white paper titled “China’s Actions for Disaster Prevention and Reduction”.⁵³⁸ Although the document does not explicitly mention the concept of resilience, it argues that with the years of experience in disaster reduction and relief work, the Chinese government has established a disaster reduction and relief mechanism that is tailored to the nation’s situation. According to the document, Chinese government has established a series of disaster emergency mechanisms, including a disaster emergency response system, disaster information release mechanism, emergency relief materials reserve system, disaster early warning, consultation and information sharing system, major disaster rescue and relief joint coordination mechanism and emergency social mobilisation mechanism.⁵³⁸

The next step in China’s efforts to build national ability to better withstand and recover from disasters was the National Comprehensive Disaster Prevention and Reduction Plan (2011-2015) issued by the General Office of the State Council in 2011. The Plan lists 10 tasks aimed at building up national capacity, including “national disaster monitoring and early warning, risk management, civil engineering measures, community disaster reduction, emergency response, recovery and reconstruction, technology empowerment, and social mobilization” (Jiang 2013, 102). The Plan’s goal is to implement eight key projects, including “a comprehensive natural disaster risk survey, IT-empowered comprehensive disaster emergency and relief command system, a national disaster relief material reserve, and the launch of an environment monitoring and disaster reduction satellite constellation” (ibid). All these projects are aimed at addressing core issues in multi-hazard response, cross-agency collaboration, and cross-area cooperation, in order to improve China’s comprehensive disaster prevention and reduction capacity (ibid.).

In November 2014, President Xi Jinping and President Barack Obama made a historic China-US Joint Announcement on Climate Change. The Announcement also included mutual commitment to increase efforts dedicated to building climate resilience. Both parties committed to work at both the national and international levels to build resilience and reduce vulnerability. They underscored the importance of continued, robust financial support beyond 2020 to help developing countries to build low-carbon and climate-resilient societies.⁵⁴⁶ China was said to making great efforts to advance climate resilient and sustainable development through accelerating institutional innovation and enhancing policies and actions.⁵⁴⁷

In June, 2015, China and the EU issued their joint statement on climate change underlining that the Two Sides are effectively embarking on sustainable, resource efficient, green, low-carbon and climate resilient development.⁵⁴⁸

4.1.2. Institutional Framework for Delivering Resilience

Despite the fact that the concept of resilience is not explicitly defined in the state-level official documents of China, it has a rather clearly defined framework for institutions that are involved in disaster risk management and reduction efforts. Under the unified leadership of the State Council, the central organs coordinating and organising disaster reduction and relief work in China are the National

⁵⁴⁶ NDRC (2015). China-U.S. Joint Presidential Statement on Climate Change. *National Development and Reform Commission*. Available at: http://en.ndrc.gov.cn/newsrelease/201509/t20150929_755626.html. Accessed 3 March 2016.

⁵⁴⁷ Ibid. P. 4.

⁵⁴⁸ NDRC (2015). China-EU Joint Statement on Climate Change. *National Development and Reform Commission*. Available at: http://qhs.ndrc.gov.cn/gwdt/201506/t20150630_709979.html. Accessed 3 March 2016.

Disaster Reduction Committee, State Flood and Drought Control Headquarters, State Earthquake Control and Rescue Headquarters, State Forest Fire Control Headquarters and National Disaster Control and Relief Coordination Office. Local governments are also involved into the overall disaster reduction and relief process. During disaster reduction and relief work, the People's Liberation Army, the Armed Police, militiamen and reservists, as well as policemen play a central role, and often act as task forces. In the aforementioned document "China's Actions for Disaster Prevention and Reduction", it is also mentioned that social groups, NGOs and volunteers are also involved in the effort.⁵³⁸

The Disaster Reduction Action Plan (2006-2015) briefly mentions involvement of communities and individuals in the disaster management process. It is argued that "the State, governments, community as well as individual make adequate preparations, actively understand and learn various effective and efficient disaster management knowledge and escape skills."⁵⁴⁹

4.1.3. Critical Infrastructure and Technical Resilience

Although no official state-level definition of critical infrastructure resilience was found in China, the country aims to build infrastructures that are more able to successfully withstand disasters. For example, in the National Natural Disaster Reduction Plan (1998-2010) it is mentioned that cities and their buildings as well as facilities must meet the required disaster defence standards.⁵⁵⁰ It is argued that infrastructures should be engineered in such a way that they withstand floods, earthquakes, typhoons, windstorms, landslides, debris flows, fires, etc. It is also noted that disaster defence and resistance levels of large and medium industrial bases, main lines of communication and transportation, important facilities and lifeline engineering should be raised.⁵⁵⁰

In China, disaster risk factors are included in the scheme of infrastructure project planning. In the course of constructing new infrastructures and maintaining existing ones, formulation of land utilization planning, city planning and post-disaster rehabilitation and reconstruction, disaster reduction factors are given full account and included in design scheme.⁵⁴² The Disaster Reduction Plan (2006-2015) mentions that disaster resistance capabilities should be strengthened in all principal public facilities and infrastructure, especially schools, clinics, hospitals, water plants, power plants, communication and transportation routes and cultural preservation places.⁵⁴²

The white paper "China's Actions for Disaster Prevention and Reduction" notes that "China has promulgated the Regulations on the Administration of Disaster Prevention of Urban Public Utilities, the Urban Earthquake and Disaster Prevention Planning Standards and the Design Specifications for the Earthquake-proof Buildings in Towns (Townships) and Villages. China has published the Zoning Map of China with Seismological Parameters, improved its earthquake-proof evaluation management system for key construction projects, and promoted the implementation of safety guarantees for the earthquake-proof houses in rural areas. Construction and reinforcement of 2.45 million such houses have been completed."⁵⁵¹ Since 2006, China has been implementing highway disaster prevention projects due to a high number of highways being destroyed by floods and earthquakes. By 2008, a total of 1.54 billion yuan had been invested to renovate bridge structures, road embankments,

⁵⁴⁹ NCDR (2006). Disaster Reduction Action Plan of the People's Republic of China (2006-2015). *Office of the China National Committee for Disaster Reduction*. Available at: http://www.preventionweb.net/files/30351_chinadisasterreductionactionplan200.pdf. Accessed: 15 March 2016. P. 13.

⁵⁵⁰ China National Committee for IDNDR (1998). The National Natural Disaster Reduction Plan of the People's Republic of China. *China National Committee for IDNDR*. Available at: http://www.adrc.asia/management/CHN/china_national_disaster_reduction_plan.html. Accessed: 14 March 2016. P. 25.

⁵⁵¹ The Information Office of the State Council (2009). China's Actions for Disaster Prevention and Reduction. *Information Office of the State Council of the People's Republic of China*. Available at: <http://reliefweb.int/report/china/full-text-chinas-actions-disaster-prevention-and-reduction>. Accessed: 14 March 2016. P. 7.

International Survey

roadbeds, flood-proof and drainage facilities with focus on disaster prevention facilities in mountainous and hilly areas.⁵⁵¹ China is also building a three-dimensional natural disaster monitoring system, including land monitoring, ocean and ocean-bed observation, and space-air-ground observation.⁵⁵¹

Recently the country has been implementing a number of initiatives aimed at building more disaster resilient infrastructures that would eventually increase the overall community resilience. For example, acknowledging the increasing flood risks posted by heavy rainfall, in 2007 Hong Kong's Drainage Services Department undertook a large project to build a new drainage tunnel of Northern Hong Kong Island.⁵⁵² To address the increasing number and severity of storm surges around Tai O, the Hong Kong Civil Engineering and Development Department installed a new sea wall.⁵⁵³

The Shanghai municipal government has built four levels of protection around the city to fight against floods, including the Huangpu river levee, seawalls, drainage systems, and advanced flood information control system.⁵⁵⁴ The central government has intervened to help address Beijing's water scarcity challenges via large, national resilient infrastructure projects to bring water to Northern China.⁵⁵⁵

In the aforementioned Winchuan earthquake almost 5,400 children were killed or went missing when 4,500 classrooms were destroyed.⁵⁵⁶ In the aftermath of this disaster, starting from 2009, China started reinforcing school buildings nationwide in order to make them meet the earthquake withstanding standard.⁵⁵¹ Country adapted a set of rules, such as:

- "Prioritization of the education sector in the disaster prevention, reduction and post-earthquake reconstruction programme;
- New standards and codes on school construction;
- Successful school reconstruction in quake-affected areas;
- The National Primary and Secondary School Safe School Building Programme;
- Enhanced education on disaster prevention and relief; and
- Capacity building in disaster prevention and reduction."⁵⁵⁷

In general, the entire Sichuan region (most affected area by the earthquake) in China experiences a kind of creative destruction due to the massive rebuilding efforts.⁵⁵⁸

4.1.4. Organisational Resilience

There is no existing official state level definition of organizational resilience in China. None of the afore-discussed official documents mention business organisations in relation to disasters. It can

⁵⁵² Szalwinski, A., Lewis, J. (2015). China and US Case Studies: Preparing for Climate Change. Hong Kong: Improving Coastal Resilience and Managing Urban Heat. *Georgetown Climate Center*. Available at: http://www.georgetownclimate.org/sites/www.georgetownclimate.org/files/GCC-HongKong_UrbanHeat-August2015.pdf. Accessed 3 March 2016.

⁵⁵³ Ibid.

⁵⁵⁴ Lu, M., Lewis, J. (2015). China and US Case Studies: Preparing for Climate Change. Shanghai: Targeting Flood Management. *Georgetown Climate Center*. Available at: http://www.georgetownclimate.org/sites/www.georgetownclimate.org/files/GCC-Shanghai_Flooding-August2015.pdf. Accessed: 3 March 2016.

⁵⁵⁵ Lu, M., Lewis, J. (2015). China and US Case Studies: Preparing for Climate Change. Beijing: Preparing for Water Scarcity and Drought. *Georgetown Climate Center* Available at: http://www.georgetownclimate.org/sites/www.georgetownclimate.org/files/GCC-Beijing_Drought-August2015.pdf. Accessed: 3 March 2016.

⁵⁵⁶ See <http://news.cctv.com/China/>.

⁵⁵⁷ UNISDR (2011). Building Resilient Cities – My city is getting ready! School Safety Baseline Study 2011. Thematic Platform on Knowledge and Education (TPKE) 1 Million Safe Schools and Hospitals – Make a Pledge, Safe a Life, *UNISDR*. Available at: http://www.unisdr.org/files/14043_campaignkit1.pdf. Accessed: 4 February 2016.

⁵⁵⁸ Bennet, D. (2008.) Do natural disasters stimulate economic growth? *New York Times*. Available at: http://www.nytimes.com/2008/07/08/business/worldbusiness/08iht-disasters.4.14335899.html?_r=0. Accessed: 4 February 2016.

generally be argued that business resilience and continuity concept is a relatively new notion in the organizational environment of China. In 2009, KPMG conducted an extensive study on the existing business resilience and continuity practices in different Chinese organisations.⁵⁵⁹ The research indicates that Chinese organisations are reasonably familiar with the concept of business resilience and continuity. The results of the survey indicate that organisations are highly concerned about their business continuity, with hardware failure being the most pressing area of concern. Other important considerations that drive business resilience and continuity planning in China are employee safety and a wish to gain competitive advantage in the face of a crisis. However, the main obstacle for the actual implementation of business resilience and continuity is the lack of resources devoted to business continuity training for employees.⁵⁵⁹

According to the survey, Chinese organisations show lack of commitment to follow any international standards related to business resilience and continuity due to the lack of commercial case in doing so.⁵⁵⁹ China also lacks internal state-level regulations addressing continuity within organisations.

Almost half of the respondents indicated that they do not have a dedicated recovery facility. These results indicate that all these organisations would face rather severe problems related to their ability to continue to provide services when a natural or man-made disaster occurs.⁵⁵⁹ It also should be stressed that many organisations in China fail to recognise and mitigate their dependency on external processes, partner, suppliers and service providers, which is of key importance for a successful BCM implementation.

4.1.5. Social Resilience

While doing the research we could not find an official state-level definition of social resilience. Nevertheless, it should be noted that China has been implementing a number of initiatives aimed at increasing overall social resilience of communities. The National Natural Disaster Reduction Plan (1998-2010) stresses that “education of disaster reduction must be orientated to the society. Combining popular education with professional education in this regard is important. And the people’s knowledge of disaster reduction should be enhanced.”⁵⁶⁰ It is urged that people’s consciousness of disaster reduction should be increased using different media channels. Disaster reduction education should be deepened in primary and secondary school as well as extended at higher levels of education.⁵⁶¹ China carries out disaster emergency rehearsal in primary and secondary schools, allowing the majority of teenagers to understand basic knowledge on disaster risk avoidance. The Disaster Reduction Plan (2006-2015) argues that there is a need for “publicity and popularization on disaster reduction knowledge [and that] the public’s awareness on disaster preparedness and reduction and self-rescue capabilities should be enhanced, and the concepts of the public should be promoted to transit from single disaster resistance and relief to efforts joining reasonable avoidance of risks with disaster resistance and relief.”⁵⁶² China also has a goal to build disaster reduction work network in which government, enterprises, social groups and individuals would jointly work together in order to reduce disaster risks in the country.⁵⁶²

⁵⁵⁹ KPMG (2009). Business Resilience in China. KPMG. Available at: <https://www.kpmg.com/CN/en/IssuesAndInsights/ArticlesPublications/Documents/business-resilience-china-0903.pdf>. Accessed 4 March 2016.

⁵⁶⁰ China National Committee for IDNDR (1998). The National Natural Disaster Reduction Plan of the People’s Republic of China. China National Committee for IDNDR. Available at: http://www.adrc.asia/management/CHN/china_national_disaster_reduction_plan.html. Accessed: 14 March 2016. P.11.

⁵⁶¹ Ibid. P. 17.

⁵⁶² NCDR (2006). Disaster Reduction Action Plan of the People’s Republic of China (2006-2015). Office of the China National Committee for Disaster Reduction. Available at: http://www.preventionweb.net/files/30351_chinadisasterreductionactionplan200.pdf. Accessed: 15 March 2016. P.9.

International Survey

China attaches importance to strengthening community-based disaster risk reduction management, and since 2007 has been building “National Comprehensive Disaster-reduction Demonstration Communities” in order to encourage communities to establish disaster reduction work mechanism, develop disaster emergency response and relief contingency plans, organise and launch community disaster risk and hidden danger inspection, work out their own disaster risk map and help their residents clearly know various disaster risks and their distribution as well as shelters and routes in the community and master basic methods and skills of self-aid and mutual aid for disaster prevention and reduction.⁵⁶³ By 2008, 284 communities had been awarded the title of “National Comprehensive Disaster-reduction Demonstration Community” by the state.⁵⁴² All local governments and departments concerned organise various promotional and educational activities around the National Day of Disaster Prevention and Reduction. These events are usually aimed at promoting knowledge and strengthening awareness in disaster preparedness among middle and primary schools and kindergartens.⁵⁶³ The country is also implementing “Going to the Countryside” program, which encourages development of advanced culture, science and technology as well as health care in rural areas, and continuously develop new methods to teach specific knowledge and skills and promote establishment of education bases and networks on disaster prevention and reduction.⁵⁶³

China also has “a human-oriented early warning system, allowing information on disaster to be released in a timely and effective manner, and allowing the public to efficiently and effectively avoid disasters.”⁵⁶⁴ For example, Hong Kong put in place an extensive flood warning system. When a Red or Black Rainstorm Warning Signal 8 or above is issued by the Hong Kong Observatory, the Emergency Control Center of the Drainage Services Department immediately goes to work to take preventive measures and remind residents in flood prone zones about the flood risks involved.⁵⁶⁵ Hong Kong also issues health warning for times of extreme heat or cold and puts an emphasis on information and services for the elderly during the periods of extreme heat.

4.1.6. Economic Resilience

While doing the research no official state-level definition of economic resilience in China was found. China is part of a macroeconomic surveillance which has been initiated by the Macroeconomic Research Office (AMRO) established in 2011 by the ASEAN+3. The AMRO aims to monitor and examine regional economic situations helping governments for financial risk detection and reduction.

4.1.7. Resilience Related Official Documents

- China National Committee for IDNDR. 1998. The National Natural Disaster Reduction Plan of the People’s Republic of China. Available at: http://www.adrc.asia/management/CHN/china_national_disaster_reduction_plan.html;
- Office of the China National Committee for Disaster Reduction. 2006. Disaster Reduction Action Plan of the People’s Republic of China (2006-2015). Available at: http://www.preventionweb.net/files/30351_chinadisasterreductionactionplan200.pdf;

⁵⁶³ Ministry of Civil Affairs (2012). China National progress report on the implementation of the Hyogo Framework for Action (2011-2013) – Interim. *Ministry of Civil Affairs*. Available at: http://www.preventionweb.net/files/28446_chn_NationalHFAprogress_2011-13.pdf. Accessed: 16 March 2016. P 4.

⁵⁶⁴ NCDR (2006). Disaster Reduction Action Plan of the People’s Republic of China (2006-2015). *Office of the China National Committee for Disaster Reduction*. Available at: http://www.preventionweb.net/files/30351_chinadisasterreductionactionplan200.pdf. Accessed: 15 March 2016. P.8.

⁵⁶⁵ Szalwinski, A., Lewis, J. (2015). China and US Case Studies: Preparing for Climate Change. Hong Kong: Improving Coastal Resilience and Managing Urban Heat. *Georgetown Climate Center*. Available at: http://www.georgetownclimate.org/sites/www.georgetownclimate.org/files/GCC-HongKong_UrbanHeat-August2015.pdf. Accessed 3 March 2016.

- The Information Office of the State Council. 2009. China's Actions for Disaster Prevention and Reduction. White Paper. Available at: <http://reliefweb.int/report/china/full-text-chinas-actions-disaster-prevention-and-reduction>;
- National Comprehensive Disaster Prevention and Reduction Plan (2011-2015). *In Chinese*.

4.2. Indonesia

Indonesia is one of the most disaster prone countries in the world. It is positioned on the joining point of three major tectonic plates of Eurasia, Indo-Australia and Pacific. Disasters in Indonesia increase by the year. Floods occur most often (34.1 percent of all disasters) followed by landslides at 16 percent of all disasters.⁵⁶⁶ Major fatalities are also associated with earthquakes and tsunamis. For example, Indian Ocean tsunami of 26 December 2004 killed 170 000 people⁵⁶⁷.

4.2.1. Concept of Resilience

The occurrence of the 2004 Indian Ocean tsunami resulted in significant transformation in the approach to reducing disaster risks in Indonesia. Before this devastating event occurred, management of war victims, refugees and conflict victims were the key concern in disaster management in Indonesia. The country took a rather reactive approach and disaster management was viewed as post-disaster efforts⁵⁶⁸. The adoption of the Hyogo Framework for Action (HFA) in 2005 brought huge changes through the calls for a comprehensive and systematic planning, implementing and evaluating progress in building resilience nation and community resilience worldwide, including in Indonesia⁵⁶⁹. For example, in 2005, the President of Indonesia visited Japan to receive a briefing on Japan's disaster reduction system and agreed with Prime Minister of Japan to produce a Joint Announcement on the Cooperation between the Two Countries on Natural Disaster Reduction and showed Indonesia's commitment to build disaster resilient community in the country based on the good practices from Japan.⁵⁷⁰ Immediately after the Great Indian Tsunami, Indonesia initiated its efforts towards the establishment of Indonesian Tsunami Early Warning System.⁵⁷⁰

As a response to HFA, in 2006 Indonesian government established National Action Plan for Disaster Risk Reduction (2006-2009).⁵⁶⁶ The document was created to serve as a guideline for early prevention of disasters and a reference for all stakeholders in executing disaster mitigation and risk reduction efforts, as well as establishing DRR as one of the top priorities in Indonesia. With the adoption of the Plan, the Government of Indonesia to mainstream DRR measures into the national development framework, particularly in the National Middle-term Development Plan and the Government's Annual Work Plan. The document also uses the concept of resilience. It urges to "use knowledge, innovation and education to build culture of safety and resilience at all level."⁵⁷¹

⁵⁶⁶ Republic of Indonesia (2006). National Action Plan for Disaster Reduction 2006-2009. *Republic of Indonesia* Available at: http://www.preventionweb.net/files/2557_NAPDRRen.pdf. Accessed: 18 March 2016.

⁵⁶⁷ Rofi, A., Doocy, S. and Robinson, C. (2006). Tsunami mortality and displacement in Aceh province, Indonesia. *Disasters*, 2006. Vol.30 No.3. Available from: http://www.jhsph.edu/research/centers-and-institutes/center-for-refugee-and-disaster-response/publications_tools/publications/pdf/TsunamiRofi.pdf. Accessed: 4 February 2016.

⁵⁶⁸ Djalante, B. (2013). Building Resilience to Disasters and Climate Change: Pathways for Adaptive and Integrated Resilience in Indonesia. *PhD Dissertation, Macquarie University, Department of Environment and Geography*. Available at: https://www.academia.edu/10471106/PhD_Thesis_Building_resilience_to_disasters_and_climate_change_pathways_for_adaptive_and_integrated_disaster_resilience_in_Indonesia. Accessed: 20 March 2016.

⁵⁶⁹ Ibid. P. 24.

⁵⁷⁰ The Joint Committee of Indonesia and Japan on Disaster Reduction. (2006). Building the Resilience of Indonesia and its Communities to Disaster for the Next Generation. *The Joint Committee of Indonesia and Japan on Disaster Reduction*. Available at: http://www.bousai.go.jp/kokusai/kyoryoku/pdf/report_e.pdf. Accessed: 18 March 2016.

⁵⁷¹ Republic of Indonesia (2006). National Action Plan for Disaster Reduction 2006-2009. *Republic of Indonesia* Available at: http://www.preventionweb.net/files/2557_NAPDRRen.pdf. Accessed: 18 March 2016. P. IV-1

The Action Plan is based on five pillars, namely:

1. Ensuring that DRR is a national and a local priority with a strong institutional basis for implementation;
2. Identification, assessment and monitoring disaster risks and enhancing early warning;
3. Using knowledge, innovation and education to build culture of safety and resilience at all levels;
4. Reducing underlying risk factors;
5. Strengthening disaster preparedness for effective response at all levels.⁵⁷²

To ensure the accountability of DRR on development policy, the Plan intends to develop measurable indicators and involve civil society in monitoring through the development of control mechanisms at all levels, from central up to the village level. The document provides a list of indicators measuring disaster resilience. It is argued that in the context of resilience against disasters, the success of disaster risk reduction can be measures with: distribution of income levels; level of education; level of use of medical services; level of unemployment; availability of resilience of housing; birth and mortality rates of social groups; quality of life; survival; environmental resilience; local economic resilience.⁵⁷³

Therefore, although the indicators are highly focused on measuring social resilience, several of them are also targeted towards economic and environmental dimensions of resilience. The document also mentions the establishment of the “National Disaster Resilience Index to measure capacities for disaster risk management, institutional capacities, attention to disaster risks, funding availability and emergency response preparedness”.⁵⁷⁴ Although no further information regarding the aforementioned index could be found, in November 2013, the Government of Indonesia launched the world’s first Disaster Recovery Index (DRI), which measures the progress of recovery in communities affected by the Mount Merapi eruption in 2010 and lahar floods in 2011. Index utilizes 22 variables to determine how communities are recovering from the volcanic eruption in terms of restoring infrastructure, livelihoods, housing, and social structures, among other things. The survey also measures community resilience, which is particularly important since Merapi is a permanent hazard.⁵⁷⁵

In 2007, the National Agency for Disaster Management (BNPB) of Indonesia published the “Law of the Republic of Indonesia Number 24 of 2007 Concerning Disaster Management”⁵⁷⁶. The establishment of this law officially made DRR a national priority of Indonesia. The document defines disaster management as a series of efforts encompassing policies on development with disaster risk, disaster prevention, emergency response and rehabilitation. Highly concentrated on disaster risk management, it also briefly mentions the importance of social resilience and urges for “strengthening of community’s social resilience”.⁵⁷⁷ The same year United Nations Development Programme (UNDP) together with the Government of Indonesia initiated a project “Safer Communities through Disaster Risk Reduction in Development” (SC-DRR) to help Indonesia implement the paradigm shift by mainstreaming DRR principles into the development processes. The ultimate aim of the SC-DRR was to ensure that a culture of safety becomes the norm in the country, both within government and within communities vulnerable to disasters.⁵⁷⁸ One of the initiatives implemented in the framework of the

⁵⁷² Ibid. P. IV-2-IV-6.

⁵⁷³ Ibid. V-3.

⁵⁷⁴ Ibid. V-3.

⁵⁷⁵ UNDP (2013). Launching of the World’s First Disaster Recovery Index. *United Nations Development Programme*. Available at: <http://www.id.undp.org/content/indonesia/en/home/presscenter/pressreleases/2013/11/27/launching-of-the-world-s-first-disaster-recovery-index.html>. Accessed: 22 March 2016.

⁵⁷⁶ National Agency for Disaster Management BNPB (2007). Law of the Republic of Indonesia Number 24 of 2007 Concerning Disaster Management. *BNPB* Available at: <http://www.ifrc.org/docs/IDRL/956EN.pdf>. Accessed: 22 March 2016.

⁵⁷⁷ Ibid. P. 18.

⁵⁷⁸ UNDP, Government of Indonesia. (2012). Safer Communities through Disaster Risk Reduction (SC-DRR) in Development. Evaluation Report. *United Nations Development Programme*. Available at: <http://www.undp.org/content/undp/en/home/librarypage/crisis-prevention-and-recovery/safer-communities-through-disaster-risk-reduction--sc-drr--in-de.html>. Accessed: 22 March 2016.

Programme was the proposal to build resilient villages (*desa tangguh*). As of 18 February 2013, some 1,023 villages have signed on. The initial objective of the proposal was to initiate activities “directed to integration of disaster risk reduction into sustainable development”⁵⁷⁹, however most of the community grants were used for disaster preparedness activities – evacuation routes, purchase of tents, garbage collection and similar (see section on social resilience in Indonesia).

Most recently, Indonesia started to pay attention and emphasize the importance of urban resilience. In July 2015 the President of Indonesia Joko Widodo announced Government’s plans to launch a National Disaster Risk Reduction Movement in October the same year that would include a focus on resilient cities and communities. The announcement was made at the close of three days high-level training for 30 officials in urban resilience provided by the National Authority for Disaster Management (BNPB) as part of its commitment to implementing the Sendai Framework for Disaster Risk Reduction.⁵⁸⁰

4.2.2. Institutional Framework for Delivering Resilience

The National Action Plan for Disaster Reduction 2006-2009 states that disaster management process must engage government civil society and private sectors.⁵⁸¹ Since the establishment of country’s Constitution in 1945, the Government of Indonesia is “responsible to protect the whole Indonesian nation and the entire motherland” from disasters⁵⁸¹. Article 5 of the Law of the Republic of Indonesia Number 24 of 2007 states that Government and Local Governments are responsible for the disaster management.⁵⁷⁶

Indonesian DRR institutional framework went through several adjustments since 1966. National coordinated arrangement for natural disaster in Indonesia was initiated in 1966 by the establishment of Advisory Board for Natural Disaster Management. Back then, its activities were focused on emergency relief for disaster victims. In 1979, the National Natural Disaster Management Coordinating Board (BAKORNAS PBP) was established to replace Advisory Board for Natural Disaster. The 1979 Decree also included the establishment of similar arrangement in provincial as well as in district levels. On 2 September 1999 the Presidential Decree No. 106/1999 was issued and granted BAKORNAS PBP the management of not only natural but also man-made disasters and social unrest (WHO/OCHA Mission 2002). BAKORNAS PBA formulated disaster management policy, provided guidelines and directives on policy outlines in disaster management activities, and coordinated disaster management before, during and after disaster (*ibid.*). In 2008 Presidential Decree No. 8 established the Indonesian National Disaster Management Agency (BNPB) to replace BAKORNAS PBA. It manages 399 provincial and municipality-level bureaus. BNPB was granted the coordination function of the implementation of disaster management activities in Indonesia.⁵⁸² BNPB has a set of defined functions:

- “Provide guidance and direction on disaster management effort that includes disaster prevention, emergency response, rehabilitation, and reconstruction in a fair and equitable;
- Assigning the standardization and implementation of disaster management needs based on laws and regulations;
- Delivering information to community disaster management activities;

⁵⁷⁹ Ibid. P.18.

⁵⁸⁰ UNISDR (2015). Indonesian President to focus on urban resilience. *United Nations Office for Disaster Risk Reduction*. Available at: <https://www.unisdr.org/archive/45010>. Accessed: 23 March 2016.

⁵⁸¹ Republic of Indonesia (2006). National Action Plan for Disaster Reduction 2006-2009. *Republic of Indonesia*. Available at: http://www.preventionweb.net/files/2557_NAPDRRen.pdf. Accessed: 18 March 2016. P.III-1

⁵⁸² See <http://www.bnpb.go.id/profil>.

International Survey

- Use and account for donations / support national and international projects.⁵⁸³

BNPB supported various initiatives, including: conduct of disaster risk analyses and risk mapping; organization of disaster risk reduction forums; support to contingency planning initiatives; and the conduct of trainings for bureau staff. Notably, BNPB helped develop the aforementioned “Resilience Villages” programme.⁵⁸⁴

Considering that the majority of Indonesian regions are prone to different natural disaster, the Government planned to establish local disaster offices in all relevant regions. “By the Head of BNPB Regulation No 3/2008 on the Establishment of BPBD and the Ministry of Home Affairs Regulation No 46/2008 on BPBD Organization and Working Mechanism, such offices were established in provincial, regency and city regions”⁵⁸⁵. On the other hand, community groups that showed interest in participating in disaster management activities evolved rather sporadically in different regions of the country. Therefore, some regions established disaster reduction platforms or forums that involve government and non-government stakeholders. At the national level, a National Platform for DRR, a multi-stakeholder body to advocate for DRR, was established to provide coordination, analysis and advice to participating international and national stakeholders (ibid.). All of the aforementioned organisations engage in education and training programs to promote the capacity of local communities to identify, monitor and deal with existing natural disasters.

Prior to establishment of the National Law on Disaster Risk Management in 2007⁵⁷⁶, National Development Planning Agency (Bappenas) served as the initial home for all the DRR initiatives in Indonesia. The newly established law made National Disaster Management Agency (BNPB) responsible for future DRR work. However, formed on the basis of the former disaster response unit Bakornas, the new BNPB faced major challenges such as unfamiliarity with DRR concepts and approaches⁵⁸⁶. Up until now BNPB’s functions as a key actor in DRR work remain highly underdeveloped and its interaction with other line ministries on DRR work remains limited.⁵⁸⁶ It should also be stressed that awareness of DRR principles across all other governmental organisations of Indonesia also is low, and agencies remain focused on their preparedness and response functions, which reflects the legacies of the previous disaster management paradigm.⁵⁸⁶

4.2.3. Critical Infrastructure and Technical Resilience

Although Indonesia does not have a clear definition of critical infrastructure resilience, official state-level documents urge to increase resilience of state’s infrastructure. For example, National Action Plan for Disaster Reduction 2006-2009 stresses the need to protect and strengthen critical public infrastructures, such as schools, hospitals, power plants, to safeguard against disaster impacts. The document also urges for mainstreaming disaster risks into planning procedures for key infrastructure projects, including design criteria, approval and implementation of the projects. It also encourages the revision of existing or the development of new building codes, standards, rehabilitation and

⁵⁸³ Information retrieved from the official BNPB web page. For more information see: <http://www.bnpb.go.id/profil/tugas-dan-fungsi>.

⁵⁸⁴ UNDP (2013). Indonesia’s National Disaster Management Agency, *United Nations Development Programme*. Available at: <https://www.unisdr.org/2013/sasakawa/documents/nominees/BNPB.pdf>. Accessed: 23 March 2016.

⁵⁸⁵ Darwanto, H. (2012). Preliminary Examination of Existing Methodologies for Allocating and Tracking National Government Budget for Disaster Risk Reduction (DRR) in Indonesia. *UNISDR*. P. 6. Available at: <http://www.preventionweb.net/english/hyogo/gar/2013/en/bgdocs/Darwanto.%202012.pdf>. Accessed: 25 May 2016.

⁵⁸⁶ UNDP, Government of Indonesia (2012). Safer Communities through Disaster Risk Reduction (SC-DRR) in Development. Evaluation Report. *United Nations Development Programme*. Available at: <http://www.undp.org/content/undp/en/home/librarypage/crisis-prevention-and-recovery/safer-communities-through-disaster-risk-reduction--sc-drr--in-de.html>. Accessed: 22 March 2016. P.21.

reconstruction practices.⁵⁸⁷ The document is built on the principle of “building back better”. As Indonesia is prone to earthquakes, the country planned to build seismic-resilient houses and buildings. “It is expected that seismic-resilient building will be widely accepted after revision of building codes, establishment of building guidance system, provision of incentives in accordance with present condition in Indonesia and implementation of building codes properly”⁵⁸⁸.

For example, Japan International Cooperation Agency (JICA) has been working with the Ministry of Public Works to promote disaster-resistant construction practices in Indonesia. In earthquake-affected areas such as Padang, JICA built or sponsored earthquake-proof constructions for several schools.⁵⁸⁹ In close cooperation with Indonesian government agencies, the World Bank initiated a Disaster and Climate Risk Review for National Development project. The review will focus on six medium-sized cities in Indonesia, and identify vulnerable locations and structures that need retrofitting or restructuring, the risks reduction programs to be incorporated into urban planning, and other strategy options for building urban resilience. These strategy options include upgrading city infrastructure to be more disaster-resilient.⁵⁹⁰

In 2015, the Government of Indonesia announced about a plan for massive infrastructure spending over the next five years with the aim to increase its disaster resilience. The Government allocated US \$150 billion to finance infrastructure projects, like new dams, roads and irrigation systems, that would potentially reduce disaster risk in the long term.⁵⁹¹

4.2.4. Organisational Resilience

Due to the fact that resilience culture is relatively new in Indonesia, the country does not pay sufficient attention to organisational resilience. During the research on existing state-level official documents, no official definition of organisational resilience was found. Disaster Management Law briefly mentions that “business institutions shall have an opportunity to take part in disaster management, both jointly and severally with other parties”⁵⁹². It is further argued that “business institutions shall adjust their activities to disaster management policy. Business institutions shall come under obligation to submit a report to the government and/or agency in charge of disaster management and to transparently inform the public thereof. Business institutions shall come under obligation to consider the principles of humanity in performing their disaster management economic function”⁵⁹³.

4.2.5. Social Resilience

After the Indian Ocean tsunami government institutions and non-governmental organisations alike have been keen on developing community-based initiatives to build the resilience of people living in hazard-prone areas in the country (Ascholani et al. 2012). The Law on Disaster Management states

⁵⁸⁷ Republic of Indonesia (2006). National Action Plan for Disaster Reduction 2006-2009. *Republic of Indonesia* Available at: http://www.preventionweb.net/files/2557_NAPDRRen.pdf. Accessed: 18 March 2016. P. IV-6

⁵⁸⁸ The Joint Committee of Indonesia and Japan on Disaster Reduction. (2006). Building the Resilience of Indonesia and its Communities to Disaster for the Next Generation. *The Joint Committee of Indonesia and Japan on Disaster Reduction*. Available at: http://www.bousai.go.jp/kokusai/kyoryoku/pdf/report_e.pdf. Accessed: 18 March 2016. P.20.

⁵⁸⁹ The Joint Committee of Indonesia and Japan on Disaster Reduction. (2006). Building the Resilience of Indonesia and its Communities to Disaster for the Next Generation. *The Joint Committee of Indonesia and Japan on Disaster Reduction*. Available at: http://www.bousai.go.jp/kokusai/kyoryoku/pdf/report_e.pdf. Accessed: 18 March 2016. P.31.

⁵⁹⁰ The World Bank (2014). Indonesia: Helping Build Resilient Communities. *The World Bank*. Available at: <http://www.worldbank.org/en/results/2014/04/14/indonesia-helping-build-resilient-communities>. Accessed: 31 March 2016.

⁵⁹¹ Widhiarto, H. (2015). Infrastructure spending essential for disaster resilience. *Jakarta Post*. Available at: <http://www.thejakartapost.com/news/2015/03/17/infrastructure-spending-essential-disaster-resilience.html>. Accessed: 31 March 2016.

⁵⁹² National Agency for Disaster Management BNPB (2007). Law of the Republic of Indonesia Number 24 of 2007 Concerning Disaster Management. *BNPB* Available at: <http://www.ifrc.org/docs/IDRL/956EN.pdf>. Accessed: 22 March 2016.

⁵⁹³ Ibid. P. 15.

that there is an urge of “strengthening of community’s social resilience”⁵⁹⁴. Various approaches have been applied however most of them have been based on the “preparedness” approach, in which the programs are mostly geared towards enhancing the emergency response capacity of people (Ascholani et al. 2012).

Since the Indian Ocean tsunami, the Government of Indonesia began to argue for more extensive involvement of communities in the process of DRM and stimulation of a culture of disaster resilience. It was argued for systematic involvement of communities in “disaster risk reduction, including in the process of decision-making for issues [of] mapping, planning, implementation, monitoring and evaluation, through creation of networking, including volunteer work, strategic human resource management, and by making legal regulations and defining responsibilities and delegation of authority”⁵⁹⁵. In Indonesia, disaster education was introduced within school curriculums. Together with UNDP, Indonesian Government developed a comprehensive disaster education curriculum, with separate volumes tailored for students in elementary, junior high and senior high schools.⁵⁹⁶

More extensive communities’ disaster awareness was started to be built by “promoting the implementation of local risk assessment and disaster preparedness programmes in schools and institutions of higher education; promoting the implementation of programmes and activities in schools for learning to minimize the effects of hazards; promoting community-based training initiatives to enhance local capacities to mitigate and cope with disasters; ensuring access to appropriate training and educational opportunities for women and vulnerable constituencies.”⁵⁹⁷ To reduce disaster-related casualties, the Government introduced several physical measures, such as early warning systems, spatial plan regulation, and repair of evacuation roads. Since the 2004 Indian Ocean tsunami international funding was devoted to building the Indonesia Tsunami Early Warning System, the German-Indonesia Early Warning System, and the Indian Ocean Tsunami Warning. All these systems were installed in order to increase community resilience in Indonesia. However, the social dimension of the tsunami warning system has not been yet properly addressed in Indonesia. Many communities do not know which organisation is authorized to issue and disseminate warnings, where to get the information from, and what needs to be done when a warning is issued⁵⁹⁸.

Extensive risk mapping, evacuation planning, contingency planning, emergency response training and disaster simulations were also conducted in hazard-prone areas across the country. The government also initiated “Sister Village” program, where villages in the affected areas are encouraged to foster collaboration with villages in the lower grounds, including in arrangements for future emergency situations (Ascholani et al. 2012, 8).

The World Bank initiated an Indonesia Scenario Assessment for Emergencies (InaSAFE), a free software program that produces realistic natural-hazard impact scenarios for better planning, preparedness, and response activities. Indonesian communities are also involved in the Safe School

⁵⁹⁴ Ibid. P. 18.

⁵⁹⁵ Republic of Indonesia (2006). National Action Plan for Disaster Reduction 2006-2009. *Republic of Indonesia* Available at: http://www.preventionweb.net/files/2557_NAPDRRen.pdf. Accessed: 18 March 2016. P. IV-3

⁵⁹⁶ UNDP, Government of Indonesia. (2012). Safer Communities through Disaster Risk Reduction (SC-DRR) in Development. Evaluation Report. *United Nations Development Programme*. Available at: <http://www.undp.org/content/undp/en/home/librarypage/crisis-prevention-and-recovery/safer-communities-through-disaster-risk-reduction--sc-drr--in-de.html>. Accessed: 22 March 2016. P.14

⁵⁹⁷ Republic of Indonesia (2006). National Action Plan for Disaster Reduction 2006-2009. *Republic of Indonesia* Available at: http://www.preventionweb.net/files/2557_NAPDRRen.pdf. Accessed: 18 March 2016. P. IV-5.

⁵⁹⁸ Djalante, B. (2013). Building Resilience to Disasters and Climate Change: Pathways for Adaptive and Integrated Resilience in Indonesia. *PhD Dissertation, Macquarie University, Department of Environment and Geography*. P. 790. Available at: https://www.academia.edu/10471106/PhD_Thesis_Building_resilience_to_disasters_and_climate_change_pathways_for_adaptive_and_integrated_disaster_resilience_in_Indonesia. Accessed: 20 March 2016.

program, whereby the rehabilitation of schools damaged by disasters uses special allocation funds, capital investment and disaster management schemes.⁵⁹⁹

However, so far social resilience concept is rooted in political rather than community level. DRR activities undertaken at the community level are better classified as disaster preparedness rather than DRR activities. Different aforementioned activities can be seen to have raised DRR awareness in the communities, however, they have not produced a model or ideas that the Government can use to help make communities more disaster resilient.⁵⁹⁹ All these processes require giving communities more time and flexibility to try new things and approaches, and explore processes through which government and communities can better collaborate in reducing disaster risks.⁶⁰⁰

4.2.6. Economic Resilience

The concept and practice of economic resilience are not deeply rooted in Indonesia. Nevertheless the country makes attempts to make its economy more resilient towards future crises. For example, to prepare against future economic crises Indonesia is part of macroeconomic surveillance initiated by the Macroeconomic Research Office (AMRO) established in 2011 by the ASEAN+3 (the Association of Southeast Asian Nations plus China, Japan and the Republic of Korea). The AMRO aims to monitor and examine regional economic situations helping governments to detect and reduce any financial risks.⁶⁰¹

4.2.7. Resilience Related Official Documents

- Republic of Indonesia. 2006. National Action Plan for Disaster Reduction 2006-2009. Available at: http://www.preventionweb.net/files/2557_NAPDRRen.pdf;
- The Joint Committee of Indonesia and Japan on Disaster Reduction. 2006. Building the Resilience of Indonesia and its Communities to Disaster for the Next Generation. Available at: http://www.bousai.go.jp/kokusai/kyoryoku/pdf/report_e.pdf;
- National Agency for Disaster Management. 2007. Law of the Republic of Indonesia Number 24 of 2007 Concerning Disaster Management. Available at: <http://www.ifrc.org/docs/IDRL/956EN.pdf>;
- National Disaster Management Plan 2010-2014. 2010. Available at: <http://www.mpbi.org/files/peraturan/RENAS-PB-2010-2014.pdf>. In Indonesian;
- National Guidelines for Disaster Management 2010-2014. 2010. In Indonesian;
- National Action Plan on Disaster Risk Reduction 2010-2012. 2010. Available at: <http://www.mpbi.org/files/peraturan/RAN-PRB-2010-2012.pdf>. In Indonesian;
- United Nations Development Programme and Government of Indonesia. 2012. Safer Communities through Disaster Risk Reduction (SC-DRR) in Development. Evaluation Report. Available at: <http://www.undp.org/content/undp/en/home/librarypage/crisis-prevention-and-recovery/safer-communities-through-disaster-risk-reduction--sc-drr--in-de.html>.

4.3. Japan

Japan is yet another Asian country that is prone to various natural disasters. In 2011, the country was hit with history's costliest natural and nuclear disaster. Japanese government, businesses, and the

⁵⁹⁹ Ibid. P.27.

⁶⁰⁰ Ibid. P.24.

⁶⁰¹ ACCCRN-Indonesia Best Practices Transfer Program. Available at: <http://accrn.net/country/indonesia>. Accessed: 4 February 2016.

public experienced months of damaging power outages following the disaster⁶⁰². Despite this devastating event, Japan is considered as one of the world's leaders in the field of resilience.

4.3.1. Concept of Resilience

When analysing the concept and practice of resilience in Japan, the overall debate can be divided into two periods: before Fukushima disaster in March 2011, and after. The devastating event made Japan a world leader in building disaster resilience in critical energy, water, transport, and other lifeline infrastructures⁶⁰². Since its beginning as a modern state, Japan has spent over a century in establishing and enhancing its disaster reduction system. The first major change experienced by Japan's disaster reduction administration was after the Ise-Wan Typhoon in 1959, which caused extensive damage to the country. In 1961 Japan established the Disaster Countermeasure Basic Act, which required replacing ex-post disaster countermeasures with ex-ante measures to "prevent disasters from happening"⁶⁰³ and became the beginning of present day disaster related measures in Japan. The Ise-Wan Typhoon was the major turning point in the history of Japan's disaster risk administration as since then it became the prevalent perspective to regard budget spending for disaster reduction not as expenditures but as investments.⁶⁰⁴ The Act promoted "comprehensive and systematic advancement of disaster prevention, countermeasures and relief activities when disasters strike, recovery and restoration. Also, various specialized institutions, including the National Research Center for Disaster Prevention [...] of the Science and Technology Agency and the Typhoon Research Department of the Meteorological Research Institute of the Japan Meteorological Agency were established"⁶⁰⁵.

After the Great Hanshin Awaji earthquake in 1995, Japanese government started to upgrade earthquake resistance of infrastructure as well as enhance the measures to make houses and buildings more quake resistant, and measures for crowded city blocks of wooden houses. The government has strengthened design and other relevant standards after every large-scale disaster, focusing on infrastructural measures, however it has taken actions mostly after disasters actually occurred.⁶⁰⁶

In February 2007, Japan's federal government launched an emergency warning system, providing municipalities with a plan and solution to respond to natural disasters. The system was put to the test in the aftermath of the tsunami and earthquake that hit the country on the 11th March 2011. Although it is rather difficult to assess the impact of the system in the aftermath of the tsunami and earthquake, the emergency warning system ensured that no trains were derailed and no elevated bridges collapsed, while flights heading for Tokyo's airport landed safely.⁶⁰⁷

The Great East Japan Earthquake revealed the limits of conventional disaster prevention measures, which have mainly been focused on infrastructure development from the perspective of protection

⁶⁰² DeWit, A. (2016). Disaster Risk Reduction and Resilience as a Structural Reform in Abenomics. *The Asia-Pacific Journal*. Vol. 13, Issue 1, No. 2. Available at: <http://apjpf.org/-Andrew-DeWit/4248/article.pdf>. Accessed: 20 May 2016.

⁶⁰³ ADRC (1997), Japan Disaster Countermeasures Basic Act No. 223. 1961. *Asian Disaster Reduction Centre*. Available at: <http://www.adrc.asia/documents/law/DisasterCountermeasuresBasicAct.pdf>. Accessed: 1 April 2016.

⁶⁰⁴ The Joint Committee of Indonesia and Japan on Disaster Reduction. (2006). Building the Resilience of Indonesia and its Communities to Disaster for the Next Generation. *The Joint Committee of Indonesia and Japan on Disaster Reduction*. Available at: http://www.bousai.go.jp/kokusai/kyoryoku/pdf/report_e.pdf. Accessed: 18 March 2016. P.9.

⁶⁰⁵ Ibid. P.10.

⁶⁰⁶ JFS (2014). Update on Japan's Efforts to Build National Resilience to Disasters. *Japan for Sustainability*. Available at: http://www.japanfs.org/en/news/archives/news_id035034.html. Accessed: 1 April 2016.

⁶⁰⁷ Smart City (2013). Smart City Resilience: Learning from Emergency Response and Coordination in Japan. *Smart City*. Available at: http://www.gsma.com/connectedliving/wp-content/uploads/2013/02/cl_SmartCities_emer_01_131.pdf. Accessed: 1 April 2016.

against disasters.⁶⁰⁸ After the Great East Japan Earthquake, the ruling Liberal Democratic Party established the National Resilience Investigation Committee, which conducted two years of discussions on how the government should build national resilience in Japan. In 2013, the Government of Japan established a Basic Act for National Resilience Contributing to Preventing and Mitigating Disasters for Developing Resilience in the Lives of the Citizenry (Act No. 95).⁶⁰⁹ The document states that instead of avoiding looking at possible natural threats, Japan should “face them squarely”⁶¹⁰. Although the document does not provide a clear definition of resilience, it could be understood that resilience is defined as “disaster prevention and mitigation, swift recovery and reconstruction from disasters and enhancement of Japan’s international competitiveness”⁶¹¹. The document briefly mentions the need to establish the Fundamental Plan for National resilience, in order to “promote measures concerning National Resilience in a comprehensive and systematic manner, the national government shall establish a fundamental plan for promoting measures concerning National Resilience (hereinafter referred to as the “Fundamental Plan for National Resilience”) as the guidelines for other national plans concerning National Resilience”.⁶¹² It further specifies the creation of the National Resilience Promotion Headquarters promoting measures concerning National Resilience in a comprehensive and systematic manner.

Following the Act No. 95, in 2014 an umbrella plan called Fundamental Plan for National Resilience – Creating a Strong and Resilience Country was established in Japan.⁶¹³ The document serves as a fundamental guideline for resilience processes in the country. It is important to note that the document draws a close parallel between resilience and vulnerability by describing the former as an opposite pole of the latter: “The Fundamental Plan for National Resilience is [...] a prescription for developing national resilience based on vulnerability assessment, which is like a health checkup of the nation”⁶¹⁴. The following four fundamental goals for national resilience are established in the document:

- “Prevent human loss by any means;
- Avoid fatal damage to important functions for maintaining administration as well as social and economic systems;
- Mitigate damage to property of the citizenry and public facilities;
- Achieve swift recovery and reconstruction”⁶¹⁵.

The document defines national resilience as “secure social and economic systems that will never become dysfunctional in any event, [secure] lives and property of local residents, [protected] industrial competitiveness and economic growth, and at the same time [ability of] both the national and local governments and the private sector [...] to enhance their capacity to address changes in circumstances and increase their productivity and efficiency”⁶¹⁵. It is further stated that Japan is committed to “promoting initiatives for building national resilience with the aim of creating safe and secure national lands, regions, and economic society that have strength and flexibility, even in the event of any

⁶⁰⁸ National Resilience Promotion Office, Cabinet Secretariat (udd.) Building National Resilience – Creating a Strong and Flexible Country. Available at: http://www.cas.go.jp/jp/seisaku/kokudo_kyoujinka/en/e01_panf.pdf. Accessed: 1 April 2016.

⁶⁰⁹ The Government of Japan (2013). Basic Act for National Resilience Contributing to Preventing and Mitigating Disasters for Developing Resilience in the Lives of the Citizenry. *The Government of Japan*. Available at: http://www.cas.go.jp/jp/seisaku/kokudo_kyoujinka/pdf/khou1-2.pdf. Accessed: 30 March 2016.

⁶¹⁰ Ibid. P. 1.

⁶¹¹ Ibid. P. 2.

⁶¹² Ibid. P. 5.

⁶¹³ The Government of Japan. (2014). Fundamental Plan for National Resilience – Creating a Strong and Resilience Country. *The Government of Japan*. Available at: http://www.cas.go.jp/jp/seisaku/kokudo_kyoujinka/en/fundamental_plan.html. Accessed: 30 March 2016.

⁶¹⁴ Ibid. P. 2.

⁶¹⁵ The Government of Japan. (2014). Fundamental Plan for National Resilience – Creating a Strong and Resilience Country. *The Government of Japan*. Available at: http://www.cas.go.jp/jp/seisaku/kokudo_kyoujinka/en/fundamental_plan.html. Accessed: 30 March 2016. P.4.

disasters”⁶¹⁵. Therefore the concept of resilience used in the document is holistic and takes into account accidents such as nuclear disasters, terror attacks and natural disasters⁶¹³.

Approach to building resilience in Japan involves:

- Implementation of measures, while closely examining all aspects of essential factors that may damage Japan’s **robustness**;
- Implementation of measures in planned manner, while having a **long-term perspective** and the concept of time management, not from a short-term perspective;
- Enhancing regional power by rebuilding **diversity** in regions, strengthening regional collaboration and thus trying to make the entire nation more resilient to disasters, with the aim of preventing the still-ongoing excess concentration in the Tokyo Metropolitan area and creating an autonomous, decentralized and coordinated nation;
- Strengthening latent **strength**, **resilience**, and **recuperative power** held by social and economic systems of all levels in Japan;
- Implementation of measures, while comprehensively ascertaining the **power of the market**, **administration** and **society**, with a broad and systematic perspective, and also keeping the ideal systems and regulations to be achieved in mind.⁶¹⁶

Japan developed a system of measuring national resilience by assessing its vulnerability to large-scale disasters.⁶¹⁷ Country developed Guidelines for Assessment of Vulnerability to Large-scale Natural Disasters and states that “assessment of vulnerability to large-scale natural disasters [...] is like a health checkup of nation, examining and assessing vulnerability for the purpose of building national resilience to large-scale natural disasters, etc.”⁶¹⁷ The Guidelines further flesh out fundamental resilience goals by envisaging large-scale natural disasters and establish eight goals that Japan’s social and economic systems should achieve in advance:

1. “Protect human lives to the utmost extent even in the event of a large-scale natural disaster.
2. Ensure prompt rescue and first-aid activities and provision of medical care from immediately after a large-scale natural disaster (including responses required in the absence of such activities).
3. Secure indispensable administrative functions from immediately after a large-scale natural disaster.
4. Secure indispensable information communication functions from immediately after a large-scale natural disaster.
5. Prevent functional disturbance in economic activities (including supply chains) even after the occurrence of a large-scale natural disaster.
6. Secure minimum networks for electricity, gas, water and sewerage, fuel and transport required for people’s lives and economic activities even after the occurrence of a large-scale natural disaster, and seek early recovery of these networks.
7. Prevent any uncontrollable secondary disaster.
8. Develop conditions that enable swift recovery and reconstruction of local society and economy even after the occurrence of a large-scale natural disaster”⁶¹⁸.

The methodology for vulnerability assessment involves⁶¹³:

1. Assess each sector of measures concerning national resilience. Targeted individual sectors of measures are 12: administrative functions/police and fire services; housing and cities;

⁶¹⁶ Ibid. P.5.

⁶¹⁷ National Resilience Promotion Headquarters (2013). Guidelines for Assessment of Vulnerability to Large-scale Natural Disasters. *National Resilience Promotion Headquarters*. Available at: http://www.cas.go.jp/jp/seisaku/kokudo_kyoujinka/pdf/shishin1-2.pdf. Accessed: 1 April 2016. P.1.

⁶¹⁸ National Resilience Promotion Headquarters (2013). Guidelines for Assessment of Vulnerability to Large-scale Natural Disasters. *National Resilience Promotion Headquarters*. Available at: http://www.cas.go.jp/jp/seisaku/kokudo_kyoujinka/pdf/shishin1-2.pdf. Accessed: 1 April 2016. P. 3-4.

healthcare and welfare; energy; finance; information and communications; industrial structures; transportation and logistics; agriculture, forestry and fisheries; national land conservation; environment; and land use (national land use)); and cross-cutting sectors are three (risk communication; countermeasures for aging infrastructure; and research and development.

2. Envisage the “worst events that should never happen” and cross-sectorally assess respective countermeasures. Vulnerability assessment is conducted while envisaging the worst events that should never happen. Regarding such events, eight aforementioned goals to be achieved in advance were set up and 45 events⁶¹⁹ that would hinder the achievement thereof were specified. The Headquarters compiled measures for avoiding these specified worst events as cross-sectoral programs covering multiple ministries and agencies, and then analysed problems of each of the individual measures comprising the respective programs. Based on the analysis results, the Headquarters ascertained the achievement levels and progress of programs and comprehensively analysed and assessed the current vulnerabilities in respective programs, and further analysed and assessed the current vulnerabilities in each sector of measures, while taking into account problems newly revealed through the former analysis and assessment by program.
3. Also assess the required resources to be input, including human resources.
4. Conduct quantitative assessment in order to monitor the progress of measures. The utmost efforts were made to set up indicators to show progress when analysing the problems of each of the individual measures, and to select Key Performance Indicators (KPIs) for respective programs, in light of the relevance and objectivity, when ascertaining the achievement levels and progress thereof.

The Fundamental Plan for National Resilience further describes a list of policies for promoting initiatives for building resilience. It describes promotion policies for each of the aforementioned 15 sectors of measures⁶²⁰. For example, for housing and cities measures against fires in densely-populated areas are described; for energy – strengthening of capacity for mutual accommodation of energy among regions; for information and communications – early implementation of measures against long-term suspension of power supply; for industrial structures – promotion of the preparation of business continuity planning and management for enterprise partnerships⁶⁰⁸. It is explained that the government will implement measures by properly combining non-structural measures, for example preparation and utilization of hazard maps, and structural measures, for example development of river banks and sea dikes, depending on disaster risks and characteristics of the regions.

In order to build safe nation, regions, economy and society with strength and flexibility, the government of Japan is continuously reviewing and implementing the PDCA cycle to check the soundness of the national land and promote initiatives to build national resilience.

⁶¹⁹ All 45 events are listed in the Fundamental Plan for National Resilience – Creating a Strong and Resilience Country, Chapter 2 Section 3, P. 13-18.

⁶²⁰ For a detailed list of promotion policies see Fundamental Plan for National Resilience – Creating a Strong and Resilience Country, Chapter 3, P. 20-43.

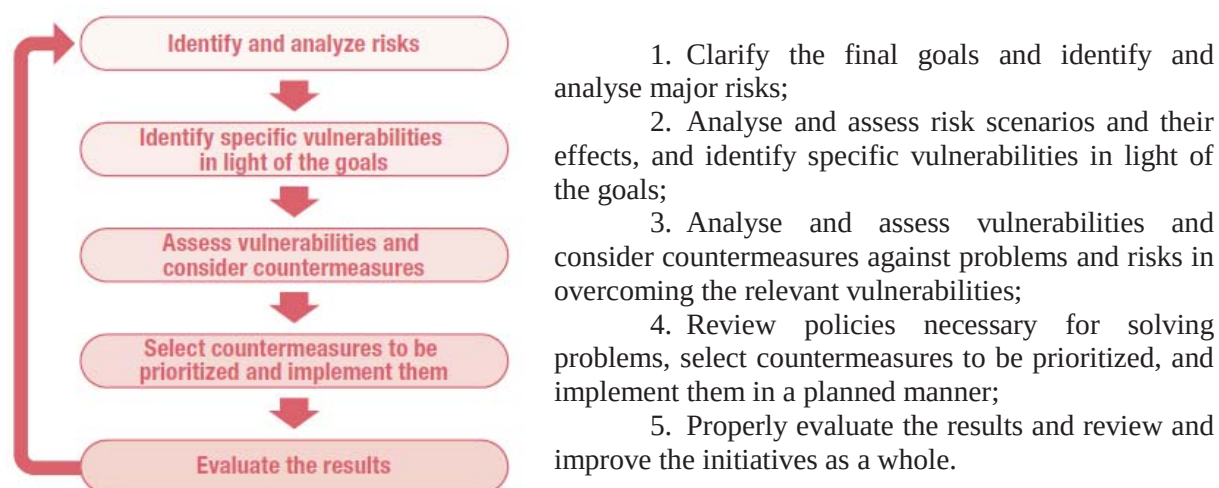


Figure 4.1 PDCA cycle. Source: National Resilience Promotion Office, Cabinet Secretariat. **Building National Resilience – Creating a Strong and Flexible Country.**

In Japan, there is a proverb that says “turn misfortune into a blessing”. Behind this is the idea that a misfortune should not be viewed from its negative side since it may later lead to a positive outcome.⁶²¹ This is the main idea behind resilience theory.

4.3.2. Institutional Framework for Delivering Resilience

In Japan, resilience is perceived as a shared responsibility between the public and private sectors as well as citizens.⁶¹³ All the ministries are involved in different aspects of national resilience. In addition, Japan has established several resilience specific agencies. As stated by the Basic Act for National Resilience, in 2013 **National Resilience Promotion Headquarters** were established as a response to 2011 disaster in the country. “[...] the Cabinet [must] work together, with this National Resilience Promotion Headquarters as a control tower, so that a vulnerability assessment can be swiftly completed for large-scale natural disasters and other issues based on the basic act, and so we can establish a basic plan for national resilience at an early date.”⁶²²

In July 2014, the **Association for Resilience in Japan (ARJ)** was inaugurated and includes 16 working groups in which politicians, bureaucrats, academics, business and representatives from subnational governments collaborate in the field of resilience⁶²³. These working groups address different aspects of resilient communities, from smart energy system to building sustainable and equitable local communities⁶⁰².

4.3.3. Critical Infrastructure and Technical Resilience

The Great East Japan Earthquake made Japan a world leader in building resilience in critical energy, water, transport and other lifeline infrastructures against increasingly frequent disasters confronting

⁶²¹ The Joint Committee of Indonesia and Japan on Disaster Reduction. (2006). Building the Resilience of Indonesia and its Communities to Disaster for the Next Generation. *The Joint Committee of Indonesia and Japan on Disaster Reduction*. Available at: http://www.bousai.go.jp/kokusai/kyoryoku/pdf/report_e.pdf. Accessed: 18 March 2016. P.35.

⁶²² The Prime Minister in Action. (2013). The Prime Minister in Action.. *National Resilience Promotion Headquarters*. Available at: http://japan.kantei.go.jp/96_abe/actions/201312/17kokudo_e.html/. Accessed: 7 April 2016.

⁶²³ Association for Resilience Japan. (Udd.) About resilience Japan Promotion Council. Available at: <http://www.resilience-jp.org/about/>. Accessed: 7 April 2016.

the country. In Japan, resilient infrastructure is defined using **four qualities**: resistance, reliability, redundancy, response and recovery⁶⁰².



Figure 4.2 Japan and the 4 R's of Infrastructure Resilience. Source: Dewit, A. 2015. *Abenomics and Japan's Economic Crisis. Disaster Risk Reduction and Resilience as Structural Reform in Abenomics.*

It could be argued that in the context of critical infrastructure resilience, the main message delivered in all the analysed documents is that the key aspect in building disaster resilient infrastructures is collaboration and information sharing between the public and private sectors of the country.

In June 2013, the Government published Japan Revitalization Strategy where the keywords were “energy”, “big data”, “ICT”, “disaster” and “resilient infrastructure”.⁶²⁴ The Plan outlines the main principle that will be used to increase resilience of national infrastructures, namely **early anomaly detection**. “This will be realized by making use of technologies including sensor, robot and non-destructive testing to grasp, accumulate and use data of damages, etc. of various infrastructures such as critical infrastructure for life, public infrastructure and industrial infrastructure”.⁶²⁵ The Government commits itself to setting a standard for infrastructure management which requires “grasping, accumulating and using infrastructure data and adopting high reliable and economical inspection, maintenance and repair technologies”.⁶²⁵

The Fundamental Plan for National Resilience of 2014 addresses five sectors of critical infrastructure (healthcare and welfare, energy, finance, ICT, transportation) and describes steps that need to be implemented to increase its resilience. The document explains that medical and welfare facilities need to be earthquake resistant. Efforts should be made to promote relocation from areas expected to be submerged in water in the event of a Nankai Trough earthquake, ensure information communications, emergency power generation and alternate water sources that support medical and welfare functions, and store water, food and other necessities, thereby strengthening disaster prevention and mitigation functions to secure business continuity. In order to ensure that all the victims expected to be generated by a disaster can receive necessary services, healthcare and welfare functions are to be made more disaster-resistant through building a broad –based collaboration system for appropriate allocation of medical resources, including materials, equipment, and personnel.⁶²⁶

The Plan states that most of the large-scale energy supply bases in Japan are located on the Pacific side, which makes them particularly vulnerable to earthquakes. Therefore, it is argued that “disaster response capacity of each facility should be strengthened, and self-sufficiency within each region and the capacity to mutually accommodate energy between regions should be enhanced. At the same time,

⁶²⁴ The Government of Japan (2013). Japan Revitalization Strategy – Japan is back. *The Government of Japan*. Available at: https://www.kantei.go.jp/jp/singi/keizaisaisei/pdf/en_saikou_jpn_hon.pdf. Accessed: 7 April 2016.

⁶²⁵ Ibid. P. 110.

⁶²⁶ National Resilience Promotion Office, Cabinet Secretariat (Udd.) Building National Resilience – Creating a Strong and Flexible Country. *National Resilience Promotion Office*. Available at: http://www.cas.go.jp/jp/seisaku/kokudo_kyoujinka/en/e01_panf.pdf. Accessed: 1 April 2016. P. 26.

the supply side and the demand side of energy should take comprehensive measures to ensure mutual support and unity, through structural development and non-structural measures, thereby seeking to enhance resilience of the energy supply chain as a whole⁶²⁷. While trying to ensure the necessary energy supply in the event of large-scale damage, the supply side needs to establish their concept of prioritization of supply destinations in advance on the premise that supply will be limited after receiving damage. Efforts should also be made to maintain and strengthen declining supply capacity of terminals (for example, service stations, etc.), introduce non-utility generation facilities to individual households, public facilities, schools and medical institutions, and secure sufficient stock fuel.⁶²⁷ It is claimed that in order to create smart societies, introduction and promotion of independent and distributed energy, such as cogeneration, fuel cells, renewable energy and hydrogen energy is important. The infrastructure for road and marine transport of energy should also be improved and the response capacity of the transport system needs to be strengthened. “With the aim of making the entirety of the energy supply-demand structure more resilient, the Ministry of Economy, Trade and Industry will endeavour to multilateralize and diversify domestic and overseas circumstances, and disaster risks in coastal areas. Means therefor may include intensive measures concerning the national energy infrastructure and distribution networks that enable mutual accommodation of electricity and natural gas, etc. between regions, promotion of regionally dispersed power sources, and ensuring domestically produced energy through the use of thermal energy and promotion of research and development for commercialization of methane hydrate.”⁶²⁸

Financial institutions are considered to be yet another part of Japan’s critical infrastructure system. The Plan explains that in order to ensure that financial services are provided in case of large-scale disaster, financial institutions “should improve the disaster resistance of their buildings, etc., ensure the backup functions of their systems, try to secure power sources and information communication functions in an emergency collaboration with relevant organizations, and establish and enhance their BCP and BCM structures. In particular, as significant settlement functions are concentrated in the Metropolitan area, they need to intensively promote efforts to minimize possible influence due to a capital island earthquake, such as by securing alternate bases. The central bank must promote its measures in consideration of its significant role in maintaining financial order from a macro perspective.”⁶²⁹ It also urged to conduct joint drills in a cross-sectoral manner.

In the past, Japan was highly focused on roads, sewage, water and fuel following a disaster as they made up the lifelines of the cities. However, a new component of critical infrastructure is telecommunications; without information technology it is not possible anymore to successfully respond to disasters. In Japan, this type of infrastructure is owned by private sector. After the 2011 tsunami and earthquake, country faced serious problems resulting from poor telecommunications. The lesson that was learnt is that the government and private sector need to share information completely.⁶³⁰

In the context of ICT resilience, the Plan states that vulnerability of the information communications system against long-term disruption of power supply, which has not been considered up until now, needs to be assessed. It also urges for enhancement of the disaster resistance of power facilities and transmission facilities/networks. “Information and communications facilities and equipment should be

⁶²⁷ Ibid. P. 28.

⁶²⁸ Ibid. P. 29.

⁶²⁹ Ibid. P. 30.

⁶³⁰ PWC (2013). Rebuilding for resilience. Fortifying infrastructure to withstand disaster. *PricewaterhouseCoopers*. Available at: <https://www.pwc.com/gx/en/psrc/publications/assets/pwc-rebuilding-for-resilience-fortifying-infrastructure-to-withstand-disaster.pdf>. Accessed: 7 April 2016.

improved by preparing emergency power supply equipment and fuel storage facilities, etc.”⁶³¹ For example, after the Great East Japan Earthquake, Japan’s mobile operators established a recovery strategy for mobile infrastructure that applies to different disaster scenarios.⁶³² The strategy includes the following elements⁶³³:

- Improve disaster resilience of the networks and establish restoration methods;
- Improved reconnection and re-establishment of coverage for local relief sites;
- Establish secure means of information distribution after the disaster;
- Provide services and solutions useful during a disaster and during recovery.

The Plan also urges to increase disaster resistance of transportation/logistics facilities in Japan. In particular, with regard to transportation networks in metropolitan areas, where main arteries and hubs for the flows of people and goods are concentrated, should not be limited to the development of facilities (structural measures mentioned above), but also should include non-structural measures, such as the enhancement of road/maritime/air traffic control, strengthening of training, and promotion of research and development. In addition, as an incentive to facility managers, establishment of a mechanism to publicise the progress in efforts to enhance disaster resistance of facilities should be discussed.⁶³⁴

Resilient cyberspace is yet another goal stated by the government of Japan. In 2013, Japan’s Information Security Policy Council adopted “Cybersecurity Strategy: Towards a world-leading, resilient and vigorous cyberspace”⁶³⁵. It is argued that such national Strategy is necessary as cyber-attacks against government institutions and critical infrastructures have become a reality and an issue for national security⁶³⁶. It is expected that implementation of the Strategy “will lead to the fast realization of a “Cybersecurity Nation” with a “world-leading, resilient and vigorous cyberspace”⁶³⁷. It is further explained that “in order to maintain the sustainability of cyberspace, in addition to reinforcing measures for responding to cyber attacks, Japan aims to conduct “resilient” cyberspace and enhance its defensive and recovery capabilities against cyber attacks and other cyber incidents by improving such functions as for recognition and analysis of cyber attacks and for information sharing related to incidents”⁶³⁸. To the best of our knowledge, this is the first official state-level document in Japan that explicitly addresses the issue of cyberspace resilience.

Particularly relevant for the current research is the section on measures for critical infrastructure providers. The Strategy explains that in the field of critical infrastructure, it is necessary to ensure that people’s lives, socioeconomic activities, government activities as well as all other activities can stably and reliably continue in the face of crisis, and thus it is necessary to implement information security measures based on the characteristics of the information system that requires protection.⁶³⁹ It is argued that sharing of information about system failures, cyber-attacks, threats and vulnerabilities between

⁶³¹ National Resilience Promotion Office, Cabinet Secretariat (udd.) Building National Resilience – Creating a Strong and Flexible Country. *National Resilience Promotion Office*. Available at: http://www.cas.go.jp/jp/seisaku/kokudo_kyoujinka/en/e01_panf.pdf. Accessed: 1 April 2016. P.31.

⁶³² Smart City (2013). Smart City Resilience: Learning from Emergency Response and Coordination in Japan. *Smart City*. Available at: http://www.gsma.com/connectedliving/wp-content/uploads/2013/02/cl_SmartCities_emer_01_131.pdf. Accessed: 1 April 2016. P. 4.

⁶³³ For further information see: <http://www.gsma.com/mobilefordevelopment/programmes/disaster-response/programme-overview/>.

⁶³⁴ National Resilience Promotion Office, Cabinet Secretariat (udd.) Building National Resilience – Creating a Strong and Flexible Country. *National Resilience Promotion Office*. Available at: http://www.cas.go.jp/jp/seisaku/kokudo_kyoujinka/en/e01_panf.pdf. Accessed: 1 April 2016. P. 34.

⁶³⁵ NISC (2013). Cybersecurity Strategy: Towards a world-leading, resilient and vigorous cyberspace. *Information Security Policy Council* Available at: <http://www.nisc.go.jp/eng/pdf/cybersecuritystrategy-en.pdf>. Accessed: 5 April 2016.

⁶³⁶ Ibid. P. 3.

⁶³⁷ Ibid. P. 4.

⁶³⁸ Ibid. P. 30.

⁶³⁹ Ibid. P. 34.

critical infrastructure operators and CEPTOAR⁶⁴⁰ is necessary for increasing critical infrastructure resilience in Japan. It is also stressed that voluntary reporting of incidents in cyber-space between critical infrastructures providers and ministries handling separate cases should be encouraged. Cyber exercises between critical infrastructure providers, cyberspace-related operators, and other related entities are seen as yet another measure aimed at increasing cyber resilience of critical infrastructures. In addition, annual implementation of training for handling large-scale cyber-attacks against critical infrastructures in Japan is required in the Strategy. Lastly, the document stresses the importance of introducing evaluation and certification of information security for critical infrastructure operators. However, there is no further information provided on the topic of such evaluation strategies.⁶⁴¹

In May 2014, Information Security Policy Council established the Basic Policy of Critical Information Infrastructure Protection⁶⁴². The Basic Policy uses the term of Critical Information Infrastructure (CII) implying physical or virtual system that controls processes, transmits, receives or stores electronic information that is vital to the functioning of critical infrastructure. It lists 13 sectors that compose CII sectors, namely: information and communication services, financial services, aviation services, government and administrative services, medical services, water services, logistic services, chemical industries, credit card services, and petroleum services.⁶⁴³ It is argued that “in order to continuously provide CII services and to avoid serious effects on the public welfare and socioeconomic activities from IT outages resulting from natural disasters, cyber-attacks or other causes, all stakeholders should protect CII by reducing the risk of IT outages as much as possible and by ensuring prompt recovery from IT outages”⁶⁴⁴. Responsibility for the CII protection is primarily assigned to CII operators. “In addition, a sense of security should be nurtured among the public and social development, resilience and international competitiveness should be promoted through activities in cooperation between Government and private sectors”⁶⁴⁴. The principle of 5W1H is introduced. “All the stakeholders should understand the 5W1H (when, where, who, why, what and how) of IT outage response depending on the scale of IT outages and should be able to calmly address signs or occurrence of an IT outage. They should be able to cooperate with other stakeholders and respond in a cooperative and concerted manner in addition to ensuring robust communication among various stakeholders and taking proactive measures”⁶⁴⁴. The applicable CII services and service maintenance levels are shown in Appendix 1. Information sharing system among all the CII stakeholders in times of normal and crisis functioning is shown in Appendix 2.

In September 2015, the Government of Japan established a new Cybersecurity Strategy⁶⁴⁵. The Strategy has an extensive discussion on the measures for CII protection. It is argued that “in the circumstances, the public and private sectors must work together to protect CII, in particular, information and communications services, electric power supply services, and financial services, of which the functional failure or deterioration would risk enormous impacts to the people’s living conditions and economic activities. Such task cannot be entirely designated to the Government as a sole stakeholder, leaving the private sector with no responsibility, or vice versa; rather, it calls for strong public-private partnerships. As CII is required by its nature to provide a continuous supply of service, for its protection, it is crucial to reduce the occurrence of system failures caused by cyber attacks or other reasons to the minimum extent; it is also crucial to carry out early detection of any

⁶⁴⁰ Capability for Engineering of Protection, Technical Operation, Analysis and Response. A system for sharing and analysing information in different fields of critical infrastructure.

⁶⁴¹ NISC (2013). Cybersecurity Strategy: Towards a world-leading, resilient and vigorous cyberspace. *Information Security Policy Council* Available at: <http://www.nisc.go.jp/eng/pdf/cybersecuritystrategy-en.pdf>. Accessed: 5 April 2016. P.35.

⁶⁴² NISC (2014). The Basic Policy of Critical Information Infrastructure Protection. *Information Security Policy Council*. Available at: http://www.nisc.go.jp/eng/pdf/actionplan_ci_eng_v3.pdf. Accessed: 5 April 2016.

⁶⁴³ Ibid. P. 9.

⁶⁴⁴ Ibid. P. 13.

⁶⁴⁵ The Government of Japan (2015). Cybersecurity Strategy. *The Government of Japan*. Available at: <http://www.nisc.go.jp/eng/pdf/cs-strategy-en.pdf>. Accessed: 5 April 2016.

system failure and prompt recovery from damage or failure⁶⁴⁶. The Strategy outlines four principles aimed at increasing CII resilience, namely⁶⁴⁷:

- Conducting constant review on the scope of CIIP. It has become necessary to include new sectors in the CII sectors, therefore the Government will conduct a constant review on CII itself.
- Ensuring effective and prompt information sharing. “To make information sharing more active, it is essential to relieve CII operators’ psychological burden of potentially losing the credit or ruining the reputation of their businesses if providing information to a relevant party, and enable them to recognize the advantages of such action instead. The Government will encourage CII operators to create a common understanding on making appropriate modifications of information to be provided, such as concealing informers’ identities and specifying the scope and limit of information to be shared, and will create an environment where informers will not suffer any unreasonable loss or disadvantage from providing information⁶⁴⁸”.
- Offering tailored support to CII sectors.

There are quite a few real-life examples when Japan’s critical infrastructure resilience was tested. For example, during the Great East Japan Earthquake in Tokyo, in line with the Tokyo Metropolitan Government’s plan, the Shinkansen bullet trains received a warning to stop, Tokyo’s subways were immediately evacuated, surgical operations ceased, gas was disconnected and nuclear reactors received an order to enter the shutdown process. Tokyo Electric Power Company (TEPCO) started preparing for power outage and prioritisation of power distribution for electric grid. High priority was given to hospitals, power and nuclear plants, traffic control agencies, as well as governmental bodies responsible for collecting and analysing data.⁶⁴⁹

4.3.4. Organisational Resilience

In Japan, the concept of organisational resilience is closely linked to the concepts of business continuity management (BCM) and business continuity planning (BCP). Continuation of businesses in the event of a large-scale natural disaster is considered of key importance for maintaining national economic activities in Japan.⁶¹³ The Fundamental Plan for National Resilience of 2014 stresses that BCM and BCP efforts should go beyond individual businesses and be applied collectively: “[...] companies’ activities for their individual company/business continuity planning in an emergency (BCP) and business continuity management (BCM) should further be facilitated and their efforts for achieving joint BCP and BCM across industry segments beyond the bounds of individual companies or among respective regions should also be promoted, while enhancing support measures and seeking means to build a proper evaluation system. Such positive attitude for BCP and BCM should be firmly established as Japanese business culture with the aim of ensuring resilience of supply chains and enhancing Japanese companies’ competitiveness⁶⁵⁰”. The Plan urges for an increased cooperation between the public and private sectors in order to “provide accurate information in the event of a disaster, make efforts to continue their business in relevant business or commercial zones as a whole, and ensure safety of evacuees and those stranded around major stations and should be enhanced through drills and prior information sharing regarding the possibility of using public and private

⁶⁴⁶ Ibid. P. 25.

⁶⁴⁷ Ibid P. 26-28.

⁶⁴⁸ Ibid. P. 27.

⁶⁴⁹ Smart City (2013). Smart City Resilience: Learning from Emergency Response and Coordination in Japan. *Smart City*. Available at: http://www.gsma.com/connectedliving/wp-content/uploads/2013/02/cl_SmartCities_emer_01_131.pdf. Accessed: 1 April 2016. P.2.

⁶⁵⁰ The Government of Japan. (2014). Fundamental Plan for National Resilience – Creating a Strong and Resilience Country. *The Government of Japan*. Available at: http://www.cas.go.jp/jp/seisaku/kokudo_kyoujinka/en/fundamental_plan.html. Accessed: 30 March 2016. P.10.

buildings as temporary shelters”⁶⁵¹. Organisations are encouraged to ensure substitutability, such as creating multiple supply chains, ensuring substitutability of components, and dispersing or relocating factories and business establishments from the perspective of ensuring the business continuity.⁶⁵² It is further argued that in order to encourage individual companies to establish BCP and BCM structures, common national guidelines should be revised in light of the trends of international standards. “Manuals on how to establish BCP and BCM structures should be prepared as necessary depending on business types and modes and awareness-raising activities should be carried out to disseminate such guidelines and manuals”⁶⁵³. In order to further enhance the effectiveness of individual companies’ BCM and BCP structures, it is called for establishment of business continuity plans for building regional organisational resilience which requires collaboration between relevant ministries and governmental agencies, their regional branches, businesses, local governments and all other relevant stakeholders.⁶⁵⁴

In 2013, the Government of Japan established Business Continuity Guidelines (Third Edition) as the most important document describing national BCM standards.⁶⁵⁵ The BCM described in the Guidelines covers natural disasters as the main issue in Japan. The Guidelines defines BCP as “a plan describing the policy, systems, procedures, etc. by which enterprises can avoid suspension of their critical business or can recover the critical business quickly if it is interrupted, even when contingencies arise, including natural disasters [...], terrorist attacks, serious accidents, disruption of supply chains and abrupt changes in business environment, or they can recover business quickly if their business is interrupted”⁶⁵⁶. Japanese companies are encouraged to establish four plans⁶⁵⁷:

5. Business Continuity Plan
6. Plan for Implementing Proactive Measures
7. Plan for Implementing Education and Training
8. Plan for Implementing Review and Improvement.

Appendix 3 outlines a checklist for Business Continuity Guidelines prepared to enable enterprises to check their good practice in business continuity in accordance with the Guidelines.

4.3.5. Social Resilience

Although none of the official state-level documents in Japan define the very concept of social resilience, it is addressed quite extensively in the country. For example, the Fundamental Plan for National Resilience urges to “strengthen bonds between people and the functions of the communities, and endeavour to develop an environment where actors who promote initiatives for building resilient communities can carry out their activities properly in each region”⁶⁵⁸. In Japan, citizens are encouraged to be actively involved in the process of building national resilience. At the center of social resilience paradigm in Japan is the importance of information sharing and public awareness. For example, the Japanese have an interesting custom related to earthquake and tsunami awareness. Immediately following an earthquake, people turn TV on public broadcast channel and wait to obtain tsunami

⁶⁵¹ Ibid. P.25.

⁶⁵² Ibid. P.32.

⁶⁵³ Ibid. P.33.

⁶⁵⁴ Ibid. P.34.

⁶⁵⁵ Cabinet Office, Government of Japan (2013). Business Continuity Guidelines – Strategies and Responses for Surviving Critical Incidents. Third Edition. *The Government of Japan*. Available at: http://www.adrc.asia/publications/psdrr/pdf/guideline03_en.pdf. Accessed: 6 April 2016.

⁶⁵⁶ Ibid. P. 3.

⁶⁵⁷ Ibid. P. 21.

⁶⁵⁸ The Government of Japan. (2014). Fundamental Plan for National Resilience – Creating a Strong and Resilience Country. *The Government of Japan*. Available at: http://www.cas.go.jp/jp/seisaku/kokudo_kyoujinka/en/fundamental_plan.html. Accessed: 30 March 2016. P.6.

warning information from Japan Meteorological Agency, which appears as a specialised screen image.⁶⁵⁹ The opinion of people regarding disaster management measures is perceived as highly important by the responsible institutions. For example, during the earthquake in Japan in March 2011 people expressed the need to get all disaster related information from one source. To address this challenge, in September 2012, the Japanese government started a month-long pilot of a new central web portal that could communicate critical information during an emergency, collected from a large number of governmental agencies, to improve citizens' safety in the wake of a natural disaster. The web portal also offers Twitter-style functionality, so that all citizens could use it to leave their personal messages.⁶⁴⁹

In order to build community resilience “voluntary efforts should be promoted through bi-directional communications, encouraging participation of all related parties, including the national and local governments, citizens, companies, based on the concept of self-help efforts, mutual assistance and public help”⁶⁶⁰. In order to increase disaster awareness from early age, Japan implements disaster prevention education at schools. The Government works with the private sector, non-profit organisations and citizens to conduct annual preparedness exercises.⁶³⁰ The country also encourages citizens to maintain a week's reserve of food, water and medication. For example, certification of those condo buildings, where teams of residents are prepared to help the older and less healthy among them, is offered in Sendai. Eventually, the Government want all the condo buildings at least in Sendai to be certified in this way.⁶³⁰

Another example of the Government measures aimed at increasing social resilience is a smart system that helps to quickly warn people about the risk of an upcoming hazard. It was developed with support from technology vendor NEC and involves observation systems, information gathering capabilities, data analysis and decision-making aids, together with an intelligent warning system, all linked together in an interoperable manner. The system uses seismometers to detect the first shockwave caused by an earthquake. Computers then analyse the wave and estimate how powerful the second one will be. If the waves are above a certain threshold, a warning alert with instructions for the public action are issued.⁶⁴⁹ High technologies are also used to monitor radiation levels across the country and issue immediate public evacuation if necessary. This project is implemented by the Government using SIM-enabled devices located in farmlands, parks, offices and danger and evacuation zones, using the mobile networks to transmit measurements of radiation.⁶⁶¹

4.3.6. Economic Resilience

In Japan, an economic paradigm is based on National Resilience. In 2015 the Cabinet Secretariat's National Resilience Council (NRC) undertook a survey of private sector investment in resilience. The survey determined that private sector spending on resilience was USD105 billion in 2013 and is likely to be double in size by 2020. Three core sectors that received the most investment are:

1. Electric vehicles, at JPY 2.6 trillion in 2013 and projected to be JPY 6.13 trillion in 2020;
2. Renewable energy (solar), at JPY 2.26 trillion in 2013 and JPY 3.88 trillion in 2020;
3. Power generation and transmission bolstering, JPY 958 billion in 2013 and JPY 1.02 trillion in 2020 (Dewit 2016, 1).

⁶⁵⁹ The Joint Committee of Indonesia and Japan on Disaster Reduction. (2006). Building the Resilience of Indonesia and its Communities to Disaster for the Next Generation. *The Joint Committee of Indonesia and Japan on Disaster Reduction*. Available at: http://www.bousai.go.jp/kokusai/kyoryoku/pdf/report_e.pdf. Accessed: 1 April 2016. P.31.

⁶⁶⁰ The Government of Japan. (2014). Fundamental Plan for National Resilience – Creating a Strong and Resilience Country. *The Government of Japan*. Available at: http://www.cas.go.jp/jp/seisaku/kokudo_kyoujinka/en/fundamental_plan.html. Accessed: 30 March 2016. P. 146.

⁶⁶¹ Ibid. P. 4.

International Survey

It is evident that in the aftermath of 2011 disaster, building resilience in Japan in both the private and public sectors has become explicitly and powerfully linked to renewable energy systems and their enabling storage and transmission technologies. Other private sector investments include earthquake-proofing of buildings and equipment, reinforcement of transport systems (roads and railroads), disaster-relief robotics, communication resilience, and training of special leadership (ibid. P. 2). Moreover, Japan earns from exporting resilient infrastructures and services to other countries (ibid. P. 3).

4.3.7. Resilience Related Official Documents

It should be noted that there is a number of official state-level documents that might be relevant in the context of national resilience, however, they are not translated to English.

- Japan Disaster Countermeasures Basic Act No. 223. 1961. Available at: <http://www.adrc.asia/documents/law/DisasterCountermeasuresBasicAct.pdf>.
- National Resilience Promotion Office, Cabinet Secretariat. Building National Resilience – Creating a Strong and Flexible Country. Available at: http://www.cas.go.jp/jp/seisaku/kokudo_kyoujinka/en/e01_panf.pdf.
- The Government of Japan. 2013. Basic Act for National Resilience Contributing to Preventing and Mitigating Disasters for Developing Resilience in the Lives of the Citizenry. Available at: http://www.cas.go.jp/jp/seisaku/kokudo_kyoujinka/pdf/khou1-2.pdf.
- National Resilience Promotion Headquarters. 2013. Guidelines for Assessment of Vulnerability to Large-scale Natural Disasters. Available at: http://www.cas.go.jp/jp/seisaku/kokudo_kyoujinka/pdf/shishin1-2.pdf.
- Japan Government. 2013. Japan Revitalization Strategy – Japan is back. Available at: https://www.kantei.go.jp/jp/singi/keizaisaisei/pdf/en_saikou_jpn_hon.pdf.
- Information Security Policy Council. 2013. Cybersecurity Strategy: Towards a world-leading, resilient and vigorous cyberspace. June 10, 2013. Available at: <http://www.nisc.go.jp/eng/pdf/cybersecuritystrategy-en.pdf>.
- Cabinet Office, Government of Japan. 2013. Business Continuity Guidelines – Strategies and Responses for Surviving Critical Incidents. Third Edition. Available at: http://www.adrc.asia/publications/psdrr/pdf/guideline03_en.pdf.
- The Government of Japan. 2014. Fundamental Plan for National Resilience – Creating a Strong and Resilience Country. Available at: http://www.cas.go.jp/jp/seisaku/kokudo_kyoujinka/en/fundamental_plan.html.
- The Government of Japan. 2015. Cybersecurity Strategy. September 4, 2015. Available at: <http://www.nisc.go.jp/eng/pdf/cs-strategy-en.pdf>.

4.4. Philippines

The Philippines is situated in the Pacific Ring of Fire where two major tectonic plates (Philippine Sea and Eurasia) meet which makes the country particularly vulnerable to natural disasters. This explains the occurrence of earthquakes and tsunamis as well as volcanic eruptions. The country is located along the typhoon belt on the Western North Pacific Basin where 66 percent of tropical cyclones enter and originate. On the average, the country faces 20 tropical typhoons every year, of which 5 to 7 can be destructive.⁶⁶²

⁶⁶² The Government of Philippines (2010). Strengthening Disaster Risk Reduction in the Philippines: Strategic National Plan 2009-2019. *The Government of Philippines*. Available at: http://www.adrc.asia/countryreport/PHL/2009/PHL_attachment.pdf. Accessed: 11 April 2016.

4.4.1. Concept of Resilience

As in many countries around the world, disaster management in the Philippines has started from a purely disaster responsive approach by focusing on the provision of assistance or intervention during or immediately after a disaster. In the 20th century, efforts to model hazards in different countries started to occur. Such efforts shifted the Philippines' disaster management perspective from reactive to more proactive framework. Slowly the development approach to disaster management implying that disasters are seen as a development concern and may arise as a result of unsustainable development practices. Starting from 2005, non-engineering and non-structural measures, such as community-based disaster preparedness and early warning, land use planning and similar, were started to be introduced in the country. The focus on single hazard approach shifted to the all-hazard one. Eventually, the shift in focus on hazards to vulnerabilities occurred.⁶⁶³

In 2010 the Congress of the Philippines established the Philippine Disaster Risk Reduction and Management Act of 2010. As its first goal the document lists “building the resilience of local communities to disasters including climate change impacts”⁶⁶⁴. The Act defines resilience as “the ability of a system, community or society exposed to hazards to resist, absorb, accommodate and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions”⁶⁶⁵. On the other hand vulnerability is defined as “the characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard. Vulnerability may arise from various physical, social, economic, and environmental factors such as poor design and construction of buildings, inadequate protection of assets, lack of public information and awareness, limited official recognition of risks and preparedness measures, and disregard of wise environmental management”⁶⁶⁶.

In 2010, the Strategic National Action Plan (SNAP) on Disaster Risk Reduction 2009-2019 was adopted in the Philippines. It serves as a road map indicating the vision and strategic objectives of the country for the next 10 years.⁶⁶² As its main goal “consistent with the global commitment, the Philippine SNAP aims to build the resilience of communities to disasters. In more concrete terms, the expected outcome is to reduce disaster losses in lives, in the social, economic and environmental assets of communities and countries”⁶⁶⁷. The SNAP contains 18 priority programs, including: the Disaster Risk Management (DRM) Act; Multi-stakeholder Dialogues on Disaster Risk Reduction; Institutionalization of Disaster Management Office (DMO); Enhancing Capacity Development for Local Disaster Coordinating Councils (LDCCs); Mainstreaming DRR into the Peace Process; Mainstreaming DRR in Various Government Plans and Programs; Public-Private Partnership (PPP); Resource Mobilization; Information and Database Generation; Knowledge Management; Supporting DRR: Mainstreaming through Sectoral Approach; Preparedness for Effective Disaster Response; Information, Education and Communication (IEC) Campaign; Institutional and Technical Capacity Building; Education and Research; Forecasting and Early Warning; Risk Evaluation; Development of Tools for Assessment and Monitoring of DRR Measures. SNAP defines resilience in a close link with vulnerability: “resilience of communities comes from the dual activities of reducing vulnerability to hazard impact and building capacity to deal with them when they occur”⁶⁶⁸.

⁶⁶³ Department of National Defence. 2011. National Disaster Risk Reduction and Management Framework *NDRRMF*. Available at: http://www.adrc.asia/documents/dm_information/Philippines_NDRRM_Framework.pdf. Accessed: 11 April 2016.

⁶⁶⁴ Republic of Philippines (2010). Philippine Disaster Risk Reduction and Management Act of 2010. *Republic of Philippines*. Available at: <http://www.ifrc.org/docs/idrl/878EN.pdf>. Accessed: 11 April 2016.

⁶⁶⁵ Ibid. P. 9.

⁶⁶⁶ Ibid. P. 10.

⁶⁶⁷ Ibid. P. 17.

⁶⁶⁸ Ibid. P. 16.

In 2011, the National Disaster Risk Reduction and Management Framework (NDRRMF) was adopted in the country.⁶⁶³ The document states that “there is an urgent need for the country to work together through multi-stakeholder partnerships and robust institutional mechanisms and processes so that Filipinos will be able to live in **safer, adaptive and disaster resilient** communities on the path to developing sustainability”⁶⁶³. By adaptive community it is meant that communities are empowered and “develop the “right” mindset and positive behavioural changes towards reducing and managing risks and lessening the effects of disasters. This term is about building back better or building on from our learnings, good practices, research and experiences, helping us address the underlying causes of our vulnerability and increasing our ability to adjust to the situation before us. By being adaptive, we learn to innovate and go to the next level”⁶⁶³. The concept of resilience closely linked to system’s ability of bouncing back. “The risk reduction efforts have been successful and made the people stronger (in a positive way and not just in terms of their coping mechanism), increasing their ability to bounce back after a disaster. We want to instill the culture of safety by increasing people’s capacity to bounce back and decrease disaster losses and impact”⁶⁶³.

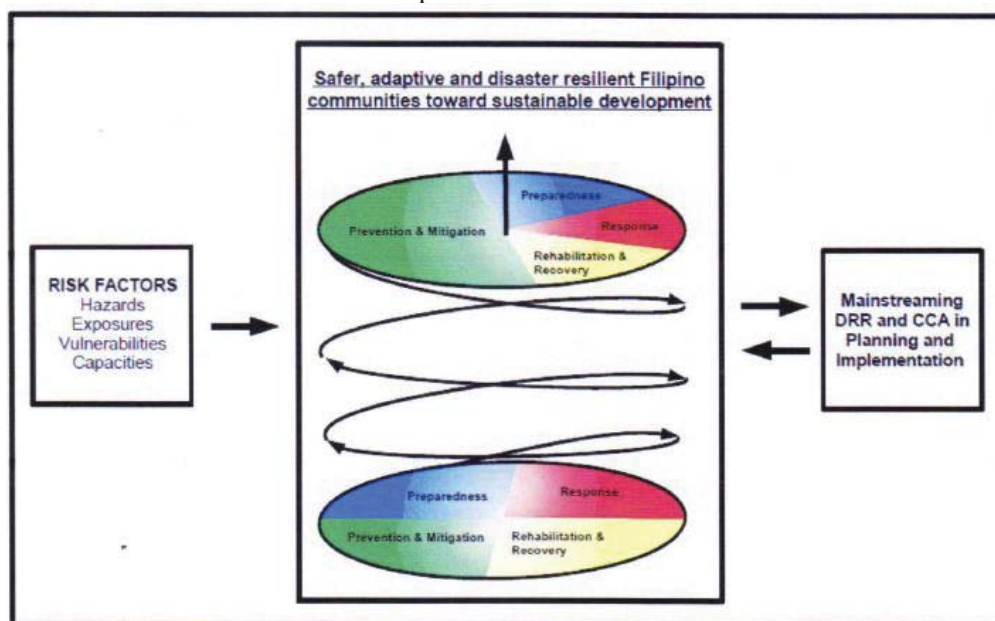


Figure 4.3 National Disaster Risk Reduction and Management Framework.

4.4.2. Institutional Framework for Delivering Resilience

In 2010, to implement the Disaster Management Law (DRM), the **National Disaster Reduction and Management Council** (NDRRMC) was created. The Council was tasked with developing a National Disaster Risk Reduction and Management Framework (NDRRMF).⁶⁶⁹

Another actor involved in DRM and resilience building practices is the **Office of Civil Defence**. By law, the Office formulates and implements the National Disaster Risk Reduction and Management Plan (NDRRMP) and ensures that physical framework, social, economic and environmental plans of communities, cities, municipalities and provinces are consistent with such plan.⁶⁷³ it has the primary mission of administering a national defence and DRR and DRM program by providing leadership in the continuous development of strategic and systematic approaches as well as measures to reduce the vulnerabilities and risks to hazards and manage consequences of disasters.⁶⁶⁹

⁶⁶⁹ Republic of Philippines (2010). Philippine Disaster Risk Reduction and Management Act of 2010. *Republic of Philippines*. Available at: <http://www.ifrc.org/docs/idrl/878EN.pdf>. Accessed: 11 April 2016.

At the regional level, responsibility for DRM and resilience activities is entrusted to **Regional Disaster Risk Reduction and Management Councils** (RDRRMCs) which coordinate, integrate, supervise. And evaluate activities of the **Local Disaster Risk Reduction and Management Councils** (LRDRRMCs). The RDRRMC are responsible in ensuring that disaster sensitive regional development plans are updated, and in case of emergencies convene the different regional line agencies and concerned institutions and authorities.⁶⁶⁹

4.4.3. Critical Infrastructure and Technical Resilience

In 2013, the Government of Philippines together with the World Bank and other partners organised the Forum on Safe and Resilient Infrastructure. The forum and the government executive meeting served as a venue for the government of Philippines to set policy and an initial strategy for a cross-sectorial Philippine program for building the resilience of public infrastructure. During the forum, resilient infrastructure was defined as the one that is able to “absorb a disturbance or disaster and still retain its structural capacity and its ability to perform its basic function”⁶⁷⁰. It is further argued that “resilient infrastructures depend on structural and non-structural measures and systems that in their totality allow continued operation or use of the structure in the event of a natural disaster”⁶⁷¹. Under the Safe and Resilient Infrastructure Program, the country introduced a set of technical guidelines (based on the example of Turkey) to address the seismic design requirements for upgrading existing public schools and hospitals in Metro Manila. The **retrofitting** guidelines allow for a certain level of damage to be acceptable and make strengthening possible and cost effective (as compared to rebuilding) for as many structures as possible. In the guidelines, the **Life Safety (LS) structural performance** level is used for evaluating existing buildings. The LS performance level implies significant damage to the structure is expected to occur, given a particular level of ground shaking, but some margin against either partial or total structural collapse remains.⁶⁷²

All the official state-level documents related to resilience in the Philippines describe the principle of “building back better” when talking about infrastructure resilience. The slogan was introduced in Asia when reconstruction and rehabilitation proceeded in the countries affected by the Indian Ocean Tsunami of December 2004. However, current practices in the Philippines have not ensured that better and safer structures are built on safe locations during reconstruction and rehabilitation. Engineering and land use practices have also not been risk sensitive.⁶⁷³ Six recommendations for safer infrastructure and public facilities in Philippines were made during the Forum:

- Update the National Structural Code to include requirements for the strengthening of existing buildings;
- Make use of a plan-checking mechanism or agency;
- Improve enforcement and inspection of construction practices and materials;
- Provide focused training programs for engineers;
- Prioritise investments to upgrade critical physical assets;
- Systematically upgrade both existing and new structures.⁶⁷⁴

⁶⁷⁰ The World Bank. (2014). Forum on Safe and Resilient Infrastructure: Proceedings Report. *The World Bank*. Manila, Philippines. Available at: <https://www.gfdrr.org/sites/gfdrr/files/Philippines-Forum-on-Safe-and-Resilient-Infrastructure.pdf>. Accessed: 11 April 2016. P. 2.

⁶⁷¹ Ibid. P. 3.

⁶⁷² The World Bank (2014). East Asia and Pacific EAP Critical Infrastructure Risk Assessment and Retrofitting Program. Safe and Resilient Infrastructure in the Philippines. Applications of International Experience. *The World Bank*. Available at: http://www-wds.worldbank.org/external/default/WDSPContentServer/WDSP/IB/2015/03/03/000477144_20150303153030/Rendered/PDF/ACS121820WP0Bo0B00P13104100PUBLIC00.pdf. Accessed: 11 April 2016.

⁶⁷³ Government of Philippines (2011). National Disaster Risk Reduction and Management Plan (NDRRMP) 2011-2028. *NDRRMP*. Available at: http://www.ndrrmc.gov.ph/attachments/article/41/NDRRM_Plan_2011-2028.pdf. Accessed: 11 April 2016.

⁶⁷⁴ The World Bank. (2014). Forum on Safe and Resilient Infrastructure: Proceedings Report. *The World Bank*. Manila, Philippines. Available at: <https://www.gfdrr.org/sites/gfdrr/files/Philippines-Forum-on-Safe-and-Resilient-Infrastructure.pdf>. Accessed: 11

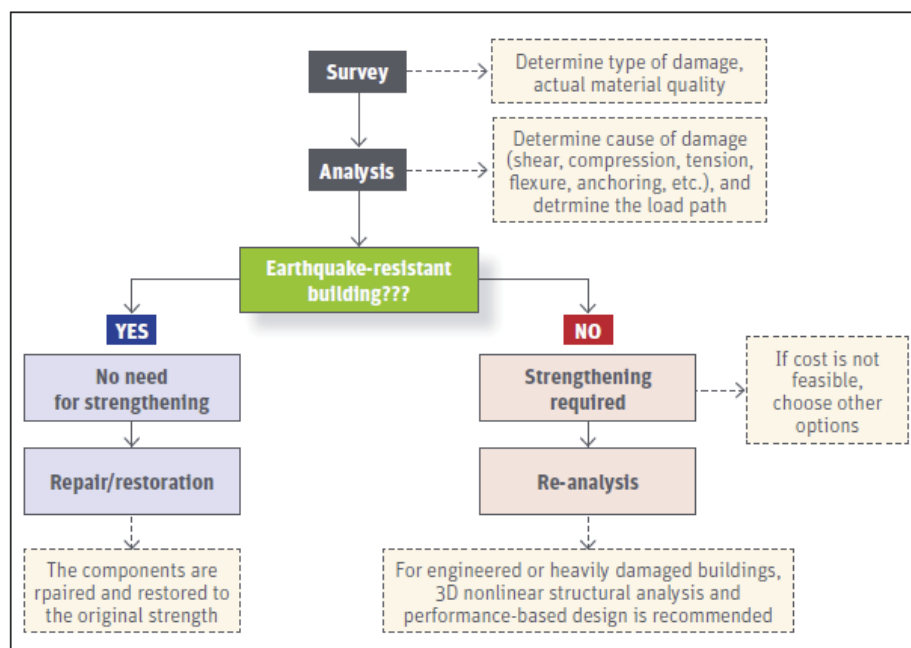


Figure 4.4 Safe Schools Program steps for retrofitting. Source: The World Bank. 2013. Forum on Safe and Resilient Infrastructure.

4.4.4. Organisational Resilience

No information related to the concept of organisational resilience in the Philippines was found.

4.4.5. Social Resilience

At the very centre of the Philippines disaster risk management paradigm lays the goal of building resilience communities. The country aims to implement community-based risk management processes. The National Disaster Coordinating Council (NDCC) “adopted community-based disaster risk management (CBDRM) as a model to engage communities in DRR undertaking”⁶⁷⁵. For example, in 2010 the Government of Philippines urged to integrate disaster risk reduction and management education in the school curricula of secondary and tertiary level of education. Communities, especially youth are encouraged to participate in disaster risk reduction and management activities, such as organising quick response groups, particularly in identified disaster-prone areas.⁶⁶⁴

July is designated as the National Disaster Consciousness Month in the Philippines. It is used to heighten public awareness on the importance of disaster prevention, mitigation and preparedness. Every year during this month, simultaneous nationwide earthquake drills, search and rescue exercises, and seminars are conducted. The Disaster Management School-on-Air is also aired on radio every July of each year.

April 2016.
P. 12.

⁶⁷⁵ The Government of Philippines (2010). Strengthening Disaster Risk Reduction in the Philippines: Strategic National Plan 2009-2019. *The Government of Philippines*. Available at: http://www.adrc.asia/countryreport/PHL/2009/PHL_attachment.pdf. Accessed: 11 April 2016. P. 25-26.

4.4.6. Economic Resilience

Very little has been done in the Philippines to protect economic activities and productive sectors. Although some private companies have business continuity plans, it is rather doubted that they are linked in any way with local governments' contingency plans. Fejl! Bogmærke er ikke defineret.

4.4.7. Resilience Related Official Documents

- The Government of Philippines. 2010. Strengthening Disaster Risk Reduction in the Philippines: Strategic National Plan 2009-2019. Available at: http://www.adrc.asia/countryreport/PHL/2009/PHL_attachment.pdf;
- Government of Philippines. 2010. Strategic National Action Plan (SNAP) on Disaster Risk Reduction 2009-2019. Available at: http://www.adrc.asia/countryreport/PHL/2009/PHL_attachment.pdf;
- Department of National Defense. 2011. National Disaster Risk Reduction and Management Framework NDRRMF. Available at: http://www.adrc.asia/documents/dm_information/Philippines_NDRRM_Framework.pdf;
- Government of Philippines. 2011. National Disaster Risk Reduction and Management Plan (NDRRMP) 2011-2028. Available at: http://www.ndrrmc.gov.ph/attachments/article/41/NDRRM_Plan_2011-2028.pdf;
- The World Bank. 2014. Forum on Safe and Resilient Infrastructure. Proceedings Report. Manila, Philippines. Available at: <https://www.gfdrr.org/sites/gfdrr/files/Philippines-Forum-on-Safe-and-Resilient-Infrastructure.pdf>.

5. Conclusions

Analysis indicates rather different levels of maturity of the concept of resilience in Asia. On the one hand, the case study on Japan showed the country as one of the world's leaders in resilience. Japan is not only building resilient infrastructures, invests in social resilience programs, builds its economy based on the paradigm of resilience, but also exports resilient infrastructures to other countries across the world. On the other hand, for example the Philippines struggle with the implementation of resilience programs and actions due to the lack of financial and human resources.

Appendix 1

Services and Service Maintenance Levels

CII sectors (Note1)	CII services (including procedures) (Note 2)		Service maintenance levels	
	Name	Explanation of services (including procedures) (Relevant laws)	Applicability/standards	Remarks
Information and communication services	- Electrical communication services	- Use of electrical communication facilities to act as an intermediary for others communications and providing other electrical communications facilities for the communications of other parties (Telecommunications Business Act Article 2)	- No trouble should occur causing continued loss of service for 2 hours or more for 30,000 or more users due to stoppages or deterioration of quality of service provision as a result of electrical communications facility trouble	- In accordance with Article 58 of the Ordinance for Enforcement of the Telecommunications Business Act
	- Broadcasting services	- Electrical communications broadcast aimed at direct reception by the public (Article 2 of the Broadcast Act)	- No trouble should occur causing continued stoppage of broadcasting for 15 minutes or longer as a result of trouble with base broadcasting facilities - No trouble should occur causing continued stoppage of broadcasting for 15 minutes or longer (2 hours or more for relay station wireless facilities) as a result of trouble with base broadcasting facilities and specified terrestrial base broadcasting facilities	- In accordance with the Ordinance for Enforcement of the Broadcast Act from Item 1 to Item 3
	- CATV services	- Electrical communications broadcast aimed at direct reception by the public (Article 2 of the Broadcast Act)	- No trouble should occur causing continued loss of service for 2 hours or more for 30,000 or more users as a result of broadcasting stoppages resulting from cable television facility trouble	- In accordance with Article 157 of the Ordinance for Enforcement of Broadcast Act
	- Deposits - Loans - Exchange	- Receipt of deposits or periodic deposits (Article 10 Item 1-1 of the Banking Act) - Lending of loans or discounting of bills (Article 10 Item 1-2 of the Banking Act) - Currency exchange (Article 10 Item 1-3 of the Banking Act)	- No delay or stoppage of deposit repayment should occur as a result of IT failures - No delay or stoppage of execution of loan agreements should occur as a result of IT failures - No delay or stoppage of currency exchange (bank transfer) should occur as a result of IT failures	- Refer to the "Comprehensive Guideline for Supervision of Major Banks, etc." - Excluding situations where no practical effect occurs as a result of quick substitution by other systems/equipment (for example, even if a number of ATMs were suspended, if other ATMs or windows were available at the same or neighboring branches)
Financial services	- Financial settlements	- Financial settlements (Article 2 Item 5 of the Act concerning Financial Settlements)	- No delay or stoppage of financial settlements should occur as a result of IT failures	- Refer to the "Comprehensive Guideline for Supervision of Settlement/Money Transfer Agencies" - Excluding situations where no practical effect occurs as a result of quick substitution by other systems/equipment

CII sectors (Note1)	CII services (including procedures) (Note 2)		Service maintenance levels	
	Name	Explanation of services (including procedures) (Relevant laws)	Applicability/standards	Remarks
	- Electronic records, etc.	- Electronic records (Article 56 of the Electronically Recorded Monetary Claims Act) - Information provision related to fund settlement (Articles 62 and 63 of the Electronically Recorded Monetary Claims Act)	- No delay or stoppage of information provision related to electronic record and fund settlement should occur as a result of IT failures	- Refer to "Guideline for Administrative Processes Vol 3.: Financial Companies (12 Electronic credit record agency relationships)"
Life insurance	- Insurance claim etc. payments	- Receipt of insurance claim etc. payment demands - Insurance claim etc. payment screenings - Insurance claim etc. payments	- No delay or stoppage of insurance claim etc. payment should occur as a result of IT failures	- Refer to "Comprehensive Guidelines for the Supervision of Insurance Companies" - Excluding situations where no practical effect occurs as a result of quick substitution by other systems/equipment
General insurance	- Insurance claim etc. payments	- Accident reception - Damage investigations etc. - Insurance claim etc. payments	- No delay or stoppage of insurance claim etc. payment should occur as a result of IT failures	- Refer to "Comprehensive Guidelines for the Supervision of Insurance Companies" - Excluding situations where no practical effect occurs as a result of quick substitution by other systems/equipment
Securities services	- Negotiable securities trading etc. - Transaction mediation, commission and representation for negotiable securities trading etc. - Negotiable securities etc. settlement commission	- Negotiable securities trading, market derivatives trading or foreign market derivatives trading (Article 2 Item 8-1 of the Financial Instruments and Exchange Act) - Mediation, commission or representation for negotiable securities trading, market derivatives trading or foreign market derivatives trading (Article 2 Item 8-2 of the Financial Instruments and Exchange Act) - Negotiable securities etc. settlement commission (Article 2 Item 8-5 of the Financial Instruments and Exchange Act)	- No delay or stoppage of disposal of securities received for guarantee, cancellation payments, etc. should occur as a result of IT failures	- Refer to the "Comprehensive Guidelines for Supervision of Financial Instruments Business Operators, etc." - Excluding situations where no practical effect occurs as a result of quick substitution by other systems/equipment (for example, situations where if the order system is suspended outside of market hours, replacement systems are quickly activated which are equivalent to the concerned system allowing for orders in time for market hours.)
	- Establishment of financial product markets	- Provision of market facilities for the trading of negotiable securities or market derivatives trading, and other work related to the establishment of financial product markets (Article 2 Item 14 and 16 and Article 80 and 84 of the Financial Instruments and Exchange Act)	- No delay or stoppage of trading of negotiable securities or market derivatives trading, etc. should occur as a result of IT failures	- Refer to Article 112 Item 7 of the Cabinet Office Ordinance on Financial Instruments Business, etc.
	- Money transfer services	- Work related to transfer of corporate bonds, etc. (Article 8 of the Act on Book-Entry Transfer of Company Bonds, Shares, etc.)	- No delay or stoppage of transfer of corporate bonds or shares should occur as a result of IT failures	- Refer to the "Comprehensive Guideline for Supervision of Settlement/Money Transfer Agencies" - Excluding situations where no practical effect occurs as a result of quick substitution by other systems/equipment

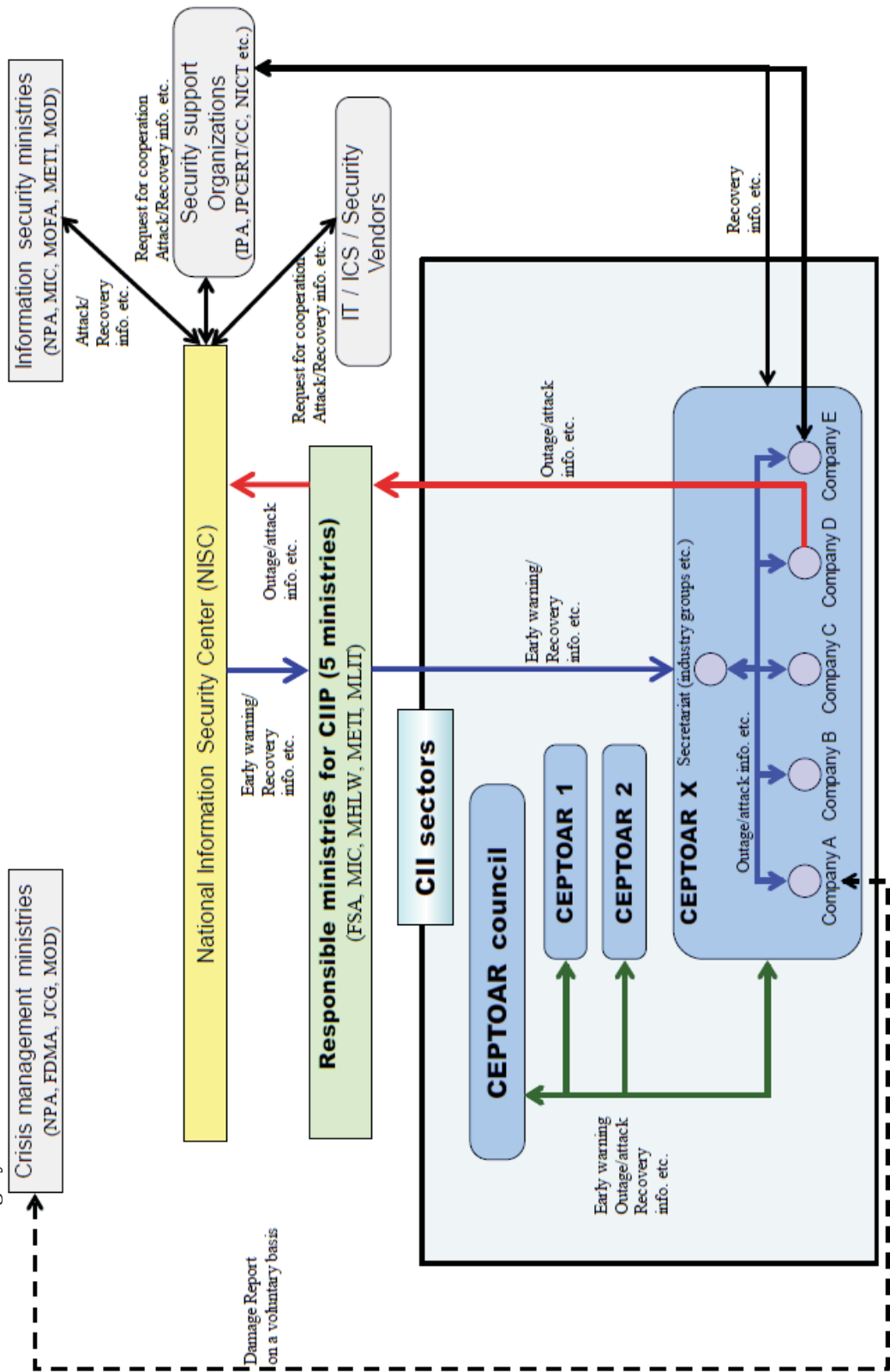
International Survey

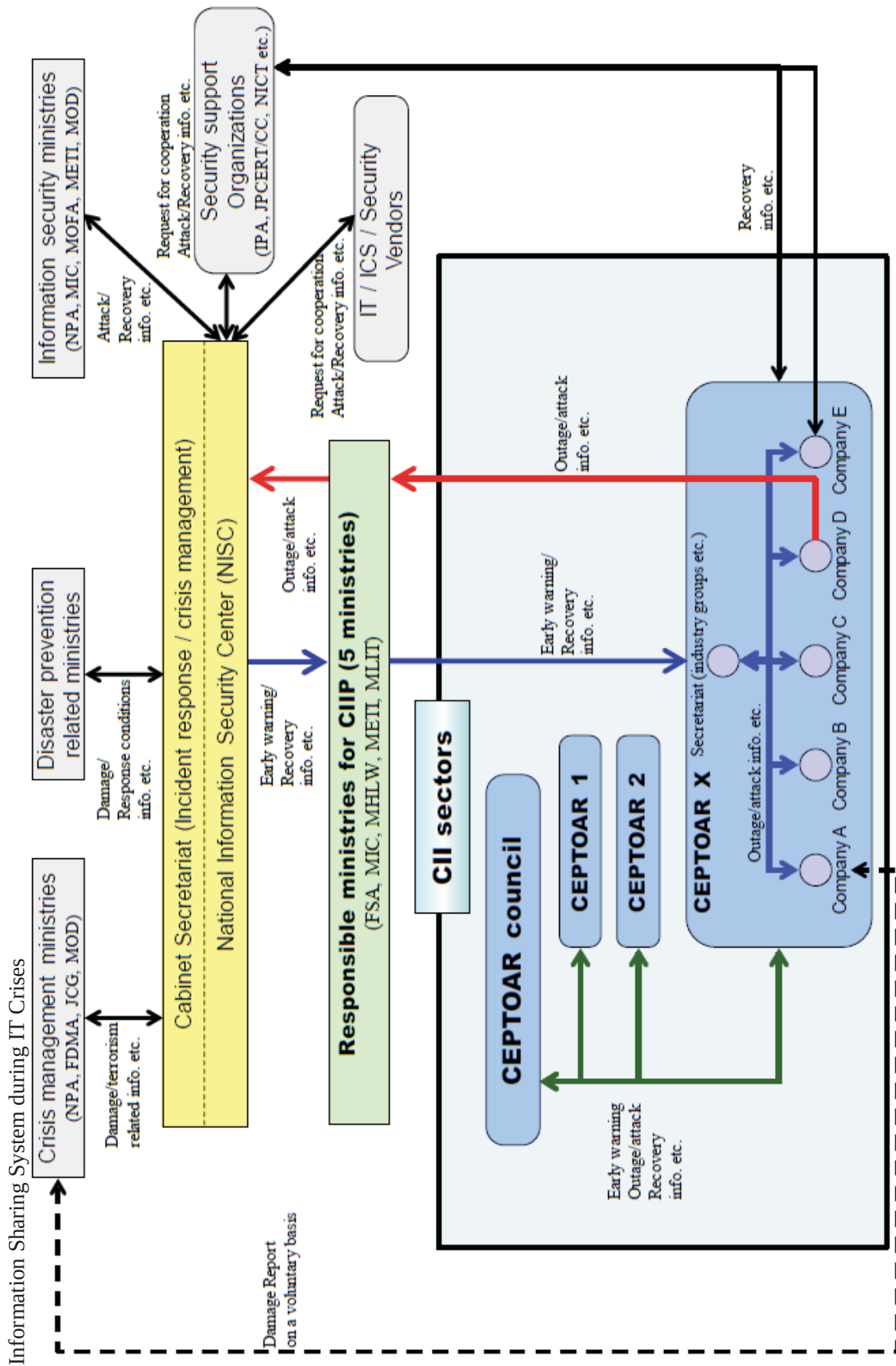
CTI sectors (Note 1)	CTI services (including procedures) (Note 2)		Service maintenance levels	
	Name	Explanation of services (including procedures) (Relevant laws)	Applicability/standards	Remarks
	- Financial product debt underwriting	- Liability assumption work through negotiable securities trading etc. targeted transactions (Article 2 Item 28 of the Financial Instruments and Exchange Act)	- No delay or stoppage of financial product settlement should occur as a result of IT failures	- Refer to the "Comprehensive Guideline for Supervision of Settlement/Money Transfer Agencies" - Excluding situations where no practical effect occurs as a result of quick substitution by other systems/equipment
Aviation services	- Air transportation services for passengers and cargo - Air traffic control service - Distribution of meteorological information - Reservations, ticketing, boarding/loading procedures - Flight maintenance - Flight plan creation	- Work providing transport of passengers or cargo for charge using airplanes based on demands of other people (Article 2 Civil Aeronautics Act) - Appropriate usage of airspace and space and smooth maintenance of air traffic (Article 95-2 of the Civil Aeronautics Act) - Distribution of forecasts, warnings, etc. adapted for airplane use (Article 14 of the Meteorological Service Act) - Air traveler reservations, air cargo reservations - Airline ticket issuance, fee collection - Airline passenger check-in and boarding, air cargo loading - Airplane inspection and maintenance - Creation of flight plans and submission to Japan Civil Aviation Bureau	- No obstacles should be caused for transport of passengers on scheduled flights due to IT failures	- Handled in the agreement related to "CEPTOAR in the aviation services sector"
Railway services	- Passenger transport services - Ticketing, entry and exit procedures	- Work providing transport of passengers or cargo for charge using railways based on demands of other people (Article 2 Railway Business Act) - Seat reservation, boarding ticket checks on boarding and exiting the train	- No obstacles should be caused for transport of passengers on as a result of suspended trains due to IT failures	- In accordance with Article 5 of the Railway Accident Reporting Code (Private railway accident etc. reports)
Electric power supply services	- General electric power supply service	- Work supplying electric power to meet general demand (Article 2 and Article 18 of the Electric Business Act)	- No supply problem incidents of over 10 minutes for supply power of 100,000 kilowatts or more should occur as a result of IT outages	- In accordance with Article 3 of the Electricity related Reporting Code
Gas supply services	- General gas supply service	- Work supplying gas through piping to meet general demand (Article 2 of the Gas Business Act)	- No supply problem incidents effecting supply to 30 or more houses should occur as a result of IT outages	- In accordance with Article 112 of the Gas Ordinance for Enforcement of the Gas Business Act

CII sectors (Note1)	CII services (including procedures) (Note 2)		Service maintenance levels	
	Name	Explanation of services (including procedures) (Relevant laws)	Applicability/standards	Remarks
Government and administrative services	- Local government administration services	- Local administration, other administration work carried out in accordance with laws or government ordinances (Article 2 Item 2 of the Local Autonomy Act)	- No obstruction of the protection of resident rights and gains should occur as a result of IT failures - System recovery should be accomplished within a time period allowing for guarantee of resident safety and security	
Medical services	- Medical examination	- Examination and treatment	- No danger to human life shall occur as a result of incorrect operation of medical equipment - No obstruction of the continued provision of medical care should occur as a result of IT failures.	- All efforts must be made to maintain the level of medical examination and treatment regardless of the degree of IT dependence.
Water services	- Supply of water through water services	- Work supplying drinking water through piping or other structures to meet general demand (Article 3 and Article 15 of the Water Supply Act)	- No interruption or decrease of water supply, abnormal quality water supply or serious problems in systems should be caused for supply of water as a result of suspended IT failures	- Important system problems refers to problems with control systems (water purification plant monitoring and control systems, pumping station operation systems, water mobilization systems, etc.) which have a serious impact on water supply in the event of a system shutdown - In accordance with "appropriate implementation of health risk management and provision of information related to damages to water supply facilities and water quality incidents" (October 25, 2013) "6.(2) In the event of information system outages in water supply"
Logistics services	- Logistics services	- Transport and storage of cargo	- No interruption of cargo transport or loss of cargo should occur as a result of IT failures	- Handled in the "agreement related to information sharing and analysis functions in the logistics sector (CEPTOAR)"
Note 1 Note 2	CII services and service maintenance levels for CII sectors newly added (chemical industries, credit card services and petroleum industries sectors) in this Basic Policy are stipulated separately. Services which make absolutely no use of IT are outside the scope of application.			

Appendix 2

Information Sharing System in Normal Circumstances





Appendix 3

Checklist for Business Continuity Guidelines in Japan

This checklist is prepared to enable enterprises to check their good practice in business continuity (continual efforts both during and after introducing BCM) in accordance with these Business Continuity Guidelines. This checklist is useful when examining what are needed for good practice in business continuity.

This checklist is also intended to help promote independent efforts by enterprises, so the management should understand and utilize the results of inspections made using the checklist. For details of the following questions, refer to the relevant sections of these Business Continuity Guidelines.

1.4 Requirements for the Management

- ☐ (1) Whether the management understands the necessity and advantages of BCM, the time, labor and investment required, and then decides to introduce and implement BCM as a key responsibility of the enterprise.
- ☐ (2) Whether the management, based on the management philosophy (raison d'être, etc.) and vision, establishes a basic policy for BCM which is linked to management, allocates management resources, establishes strategies, develop plans, including BCP, makes appropriate judgments on the implementation, coordination, improvement, etc. of measures, etc. and ensures the measures are implemented.
- ☐ (3) Whether the management actively participates in discussions, coordination, improvement, etc. concerning BCM.
- ☐ (4) Whether the management seeks stakeholders' understanding of BCM.
- ☐ (5) Whether the management strives to increase the confidence of stakeholders, including clients who are important for enterprises by periodically providing them with information on BCM and business continuity capability.
- ☐ (6) Whether the management aims to increase competitiveness, transactions, profits, etc. by building a system for improving corporate value through BCM.
- ☐ (7) When invoking a BCP, whether the management appropriately selects strategies and measures. If an unexpected incident occurs, whether the management makes judgments flexibly based on the existing BCP and gives instructions on responses.

2.1 Establishment of Basic Policy

- ☐ (1) Whether the management establishes a basic policy indicating the enterprise's concept of business continuity.
- ☐ (2) In the basic policy, whether the management defines the purpose of business continuity and the objectives to be achieved by BCM, and clarifies the types of business and the offices that are covered by BCM.
- ☐ (3) Whether the Board of Directors or the management council has made a resolution on the basic policy.

- ☐ (4) Whether the basic policy specifies that the top priority should be placed on securing the safety of customers as well as officers and employees of their enterprises, affiliates, temporary help companies, subcontractors, etc. and on preventing secondary disasters at the workplace.
- ☐ (5) Whether the basic policy describes contributions to, or coexistence with, the local community.

2.2 Creation of a System for Implementing Business Continuity Management

- ☐ (1) Whether the management establishes a company-wide BCM implementation system by designating persons responsible for BCM, members of a BCM secretariat, and persons in charge of all divisions concerned.
- ☐ (2) Whether the company-wide BCM implementation system includes the roles of preparation of a BCP, implementation of proactive measures and education/training, and continual review and improvement.
- ☐ (3) Whether the management fulfills its general responsibility and accountability for a company-wide BCM implementation system.

3.1.1 Assessment of Impact of Business Interruption

- ☐ (1) Whether an enterprise assesses the impact of an interruption (or significant deterioration) of the supply of products or services in chronological order and quantifies matters where possible, identifies its critical products and services, and examines the duration of interruption (or significant deterioration) of supply that each such product and service can withstand.

3.1.2 Determination of Critical Operations and Examination of Recovery Time Objective/Recovery Level Objective

- ☐ (1) Whether an enterprise should identify critical operations which must be continued or restored on a priority basis, based on the results of the Business Impact Analysis (BIA).
- ☐ (2) With respect to critical operations, whether an enterprise determines Recovery Time Objective (RTO) and Recovery Level Objective (RLO) and then prioritizes critical operations.

3.1.3 Identification of Key Elements and Bottlenecks

- ☐ (1) Whether all key elements indispensable for implementing critical operations (management resources) are identified without omission.
- ☐ (2) Whether those elements that cannot speed up the recovery of critical operations or raise the level of recovery of critical operations without shortening the time for securing the necessary elements are identified as "bottlenecks."

3.2 Analysis and Assessment of Risks

- ☐ (1) Whether incidents which may interrupt the business of an enterprise are identified.

International Survey

- ☐ (2) For such identified incidents, whether the possibility of occurrence and their degree of impact are assessed quantitatively and qualitatively, the kinds of incidents which should be tackled on a priority basis are identified, and such incidents are prioritized.
- ☐ (3) Whether an enterprise examines what damage is caused to key elements by incidents identified as requiring a priority response in (2) above at present (or before the implementation of measures), estimates the currently required time for securing such key elements, the time when such critical operations can be recovered under current conditions (currently-possible recovery time), and the level of operations which can be continued or recovered (currently-possible recovery level).

4.1 Basic Concept of Business Continuity Strategies and Measures

- ☐ (1) Whether a business continuity strategy is examined based on the understanding that the aim of BCM is to “continue critical operations even if an enterprise faces a critical incident.”
- ☐ (2) Whether both site recovery strategies and substitution strategies are always examined.
- ☐ (3) Whether the management determines business continuity strategies and measures to be implemented, and officially determines a Recovery Time Objective (RTO) and Recovery Level Objective (RLO) for each critical operation which is feasible and which can be explained externally.
- ☐ (4) Whether records are kept of the grounds for determining strategies and measures based on analyses, materials showing the development process, reasons for making selections, etc.

4.2.1 Continuation or Early Recovery of Supply of Critical Products and Services

- ☐ (1) Whether strategies and measures for the continuation or early recovery of critical products and services are established depending on the predicted damage (for example, light, serious or severe damage).
- ☐ (2) Whether strategies and measures are established from perspectives of business sites, procurement and supply, and procurement of personnel.

4.2.2 Ensuring Core Functions of Enterprises

- ☐ (1) Whether measures for reducing the damage arising from an anticipated incident for buildings and facilities are taken.
- ☐ (2) Whether an alternative site which will not be affected by the same disaster is secured based on the assumption that the head office cannot be used due to damage.
- ☐ (3) Whether a system for calling out personnel in an emergency and rapidly making decisions to establish the chain of command (including a system of deputies) is secured in order to maintain the core functions of the enterprise.
- ☐ (4) Whether communication methods, facilities for power generation, etc. and lifelines are secured in order to maintain the core functions of the enterprise.
- ☐ (5) Whether systems for announcing or sharing information with clients, customers, employees, shareholders, local residents, central and local governments, etc. are established, information on contact addresses is maintained, and ways of transmitting information are secured.

4.2.3 Maintenance of Information and Information Systems

- ☐ (1) Whether important information (or vital records), including documents, is backed up and stored at two or more places that are unlikely to be simultaneously hit by the same incident.
- ☐ (2) Whether a backup system is established for important information systems (such systems are custom-made, not general-purpose), and redundant power sources and power lines for the system are secured.
- ☐ (3) Whether the frequency of backing up the information is determined after carefully examining how long a data loss can be tolerated if certain information or data used in normal times is lost.
- ☐ (4) Whether a recovery plan to prevent obstacles to operations due to loss or mismatch of data is created before a switchover is made from alternative facilities to regular ones.

4.2.4 Fund Procurement

- ☐ (1) Whether the minimum cash on hand is secured in normal times in preparation for a critical incident.
- ☐ (2) Whether measures for procuring funds in case of emergency are established by researching various systems, including disaster loan programs offered by the private sector and central/local governments.
- ☐ (3) Whether communications with financial institutions, clients and the parent company with respect to financing are maintained in normal times.
- ☐ (4) Whether clients who will agree to extend the due date for payments or make payment in cash before the due date at the time of a disaster are selected, and whether agreements with such clients are concluded, in normal times.

4.2.5 Responses to Legal Regulations, etc.

- ☐ (1) Whether measures are established to enable enterprises to comply with laws and regulations and local government regulations, etc. even if they suffer damage from an anticipated incident.
- ☐ (2) In preparation for the case in which full compliance is difficult or regulations should be relaxed to facilitate rapid business recovery, whether enterprises examine, in normal times, desirable emergency deregulation measures, etc. in collaboration with other companies and industries and make requests to related central and local government organizations.

4.2.6 Securing Consistency with Activities of Government Organizations and Social Infrastructure Operators

- ☐ (1) Whether enterprises ensure that their BCP and BCM are consistent with the BCP and BCM, disaster management operational plans, and regional disaster management plans of central and local governments and social infrastructure operators, including designated public institutions.

4.3 Coexistence with the Local Community and Contributions

- ☐ (1) Whether safety measures such as for the prevention of fire, spread of fire, or ejection or leakage of medical substances are taken in normal times, to avoid causing disruption to the local community.
- ☐ (2) At the time of disaster, whether enterprises check for problems such as fire, spread of fire, or ejection or leakage of medical substances, or whether there is a danger of collapse of affected buildings outside the premises. If the surrounding area is at risk, whether the enterprises alert all residents in the neighborhood or request them to evacuate, and report to the administrative authorities and take action with the authorities.
- ☐ (3) Whether enterprises strive not to cause heavy traffic congestion, panic buying of goods, and other problems which would impede the recovery of the local community when making or implementing business continuity plans.
- ☐ (4) Whether enterprises conclude agreements with local governments in order to contribute to the local community, and build, in normal times, close collaborative relationships with various actors in the local community. (As members of the local community, they are recommended to act in this manner.)
- ☐ (5) Whether enterprises consider asking employees other than personnel in charge of emergency tasks to stay at home immediately after a disaster causes damage, thereby enabling those employees to save other lives in the neighborhood and help the weak.

5.1.1.1 Emergency Systems

- ☐ (1) Whether emergency systems for business continuity are established, and whether the roles and responsibilities of persons concerned and the chain of command are clarified.
- ☐ (2) Whether the management acts as the general manager of such emergency systems for business continuity.
- ☐ (3) In preparation for the case that key players are killed, injured or out of communication, whether authority is assigned to at least two other persons, and deputies and their ranking are determined in advance.
- ☐ (4) For initial responses in case of a disaster and the prevention of secondary disasters, whether persons and their duties, a responsible person for each division or team, a personnel plan, roles and authorities of persons, systems, etc. are designated or determined.

5.1.1.2 Emergency Response Procedures

- ☐ (1) Whether the order of priority for responses is determined at each stage, as necessary responses will naturally change over time after an incident.
- ☐ (2) Whether procedures of the disaster-response headquarters at the initial stage include the following:
 - Persons to gather to establish the headquarters after an incident, the plan and the designated place
 - Procedure for checking damage to management resources, including buildings, facilities and employees
 - Procedure for ensuring the safety of customers and employees, and distribution of goods
 - Procedure for preventing secondary disasters

- Procedure for transmitting information on the conditions of an enterprise
- Procedure for invoking a Business Continuity Plan
- Procedure for recording responses taken
- ☐ (3) Whether procedures for employees at the initial stage include the following:
 - Procedure for ensuring the safety of themselves and other persons
 - Procedure for reporting on the safety of themselves
- ☐ (4) Whether procedures for business continuity responses of the disaster-response headquarters and the business continuity organization include the following:
 - Procedure for verifying and adjusting matters needed for the business continuity of an enterprise
 - Procedure for confirming the capacity and possibility of business continuity at current and alternative sites
 - Procedure for determining strategies and measures to be implemented
 - Procedure for continuity and restart of operations
 - Procedure for transmitting information on the conditions of an enterprise
 - Procedure for returning to normal operations
 - Procedure for recording responses taken

5.1.2 Plan for Implementing Proactive Measures

- ☐ (1) Whether enterprises, in normal times, designate persons in charge of implementing proactive measures, secure budget and necessary resources, select suppliers and subcontractors, and establish a “plan for implementing proactive measures,” including a schedule.

5.1.3 Plan for Implementing Education and Training (6.2 Implementation of Education/Training)

- ☐ (1) Whether enterprises develop an education and training plan which clarifies the system for giving education and training, the annual purposes thereof, applicable persons, methods, periods, etc.
- ☐ (2) Whether the education and training plan includes education for new managers and staff in charge who are designated following an organizational change, personnel change, recruiting, etc.
- ☐ (3) Whether the education and training plan includes the development of personnel who are familiar with BCPs and manuals for implementing responses to a disaster.
- ☐ (4) Whether the education and training plan includes coordinated training with other related companies.
- ☐ (5) Whether the education and training plan ensures that education and training are conducted periodically (annually, etc.) and after personnel are drastically changed due to organizational change, personnel change, recruitment, etc. or after BCPs are reviewed or improved.

5.1.4 Plan for Implementing Reviews and Improvement

- ☐ (1) Whether a review and improvement plan which includes the systems, schedule and procedures for inspecting, reviewing and improving BCM is established.

International Survey

- ☐ (2) Whether the review and improvement plan is included in the business plan of enterprises as a whole which is approved by the management.

5.2 Documentation of Plans, etc.

- ☐ (1) Whether the plans established in Chapter 5.1 are documented to the necessary extent and detail.
- ☐ (2) Whether (a part of) the BCP to be used in case of emergency, manuals, etc. are distributed to responding persons and whether they are asked to manage such documents properly and keep them ready for use at any time.

6.1 Implementation of Proactive Measures

- ☐ (1) Whether each department in charge and persons in charge implement proactive measures without fail based on a plan for implementing proactive measures.
- ☐ (2) Whether the BCM secretariat manages the progress of proactive measures implemented by each department.

7.1.1 Assessment of Actual Functionality of Business Continuity Plan

- ☐ (1) Whether the enterprise assesses if critical operations will be able to achieve the Recovery Time Objective (RTO) and Recovery Level Objective (RLO) by means of the established BCP.

7.1.2 Inspection and Assessment of Business Continuity Management

- ☐ (1) Whether inspections and assessments are conducted to check whether BCM adapts to, or necessary amendments are made to BCM as a result of a personnel change, change of clients, change of business offices, manufacturing lines and operation implementation methods (including operation process), the commencement of provision of new products or services, a change in business from the conclusion of new contracts, etc., requirements from stakeholders, environmental changes such as revision of laws and regulations, and various other factors.
- ☐ (2) Whether inspections of clients are conducted from the viewpoint of supply chains.
- ☐ (3) Whether inspections and assessments are conducted to determine whether the kinds of anticipated incidents or predicted damage in an enterprise's BCM should be increased or expanded, and whether business fields or business offices subject to BCM should be expanded.
- ☐ (4) Whether an audit of BCM is conducted and its results are reported to the management. (Enterprises which are advanced in terms of BCM are recommended to utilize audits as means of inspecting and assessing BCM.)

7.2 Review by the Management

- ☐ (1) Whether the BCM secretariat, in preparation for the review by the management, compiles the instructions given by the management in the last review; the subsequent progress of BCM; weaknesses, problems and tasks of BCM clarified based on the results of inspection and

training; and the remaining risks, etc. which are not addressed by current measures, and then selects those matters to be judged by the management after discussions with the management.

- ☐ (2) Whether the management allows enough time for receiving explanations from the BCM secretariat, conducts necessary discussions and assessments, and take the initiative to review BCM in order to maintain and improve the enterprise's business continuity capabilities.
- ☐ (3) Whether the management, based on the results of such review, gives instructions on corrective actions which must be implemented without delay and the implementation of countermeasures, and shows the direction of improvement of BCM in future years.

7.3 Correction and Improvement

- ☐ (1) Of the problems identified in the inspection, whether practical problems that do not require management judgment are corrected as soon as possible.
- ☐ (2) For corrective actions, countermeasures and matters to be improved for which instructions are given by the management as a result of the review by the management, whether actions are taken without delay, if possible.
- ☐ (3) If investigation and analyses, the securing of budget, preparations, etc. are necessary for corrective actions, countermeasures and matters to be improved for which instructions are given by the management as a result of the review by the management, whether such measures, etc. are included in the process of continual improvement of BCM and whether the progress of implementation of such measures, etc. is managed by the BCM secretariat.

7.4 Continual Improvement

- ☐ (1) Whether the management, the BCM secretariat and enterprises as a whole assess if BCM is appropriate in light of the enterprise's management policies, business strategies, and the basic policy, purposes, etc. of BCM, whether the scope of application of BCM and covered risks are appropriate, and whether the business continuity strategy and measures are effective. Whether they make continual improvement from these viewpoints.
- ☐ (2) Whether this continual improvement is made in all processes of BCM, including policy, analyses, strategies, plans, implementation and inspections.



IMPROVED RISK EVALUATION AND IMPLEMENTATION OF RESILIENCE CONCEPTS
TO CRITICAL INFRASTRUCTURE

Appendix 6 - Resilience Concepts in Canada

Editor:

L. MELKUNAITE (DBI)

Author:

G. BAKER (SPFR)

Deliverable Number: D1.1

Date of delivery: May 31, 2016

Month of delivery: M12



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 653390

Coordinator:	David Lange at SP Sveriges Tekniska Forskningsinstitut (SP Technical Research Institute of Sweden)

Table of Contents

1	Executive Summary	196
2	Nomenclature	196
3	Resilience Concepts in Canada	196
3.1.	Concept of Resilience	197
3.2.	Institutional Framework for Delivering Resilience	199
3.3.	Critical Infrastructure and Technical Resilience	200
3.4.	Organisational Resilience	203
3.5.	Social Resilience	204
3.6.	Economic Resilience	206
3.7.	Resilience Related Official Documents	209
4	Case Studies	210
4.1.	Ontario	210
4.1.1.	Concept of Resilience	214
4.1.2.	Institutional Framework for Delivering Resilience	215
4.1.3.	Critical Infrastructure and Technical Resilience	216
4.1.4.	Organisational Resilience	218
4.1.5.	Social Resilience	219
4.1.6.	Economic Resilience	220
4.1.7.	Resilience Related Official Documents	221
5	Conclusions	221

1 Executive Summary

The concept of resilience in Canada emerged from the emergency management sector in the mid-to-late 2000's. Critical infrastructure resilience is enhanced through appropriate combination of security measures, business continuity activities, and emergency management planning. However, the country does not have an established national concept of critical infrastructure resilience. The Canadian government focuses its efforts to increase country's cyber resilience. Report also provides information on resilience building efforts in the province of Ontario. The concept of critical infrastructure assurance is discussed.

2 Nomenclature

CBRNE	Chemical, Biological, Radiological, Nuclear and Explosives
CCIRC	Canadian Cyber Incident Response Centre
CI	Critical infrastructure
CIA	Central Intelligence Agency
CIASC	Critical Infrastructure Assurance Steering Committee
CIR	Critical infrastructure resilience
CSCP	Cyber Security Cooperation Program
DRR	Disaster risk reduction
EMA	Emergency Management Act
EMCC	Emergency Management Coordinating Committee
EMCPA	The Emergency Management and Civil Protection Act
EMO	Emergency Management Ontario
FPT	Federal/Provincial/Territorial
G7	Seven largest developed economies
GFC	The global financial crisis
HIRA	A Hazard Identification and Risk Assessment
NDMP	National Disaster Mitigation Programme
NGO	Non-governmental organization
NPAS	National Public Alerting System
OCIAP	Ontario Critical Infrastructure Assurance Program
OPCC	The Office of the Privacy Commissioner of Canada
PERP	Provincial Emergency Response Plan
SSP	Successful Societies Programme
SWG	Sector Working Groups
UNISDR	United Nations Office for Disaster Risk Reduction

3 Resilience Concepts in Canada

Canada is a large country. It stretches over nearly 10 000 000 km², borders on three oceans, encompasses various types of vegetation and landscape and its climate ranges from moderate to

arctic⁶⁷⁶. This variety represents a wide range of natural hazards. Public Safety Canada⁶⁷⁷ has identified the following natural hazards^{678 679}:

- Earthquakes
- Floods
- Forest fires
- Hail
- Icebergs, sea ice and fog
- Landslides and snow avalanches
- Tornadoes
- Tsunamis and storm surges
- Volcanic eruptions
- Winter storms

The Canadian Disaster Database contains information on more than 1000 disasters that have occurred in Canada since 1900⁶⁸⁰. In order for an event to be recorded in the database, it has to meet one of the following criteria, which conform with the definition of a “disaster” given in the document *An Emergency Management Framework for Canada*⁶⁸¹:

- 10 or more people killed
- 100 or more people affected/injured/infected/evacuated or homeless
- an appeal for national/international assistance
- historical significance
- significant damage/interruption of normal processes such that the community affected cannot recover on its own.

3.1. Concept of Resilience

From a review of the available publications from the Government of Canada, the concept of resilience in a Canadian context emerged from the emergency management sector in the mid-to-late 2000's. While, for example, a list of definition in the emergency management sector entitled *Emergency and Crisis Communication Vocabulary* did not contain a definition for the concept of resilience, by 2007, the term had appeared in government publications on emergency management⁶⁸².

The current governmental approach to emergency management in Canada was shaped by the events of the World Trade Centre bombings in New York in September 2001. In response to these events in the neighbouring US, the Canadian federal government engaged in a substantial revision of its security policy, which encompassed emergency management.

⁶⁷⁶ CIA (2015). The World Factbook – Canada. *Central Intelligence Agency*. Available at: <https://www.cia.gov/library/publications/resources/the-world-factbook/geos/ca.htm>. Accessed: 3 May 2016.

⁶⁷⁷ Public Safety Canada: Public agency coordinating federal departments and agencies responsible for national security and the safety of Canadians.

⁶⁷⁸ Public Safety Canada (2014). Natural Hazards of Canada. *Public Safety Canada*. Available at: <http://www.publicsafety.gc.ca/cnt/mrgnc-mngmnt/ntrl-hzrds/index-eng.aspx>. Accessed: 10 June 2015.

⁶⁷⁹ Public Safety Canada (2003). Threats to Canada's Critical Infrastructure. *Public Safety Canada*. Available at: <https://www.publicsafety.gc.ca/lbr/archives/cn000034012674-eng.pdf>. Accessed: 2 May 2016. (No. TA03-001).

⁶⁸⁰ Public Safety Canada (2014). The Canadian Disaster Database. *Public Safety Canada*. Available at: <http://www.publicsafety.gc.ca/cnt/rsrscs/cndn-dsstr-dtbs/index-eng.aspx>. Accessed: 10 June 2016.

⁶⁸¹ Public Safety Canada (2011). An Emergency Management Framework for Canada, Second Edition - Ministers Responsible for Emergency Management, *Public Safety Canada*. Available at: <https://www.publicsafety.gc.ca/cnt/rsrscs/pblctns/mrgnc-mngmnt-frmwrk/mrgnc-mngmnt-frmwrk-eng.pdf>. Accessed: 2 May 2016.

⁶⁸² Office of Critical Infrastructure Protection and Emergency Preparedness (2003). Emergency and Crisis Communication Vocabulary, *Government of Canada*. Available at: <http://publications.gc.ca/collections/Collection/S52-2-252.pdf>. Accessed: 2 May 2016.

International Survey

In 2004 a key policy step was the release of a new national security statement entitled *Securing an Open Society: Canada's National Security Policy*⁶⁸³. The policy statement had an entire chapter devoted to emergency planning/management, and it launched significant reform of how the federal government approached emergency management. A new department of federal government was established (which was to become the current Public Safety Canada) which underscored the importance attributed to more extensive political and bureaucratic leadership in the area of emergency management in the federal government⁶⁸⁴. At this stage, the concept of resilience was not an explicit part of the policy statement.

At the July 2004 meeting of Canada's *Council of The Federation*, the premiers of the 13 Canadian provinces and territories agreed to "[...] direct their Ministers to work with the federal government to develop a coordinated strategy for emergency response and readiness for Canada, respecting provincial and territorial laws and plans already in place[...]". In January 2005, Canadian federal, provincial and territorial Ministers responsible for emergency management took the decision to "[...]work together to improve and enhance the emergency response framework in order to harmonize the federal system so that it complements each provincial and territorial system[...]"⁶⁸¹.

In 2007, the *Emergency Management Act* came into force but again it did not contained any reference to the concept of resilience⁶⁸⁵.

Also in 2007, a document entitled *An Emergency Management Framework for Canada* was published, a collaborative initiative involving the Ministers responsible for emergency management in the 13 provincial and territorial governments of Canada⁶⁸⁶ (Public Safety and Emergency Preparedness Canada 2007). This publication was the first document on emergency management from the Government of Canada to contain a definition for resilience. In the preface to the document, emergency management is described as being a "shared responsibility that builds a sustainable, prosperous and disaster-resilient society". In addition, the document included resilience as one of its nine principles at the heart of the emergency management framework. **Resilience** is defined as the capacity of a system, community or society potentially exposed to hazards to adapt, by resisting or changing in order to reach and maintain an acceptable level of functioning and structure. The document also described the evolving nature of emergency management, having moved from a traditional focus on preparedness and response, to the demand that emergency management deal with specific risks, hazards and vulnerabilities through proactive prevention and mitigation measures.

Flowing from the 2007 Emergency Management Framework was a strategy document entitled *National Strategy for Critical Infrastructure*, published in 2009⁶⁸⁷. The stated goal of this strategy document is "to build a safer, more secure and more resilient Canada". The resiliency of critical infrastructure (CI) is also mentioned extensively in the document.

Also in 2009, a policy document entitled *Federal Policy for Emergency Management: Building a Safe and Resilient Canada* was published which included some limited content on the concept of resilience. Some prominence is given to the concept in the subtitle of the document and the word *resilient* is included in the stated objective of the policy i.e., "to promote an integrated and resilient whole-of-

⁶⁸³ Government of Canada (2004). *Securing an Open Society: Canada's National Security Policy*. *Government of Canada*. Available at: <http://publications.gc.ca/collections/Collection/CP22-77-2004E.pdf>. Accessed: 2 May 2016.

⁶⁸⁴ Juillet, L., Koji, J. (2014). Reforming the Multilevel Governance of emergencies: Municipalities and the Discursive Politics of Canada's Emergency Management Policy, in: Graham, K. A. H.; Andrew, C. et al. *Canada in Cities: The Politics and Policy of Federal-Local Governance*. *McGill-Queens University Press*.

⁶⁸⁵ Government of Canada (2007). *Emergency Management Act*. *Justice Laws website*. Available at: <http://laws-lois.justice.gc.ca/eng/acts/E-4.56/>. Accessed: 3 May 2016.

⁶⁸⁶ Reserved for (Public Safety and Emergency Preparedness Canada 2007)

⁶⁸⁷ Public Safety Canada (2009). *National Strategy for Critical Infrastructure*. *Government of Canada*. Available at: <https://www.publicsafety.gc.ca/cnt/rsrcts/pblctns/srtg-crtcl-nfrstrctr/srtg-crtcl-nfrstrctr-eng.pdf> Accessed: 3 May 2016.

government approach to emergency management planning, which includes better prevention/mitigation of, preparedness for, response to, and recovery from emergencies”. *Resiliency* is also referred to in two places in the text. A definition for *resilience* is also given, but the term is not actually used anywhere else in the document.

At the same time that the federal policy document was published, a companion document, the *Federal Emergency Response Plan* was also published⁶⁸⁸. This latter document did not, however, make any explicit reference to the concept of resilience.

A second edition of the *An Emergency Management Framework for Canada* document was published in 2011, and included a revised definition for the “evolving term” *resilience*⁶⁸¹. In the second edition of the emergency management framework document, an augmented definition of resilience was given⁶⁸¹: resilience is the capacity of a system, community or society exposed to hazards to adapt to disturbances resulting from hazards by persevering, recuperating or changing to reach and maintain an acceptable level of functioning. Resilient capacity is built through a process of empowering citizens, responders, organizations, communities, governments, systems and society to share the responsibility to keep hazards from becoming disasters.

3.2. Institutional Framework for Delivering Resilience

The Canadian emergency management framework states that the emergency management responsibility is shared, not only between the federal, provincial and territorial authorities and their partners (communities, volunteers, organizations, academia, etc.), but also individual citizens, as they are expected to be prepared for disasters and contribute to community resilience⁶⁸¹. The *National Strategy for Critical Infrastructure* states that citizens should be able to cope for at least the first 72 hours after an emergency⁶⁸⁷.

Further, the emergency management framework says that the provincial and territorial governments are responsible for emergency management within their respective jurisdictions, whereas the federal government shall exercise leadership at a national level relating to emergency management responsibilities in its exclusive fields of jurisdictions and on land and properties under federal responsibility.

Since most disasters occur locally, the local (i.e. territorial or provincial) governments are responsible for the initial response, but they can, if needed, request federal assistance.

One of the principles underpinning the Public Safety Canada approach to enhancing the resilience of CI is that of *shared responsibility*⁶⁸⁹.

Public Safety Canada notes that “in Canada, responsibility for strengthening the resiliency of critical infrastructure is shared among federal, provincial and territorial governments, local authorities and critical infrastructure owners and operators. Given that disasters most often occur locally, the first response to a disruption is almost always by the owners and operators, the municipality, or the province or territory”⁶⁸⁹.

Under the *Emergency Management Act* (EMA) the federal government has national leadership obligations in relation to emergency management, including CI. In accordance with the EMA, Public Safety Canada contributes to the safeguarding of CI in Canada⁶⁸⁵. At a regional level, Public Safety

⁶⁸⁸ Government of Canada (2009). Federal Emergency Response Plan. *Government of Canada*. Available at: http://www.cpa.ca/docs/File/Emergencies/ferp_2009_EN.pdf. Accessed: 3 May 2016.

⁶⁸⁹ Public Safety Canada (2016). Enhancing Critical Infrastructure Resiliency. *Public Safety Canada*. Available at: <http://www.publicsafety.gc.ca/cnt/ntnl-scrtr/crtcl-nfrstrctr/nhncng-rslnc-eng.aspx>. Accessed: 3 May 2016.

International Survey

Canada has a network of regional offices which helps to build and support partnerships with both local and regional (including cross-border) CI stakeholders⁶⁸⁹.

3.3. Critical Infrastructure and Technical Resilience

In 2003, CI was defined as follows⁶⁸²: those systems, facilities, networks and assets on which the health, safety, security and economic well-being of Canadians depend, or which are essential to the effective functioning of governments in Canada. It also should be noted that Canada's critical infrastructure encompasses six interdependent sectors: energy and utilities; transportation; communications; safety; financial, food and health services; essential government services. A country's critical infrastructure is often referred to as its "vital lifelines". The Emergency Management Framework for Canada, which informs the National Strategy for Infrastructure, defines resilience as "the capacity of a system, community or society exposed to hazards to adapt to disturbances resulting from hazards by preserving, recuperating or changing to reach and maintain an acceptable level of functioning."⁶⁹⁰

As a companion document to the *National Strategy for Critical Infrastructure*, an *Action Plan for Critical Infrastructure* was also published in 2009⁶⁹¹. This was a joint initiative between the federal, provincial and territorial governments in Canada aimed at establishing collaboration that would strengthen CI resiliency. It is based on the understanding that "enhancing the resiliency of critical infrastructure can be achieved through the appropriate combination of security measures to address intentional and accidental incidents, business continuity practices to deal with disruptions and ensure the continuation of essential services, and emergency management planning to ensure adequate response procedures are in place to deal with unforeseen disruptions and natural disasters"⁶⁹².

The action plan builds upon the three central themes of the national strategy, namely:

- Partnerships - sustainable partnerships with federal, provincial and territorial governments and critical infrastructure sectors;
- Information Sharing - improved information sharing;
- Risk Management - a commitment to all-hazards risk management.

The action plan clarifies the roles and responsibilities of the different stakeholders. The federal government leads federal activities and is responsible for collaboration with the other stakeholders. The provincial and territorial governments lead provincial and territorial activities and are responsible for collaboration with other stakeholders as well as coordination of relevant activities amongst its own stakeholders (e.g., municipalities, local government, and CI owners/operators). The role, in turn, of CI owner/operators is to collaboratively manage the risk to their CI, with responsibility for the associated risk assessment process.

The action plan provides details of a number of initiatives:

- The establishment of sector networks covering the ten CI sectors nominated in the national strategy document;
- The establishment of a National Cross-Sector Forum to promote collaboration across the sector networks;
- The establishment of a Federal/Provincial/Territorial (FPT) CI Working Group as a standing forum for FPT government collaboration on matters of CI resiliency;

⁶⁹⁰ Emergency Management Policy Directorate, *An Emergency Management Framework for Canada* (2nd ed.), 2011. Available at: <https://www.publicsafety.gc.ca/cnt/rsrscs/pblctns/mrgnc-mngmnt-frmwrk/index-eng.aspx>.

⁶⁹¹ Government of Canada (2009). *Action Plan for Critical Infrastructure*. *Government of Canada*. Available at: <http://www.qcert.org/sites/default/files/public/documents/CAN-PL-Action%20Plan%20for%20Critical%20Infrastructure-Eng-2009.pdf>. Accessed: 3 May 2016.

⁶⁹² Ibid. P. 2

- The establishment of an information sharing framework to accelerate sharing, and improve quality and protection of CI information;
- Conduct risk assessments of CI in cooperation with governments and the private sector;
- The development of sector specific work plans to address CI risks;
- Conduct collaborative national exercises in support of a common approach to enhancing resiliency of CI;
- Collaborate to monitor implementation of the national strategy.

Public Safety Canada provides guidance on how to enhance CI resilience, through the appropriate combination of security measures, business continuity activities, and emergency management planning⁶⁸⁹.

In this context, Public Safety Canada describes a series of measures to enhance CI resilience that:

- identify risks to critical infrastructure and interdependencies;
- assess and prioritize risks;
- take mitigative or protective measures to reduce risks and the potential for disruptions;
- conduct exercises to assess measures and identify strengths and areas of improvement;
- refine and upgrade critical infrastructure plans in all sectors;
- result in swift and more effective response and recovery efforts when disruptions occur.

There are three fundamental principles to the Public Safety Canada approach to enhancing the resiliency of CI, namely; shared responsibility, an all-hazards approach, and better risk management.

The principle of shared responsibility is described in further detail in a previous section.

The *all-hazards* approach by Public Safety Canada recognises the increasing complexity and frequency of the risks to Canada's CI, including natural, intentional and accidental hazards. The approach taken with an *all-hazards* philosophy is that comprehensive planning is undertaken and all preparation, response and recovery strategies cover the full potential range of risks. The approach also includes more detailed situational awareness and response efficiency when disruption occurs.

Better risk management recognises the interdependencies and interconnection amongst CI assets, and that disruption to one asset can have a cascading effect across a network of essential services and systems. The risk management approach therefore refers to a continuous, proactive and systematic process to understand, manage and communicate risk involving all stakeholders.

In 2015, as part of its ongoing commitment to building safer and more resilient communities, Public Safety Canada also established a *National Disaster Mitigation Programme* (NDMP)⁶⁹³. The specific focus of the NDMP is to mitigate, prepare for, respond to, and recover from, flood-related events. This new initiative aims to build a body of knowledge on flood risks and invest in "foundational flood mitigation activities". The main objectives of the NDMP is to focus provincial and territorial government investment to firstly reduce the impacts of significant, recurring flood risks, and secondly to facilitate private residential flood insurance.

Canada and the U.S. have for several years had a cross-border collaboration to strengthen the safety, security and resilience of shared, critical infrastructure. The collaboration is a result of the recognition of the interconnected nature of critical infrastructure. On July 13th 2010, the U.S. Department of Homeland Security and Public Safety Canada, presented the "Canada-U.S. Action Plan for Critical Infrastructure". The action plan has three key elements; partnerships, information sharing and risk

⁶⁹³ Public Safety Canada (2016). National Disaster Mitigation Programme (NDMP). *Public Safety Canada*. Available at: <http://www.publicsafety.gc.ca/cnt/mrgnc-mngmnt/dsstr-prvntn-mtgn-ndmp/index-eng.aspx>. Accessed: 3 May 2016.

International Survey

management⁶⁹⁴. The year after, in 2011, President Obama and Prime Minister Harper announced the “Beyond the Border Action Plan”⁶⁹⁵. The plan presents a shared vision for security and economic competitiveness, with critical infrastructure and cyber-security being two of a number of topics.

The Canadian government focuses on cyber security, and has taken several measures to increase Canada’s cyber resilience. The basis for the government’s work on cyber security is the Cyber Security Strategy which Public Safety Canada is responsible for implementing⁶⁹⁶. The strategy’s main objectives are to secure government systems, secure vital cyber systems outside the federal government and to help Canadians to be secure online. There is also a 5-year action plan, effective from 2010 through 2015, describing how the strategy shall be implemented⁶⁹⁷.

In 2014, Canada also initiated a program, named the Cyber Security Cooperation Program (CSCP), which provides grants and contributions to projects increasing the resilience of Canada’s vital cyber systems through strengthened partnerships with the private sector. The program funds projects with the following objectives⁶⁹⁸:

- develop, adapt or otherwise increase the availability and access of cyber security assessment tools and methodologies for owners and operators of vital cyber systems, including critical infrastructure;
- explore existing standards and best practices and develop best practices for critical infrastructure sectors that represent vital cyber systems;
- support research and related activities, such as knowledge transfer, on pressing cyber security questions for which knowledge gaps exist and aim to better connect the research community with officials responsible for national security, the private sector, and the general public;
- support other activities that contribute to improving the resiliency of vital cyber systems outside the federal Government. Such activities include workforce development initiatives to ensure that vital cyber systems owners and operators can rely on security professionals at the forefront of their field, events such as workshops or conferences to bring more attention to specific cyber security issues, and private sector-specific awareness initiatives to facilitate the dissemination of relevant cyber security information.

Canada has also established the Canadian Cyber Incident Response Centre (CCIRC), whose task is to be the national coordination centre for cyber events. CCIRC provides advice and support to help owners and operators of systems of national importance to prepare for and mitigate cyber events, technical advice and support to respond to and recover from targeted attacks and access to trusted fora for information sharing and collaboration⁶⁹⁹.

In 2014, the University of Montreal (Université de Montréal) launched a network, funded by Networks of Centres of Excellence of Canada, for smart cybersecurity, titled SERENE RISC. The network’s

⁶⁹⁴ US Department of Homeland Security; Public Safety Canada (2010). Canada - U.S. Action Plan for Critical Infrastructure. *US Department of Homeland Security; Public Safety Canada*. Available at: <https://www.dhs.gov/publication/canada-us-action-plan-critical-infrastructure>. Accessed: 3 May 2016.

⁶⁹⁵ US Department of Homeland Security (2011). United States - Canada Beyond the Border: A Shared Vision for Perimeter Security and Economic Competitiveness - Action Plan. *US Department of Homeland Security*. Available at: <https://www.dhs.gov/action-plan>. Accessed: 3 May 2016.

⁶⁹⁶ Cabell, J.F., Oelofse, M. (2012). An Indicator Framework for Assessing Agroecosystem Resilience. *Ecol. Soc.* 17. doi:10.5751/ES-04666-170118

⁶⁹⁷ Public Safety Canada (2015). Action Plan 2010-2015 for Canada’s Cyber Security Strategy. *Public Safety Canada*. Available at: <http://www.publicsafety.gc.ca/cnt/rsrscs/pblctns/ctn-pln-cbr-scrct/index-eng.aspx>. Accessed 20 October 2015.

⁶⁹⁸ Public Safety Canada (2015). Cyber Security Cooperation Program. *Public Safety Canada*. Available at: <http://www.publicsafety.gc.ca/cnt/ntnl-scrct/cbr-scrct/cprtn-prgrm/index-eng.aspx>. Accessed: 20 October 2015.

⁶⁹⁹ Public Safety Canada (2015). Canadian Cyber Incident Response Centre (CCIRC) *Public Safety Canada*. Available at: <http://www.publicsafety.gc.ca/cnt/ntnl-scrct/cbr-scrct/ccirc-ccirc-eng.aspx>. Accessed: 10 September 2015.

objective is to improve the general public’s awareness of cybersecurity and to empower all to reduce the risks of cyber threats through knowledge. SERENE-RISC wants to move knowledge from “where it is created” to “where it can be used”, and in that manner strengthening the connection between research, policy and practise, and between those who produce the research and those who might benefit from it.

3.4. Organisational Resilience

The Canadian federal government publication *An Emergency Management Framework for Canada*, provides an emergency management governance structure that can be applied either at a federal level, or at a provincial/territorial level, of government, as shown in Figure 3.1⁶⁸¹. On the top tier, the federal, territorial and provincial (FTP) Ministers have overall responsibility. The Ministers make decisions, whereas the Deputy Ministers, on the second tier, are responsible for implementing and prioritizing the ministerial decisions and assigning the senior officials on the third tier to take responsibility for action items. On the fourth tier, the different working groups who carry out the work are found. The working groups also report back to the senior officials on the progress and results from their ongoing work.

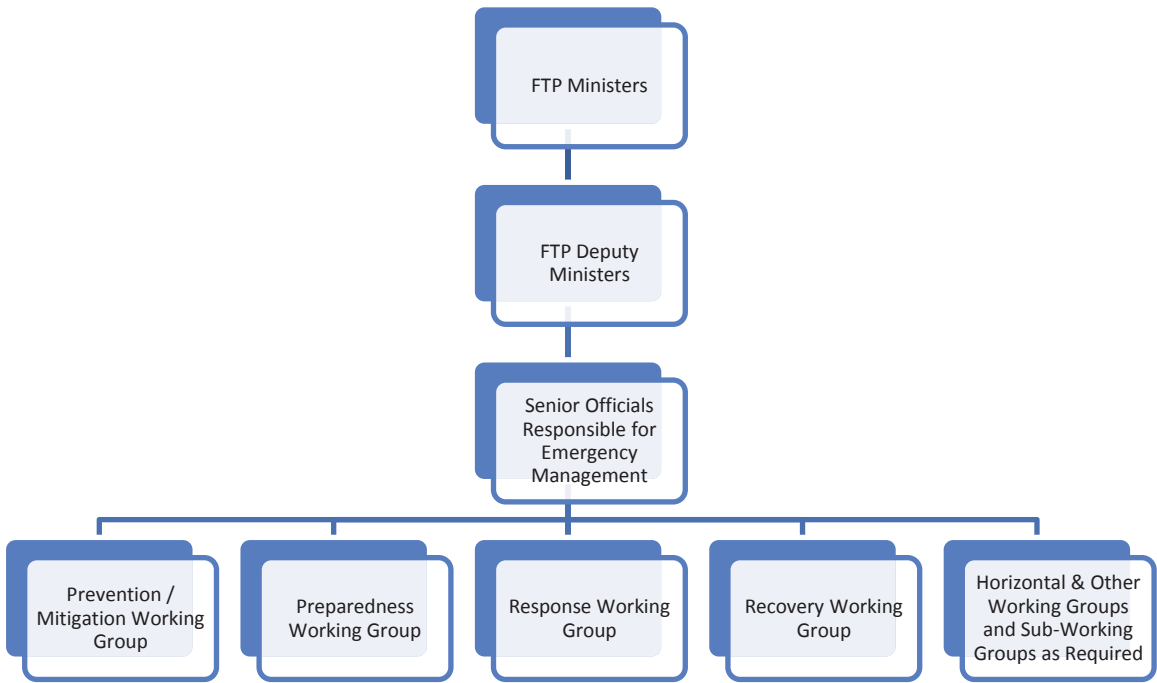


Figure 3.1. Federal, territorial and provincial governance structure.

In 2009, Public Safety Canada established a *National Platform for Disaster Risk Reduction*, in an effort to build multi-stakeholder coordinated leadership in disaster risk reduction⁷⁰⁰ (DRR). The initiative was part of the Canadian government’s ongoing commitment to meet its obligations under the UNISDR’s *Hyogo Framework for Action* (and the 2015 Sendai Framework). The purpose of the platform is to bring together interdisciplinary stakeholders with an interest in reducing the risks posed by disasters, so as to “build a sense of national, cross-sectoral ownership in the disaster reduction process through coordinated leadership and action”. Representation in the platform comes from the

⁷⁰⁰ Public Safety Canada (2016). Canada’s Platform for Disaster Risk Reduction *Public Safety Canada*. Available at: <http://www.publicsafety.gc.ca/cnt/mrgnc-mngmnt/dsstr-prvntn-mtgn/pltfm-dsstr-rsk-rdctn/index-eng.aspx>. Accessed: 9 May 2016.

International Survey

public and private sectors, academia, NGOs, professional associations and Aboriginal groups. The overall objective of this initiative is to build resilience to disasters.

The Office of the Privacy Commissioner of Canada (OPCC) has produced a Privacy Emergency Kit which addresses the problem of uncertainty about sharing personal information in an emergency situation, which can in turn result in unnecessary confusion and delays⁷⁰¹. The OPCC notes that “privacy laws should not be considered a barrier to appropriate information sharing, nor should it be used as an excuse for inaction”. The different federal and territorial privacy legislation contains provisions to allow sharing of personal information in the event of an emergency. The purpose of the Privacy Emergency kit is to provide guidance to organisations to help enhance the timeliness and content of communications during an emergency while giving people confidence that their personal information will be handled appropriately.

In the Canadian province of Québec, the Ministry of Public Security and the École Polytechnique de Montréal have collaborated on research into the concept of organizational resilience.

3.5. Social Resilience

Much of the government activity in relation to emergency management and civil protection focusses, indirectly, on protecting individual citizens from natural, man-made and accidental hazards. The concept of *social resilience* does not feature prominently in official government publications that have been reviewed as part of this research.

There is ongoing academic research in Canada in the field of societal resilience. The most prominent is the Successful Societies Programme (SSP) of the Canadian Institute for Advanced Research⁷⁰². As noted on the SSP webpage, “successful societies are those that create conditions that lead to better health, well-being and resilience for individuals and communities. The program aims to identify the cultural and social frameworks that put societies on a path toward greater and more equitable prosperity. It looks beyond simple economic analysis, and examines how an individual’s sense of identity and belonging within a culture can affect overall economic, physical and psychological well-being”.

In 2013, the SSP published a book entitled *Social Resilience in the Neoliberal Era*, which explored the consequences of neoliberal ideas and policies on social life over three decades⁷⁰³. Since the 1980s, countries around the world have introduced major reforms to improve market efficiency and wealth creation, while reducing the role of the state. The resulting neoliberal era has had unexpected effects on society and the lives of individuals⁷⁰⁴. The book also investigates *social resilience* as being the capacity of groups of people bound together in an organisation, class, racial group, community or nation to sustain and advance their well-being in the face of challenges⁷⁰².

The Canadian government acknowledges the vital role that individuals play in emergency management. As noted previously, not only governmental agencies, but also their partners, such as industry and organizations, and individual citizens are responsible for being prepared for disasters.⁶⁸⁷
681

⁷⁰¹ Office of the Privacy Commissioner of Canada (2013). Privacy Emergency Kit May 2013. Office of the *Privacy Commissioner of Canada*. Available at: https://www.priv.gc.ca/information/pub/gd_em_201305_e.pdf. Accessed: 9 May 2016.

⁷⁰² CIFAR (2016). Successful Societies. *CIFAR*. Available at: <http://www.cifar.ca/successful-societies/>. Accessed: 9 May 2016.

⁷⁰³ Hall, P., Lamont, M. (2013). *Social Resilience in the Neoliberal Era*. Cambridge University Press. Available at: http://assets.cambridge.org/97811076/59841/copyright/9781107659841_copyright_info.pdf. Accessed: 9 May 2016.

⁷⁰⁴ CIFAR (2016). *Social Resilience: Creative Responses to Social Change*. *CIFAR*. Available at: <http://www.cifar.ca/Social-resilience-Creative-responses-to-social-change>. Accessed: 9 May 2016.

As a part of preparing citizens for disasters and enabling them to be self-sufficient for at least 72 hours after a disaster takes place, the federal government of Canada has launched a website called *Get Prepared*⁷⁰⁵. On the site, information regarding different hazards and emergencies, how to act before, during and after an event, how to make an emergency plan for the family and how to prepare emergency kits is given. Following the instructions on this site help citizens raise their consciousness regarding emergency planning and behaviour.

The *National Public Alerting System* (NPAS) is a multi-channel federal/provincial/territorial (FPT) all-hazards system that provides emergency management organizations throughout Canada with a standard alerting capability to warn the public of imminent or unfolding hazards to life through such means as radio, cable television, satellite television, email and SMS text services. The NPAS complements existing public alerting systems and tools in a number of FPT jurisdictions⁷⁰⁶.

As part of a programme to connect with Canadian communities, the *Cross-Cultural Roundtable on Security* is another government initiative that was created to engage Canadians and the Government of Canada in a long-term dialogue on matters related to national security. The Roundtable brings together citizens who are leaders in their respective communities and who have extensive experience in social and cultural matters. It focuses on emerging developments in national security matters and their impact on Canada's diverse and pluralistic society. The group provides advice and perspectives to the Minister of Public Safety and the Minister of Justice, concerning matters of national security⁷⁰⁷.

The topic of one of the Roundtable meetings was *resilience*. The meeting summary records that a number of topics were presented on the theme of resilience, including the Government's all-hazards approach, the United States' experience with Hurricane Sandy and the Full Circle Community Safety Model implemented by police services in Canada. Members were consulted on work being conducted on the General Social Survey on Social Identity, on a proposed Canadian Extremist Crime Database, and heard from a Roundtable member about community-based gang prevention and rehabilitation. Members agreed on the importance of reflecting on and celebrating the contribution of all Canadians from diverse backgrounds in order to better demonstrate the resilience of diverse Canadian communities. Members emphasized that the key to building resilient communities lay within communities and underlined the importance of communication and information-sharing with communities before and during emergencies, particularly through ethnic media and with the use of new technologies⁷⁰⁸.

Another, higher level, dimension of societal resilience in Canada is Public Safety Canada's activities relating to disaster risk reduction (DRR). DRR has a strong link to community resilience and many of the DRR mitigation strategies target individual citizens and their homes. The Public Safety Canada website indicates that disaster mitigation measures (i.e., DRR) are those that eliminate or reduce the impacts and risks of hazards through proactive measures taken before an emergency or disaster occurs. To clarify the meaning of the term all-hazards, Public Safety Canada notes that an all-hazards emergency management approach looks at all potential risks and impacts, natural and human-induced (intentional and non-intentional) to ensure that decisions made to mitigate against one type of risk do not increase our vulnerability to other risks. According to Public Safety Canada, disaster mitigation

⁷⁰⁵ Government of Canada, 2015. *Get Prepared*. *Government of Canada*. Available at: <https://www.getprepared.gc.ca/index-en.aspx>. Accessed 10 October 2015.

⁷⁰⁶ Public Safety Canada (2016). National Public Alerting System. *Public Safety Canada*. Available at: <http://www.publicsafety.gc.ca/cnt/mrgnc-mngmnt/mrgnc-prprdnss/ntnl-pblc-lrtng-sstm-eng.aspx>. Accessed: 9 May 2016.

⁷⁰⁷ Public Safety Canada (2016). Connecting with Canadian Communities - Cross-Cultural Roundtable on Security. *Public Safety Canada*. Available at: <http://www.publicsafety.gc.ca/cnt/ntnl-scrtr/crss-cltrl-rndtbl/index-eng.aspx>. Accessed: 2 May 2016.

⁷⁰⁸ Public Safety Canada (2016). Cross-Cultural Roundtable on Security Meeting Summary – Resilience. *Public Safety Canada*. Available at: <http://www.publicsafety.gc.ca/cnt/ntnl-scrtr/crss-cltrl-rndtbl/smmr-2013-03-eng.aspx>. Accessed: 2 May 2016.

International Survey

measures can be either structural (i.e., physical) and non-structural (i.e., non-physical), a number of examples of which are provided on the Public Safety Canada website⁷⁰⁹:

- Hazard mapping
- Adoption and enforcement of land use and zoning practices
- Implementing and enforcing building codes
- Flood plain mapping
- Reinforced tornado safe rooms
- Burying of electrical cables to prevent ice build-up
- Raising of homes in flood-prone areas
- Disaster mitigation public awareness programs
- Insurance programs

A number of these disaster mitigation measures have direct relevance for private home owners.

3.6. Economic Resilience

The concept of economic resilience is widely used in the research literature. Hill and colleagues suggest that “for regional economic analysis, perhaps the most natural conceptual meaning of economic resilience, and the one we use, is the ability of a regional economy to maintain or return to a pre-existing state (typically assumed to be an equilibrium state) in the presence of some type of exogenous (i.e., externally generated) shock. Although only a few studies explicitly use the term “resilience,” the economic literature that deals with the idea of resilience typically is concerned with the extent to which a regional or national economy is able to return to its previous level and/or growth rate of output, employment, or population after experiencing an external shock”⁷¹⁰.

The OECD takes a broad view of the concept of economic resilience from the perspective of the need to strengthen the resilience of economies⁷¹¹. With regard to the nature and source of potential vulnerabilities, the OECD details five categories of domestic vulnerability in this respect:

1. Financial sector imbalances;
2. Non-financial sector imbalances;
3. Asset market imbalances;
4. Public sector imbalances;
5. External sector imbalances;

The OECD also includes a sixth international category, namely:

6. Spillovers, contagion and global risks.

During the global financial crisis (GFC), the Canadian economy was seen as being the most economically resilient amongst the seven largest developed economies (G7). For example, in the introduction to a report on financial plans and priorities in 2014-15, the federal Minister of Finance, the Honourable James M. Flaherty, stated that “despite ongoing uncertainty and instability from beyond our borders, Canada continues to demonstrate economic resilience. Today, more Canadians

⁷⁰⁹ Public Safety Canada (2016). About Disaster Mitigation. *Public Safety Canada*. Available at: <http://www.publicsafety.gc.ca/cnt/mrgnc-mngmnt/dsstr-prvntn-mtgn/bt-dsstr-mtgn-eng.aspx>. Accessed: 2 May 2016.

⁷¹⁰ Hill, E., St. Clair, T., et al. (2011). Economic Shocks and Regional Economic Resilience. Working Paper 2011-03. *Institute of Governmental Studies*. Available at: http://brr.berkeley.edu/brr_workingpapers/2011-03-hill_et_al-conference_economic_shocks_regional_economic_resilience.pdf. Accessed: 2 May 2016.

⁷¹¹ Röhn, O., Sánchez, A.C. et al. (2015). Economic Resilience: A New Set of Vulnerability Indicators for OECD Countries. Working Papers No. 1249. *OECD Economics Department*. Available at: [http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=ECO/WKP\(2015\)67&docLanguage=En](http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=ECO/WKP(2015)67&docLanguage=En). Accessed: 9 May 2016.

are working in good jobs than ever before. Since July 2009, employment has increased by over 1 million and is now about 620,000 above its pre-recession peak—the strongest job growth over the recovery among G7 countries. The federal tax burden is the lowest in over 50 years, and both the International Monetary Fund and the Organisation for Economic Co-operation and Development expect Canada to be among the strongest growing economies in the G7 over this year and the next. For the sixth year in a row, the World Economic Forum rated Canada’s banking system as the world’s soundest. Canada’s financial house is in order”⁷¹².

Earlier in the GFC, a 2010 report by the Department of Finance Canada, painted a similar picture of the Canadian economy and its resilience⁷¹³. The report describes four key measures of economic resilience:

- Job creation;
- Economic growth;
- Stability of financial sector;
- Low public debt.

In each of these four key metrics, Canada was ahead of the six comparable economies in the G7. The report also quotes the International Monetary Fund as stating that “Canada’s resilience bears testimony to its strong and credible policy frameworks that responded proactively to the global crisis”. Another quote in the report comes from the Economist magazine, namely that “the main reason for [Canada’s] economic resilience is that neither its financial system nor its housing market magnified the recession. The banks remained in profit. House prices held up fairly well and are now rising. And for that regulators deserve a chunk of the credit.

Some research has been done in Canada by government agencies on economic resilience. For example, Statistics Canada published a report on community vulnerability in relation to population and employment changes⁷¹⁴. In a report on regional resilience, Dabson et al. state that the Statistics Canada report by Alasia et al. “focused on economic resilience through the lens of what they termed “community resilience.” They examined the likelihood of worsening socio-economic conditions for a community as a result of particular events or actions (shocks). They applied three dimensions to their analysis: stressors, such as exposure to global competition; assets, such as human capital; and outcomes, such as population decline. The researchers’ econometric model showed that exposure to global restructuring trends increases community vulnerability to employment decline, and conditions of community distress, such as high unemployment rates, increase community vulnerability to population decline. However, community assets such as human capital, economic diversification, and proximity to metropolitan centers reduce vulnerability to population decline”⁷¹⁵.

In a broad sense, *economic resilience* is generally conceptualised as some form of external economic shock and the ability to recover. One specific dimension of the concept is the resilience of the financial system. An article published in the Financial System Review from the Bank of Canada describes the threats from cyber-attacks on the financial system and how to improve resilience against these types of

⁷¹² Department of Finance Canada (2014). Report on Plans and Priorities 2014-15. *Treasury Board of Canada Secretariat*. Available at: <https://www.tbs-sct.gc.ca/rpp/2014-2015/tbd/tbdpr-eng.asp>. Accessed: 9 May 2016.

⁷¹³ Department of Finance Canada (2010). Canada’s Global Economic Leadership - A Report to Canadians. *Department of Finance Canada*. Available at: <https://www.fin.gc.ca/pub/report-rapport/2010-6/pdf/cgel-lemc-eng.pdf>. Accessed: 9 May 2016.

⁷¹⁴ Alasia, A., Bollman, R., et al. (2008). An Index of Community Vulnerability: Conceptual Framework and Application to Population and Employment Changes 1981 to 2001. *Statistics Canada*. Available at: <http://www.statcan.gc.ca/pub/21-601-m/21-601-m2008088-eng.pdf>. Accessed: 9 May 2016.

⁷¹⁵ Dabson, B., Heflin, C. M., et al. et al. (2012). Regional Resilience - Research and Policy Brief. *RUPRI*. Available at: <http://www.nado.org/wp-content/uploads/2012/04/RUPRI-Regional-Resilience-Research-Policy-Brief.pdf>. Accessed: 9 May 2016.

International Survey

attacks⁷¹⁶. In the article, Gallagher *et al.* account for the interdependent mechanisms of the financial system, and how the failure of one financial institution to withstand attacks can propagate and affect the whole system.

Globally, large amounts of money are spent by financial companies to improve their security against attacks. According to the article, the first line of defence includes network-penetration testing, strict controls governing access to internal systems, vulnerability-scanning tools, data encryption and timely security updates. However, according to Kochan, cited by Gallagher *et al.*, the implementation of an impermeable perimeter defence to keep attackers out is no longer considered realistic or efficient to mitigate the risk⁷¹⁷. Gallagher *et al.* points out that collaboration between the different financial institutions, federal government and other key sectors is important to fight cyber-attacks and maintain resilience, as an attack may affect the whole financial system.

As noted previously, Canada has its own *Cyber Security Strategy* which Public Safety Canada is responsible for implementing⁷¹⁸. The strategy's main objectives are to secure government systems, secure vital cyber systems outside the federal government and to help Canadians to be secure online. Ensuring a resilient financial system is related to the second objective.

As noted, a resilient financial system is dependent on close collaboration between financial institutions, and to facilitate collaboration, the Canadian Cyber Incident Response Centre (CCIRC) was established. CCIRC provides advice and support to prepare for and mitigate cyber events, technical advice and support to respond to and recover from targeted attacks and access to trusted fora for information sharing and collaboration⁷¹⁹.

The Canadian Office of the Superintendent of Financial Institutions has also published guidance on cyber security to help federally-regulated financial institutions in assessing their practices and determine what changes are needed in order to comply with industry best practices⁷¹⁶.

Gallagher *et al.* report on a series of table-top exercises, where members of major Canadian banks, financial marked infrastructures and the federal government have participated. The objectives of the exercises were to identify and assess key risks, determine how to escalate incidents to decision-makers and to coordinate mitigation strategies in case of cyber-attacks.

A number of less formal initiatives are underway to improve economic resilience at the local level in Canada. Colussi outlines a series of community-based initiatives aimed at insulating communities from external economic shocks⁷²⁰. Colussi describes the *Transition Towns* programme that tries “to make the local economy more resilient. Resilient economies rely less on outside, corporate ownership and more on smaller, locally-owned business. They are based on an awareness and commitment to low carbon or no carbon. They are committed to fair wages and fair trade principles. They explore ways to create 100 mile supply chains for food and for many other products and services. And they are creating forms of exchange that do not involve cash at all. They try to hold nature, people, and profits in balance”.

⁷¹⁶ Gallagher, H., McMahon, W., et al. (2014). Cyber Security: Protecting the Resilience of Canada's Financial System. *Bank of Canada*. Available at: <http://www.bankofcanada.ca/wp-content/uploads/2014/12/fsr-december2014.pdf>. Accessed: 9 May 2016.

⁷¹⁷ Kochan, N. (2014). Taking the Strategic View of Cyber Security. *Risk.net*. Available at: <http://www.risk.net/operational-risk-and-regulation/feature/2356306/taking-the-strategic-view-of-cyber-security>. Accessed: 9 May 2016.

⁷¹⁸ Government of Canada (2010). Canada's Cyber Security Strategy: For a Stronger and More Prosperous Canada. *Government of Canada*. Available at: <http://www.risk.net/operational-risk-and-regulation/feature/2356306/taking-the-strategic-view-of-cyber-security>. Accessed: 9 May 2016.

⁷¹⁹ Public Safety Canada (2015). Canadian Cyber Incident Response Centre (CCIRC). *Public Safety Canada*. Available at: <http://www.publicsafety.gc.ca/cnt/ntnl-scr/cbr-scr/ccirc-ccirc-eng.aspx>. Accessed 10 September 2015.

⁷²⁰ Colussi, M. (2011). Strengthening Economic Resilience Canadian centre for community renewal. Available at: <http://communityrenewal.ca/blog/strengthening-economic-resilience>. Accessed: 9 May 2016.

3.7. Resilience Related Official Documents

The Canadian authorities, i.e. Public Safety Canada, acknowledge that there is an accumulated risk for disasters due to factors such as urbanization, critical infrastructure interdependencies, terrorism, climate change, diseases and movement of people and goods, and that Canada is not immune to these hazards. Canadian emergency management has adopted an all-hazards approach to address these issues.

In 2007, Public Safety Canada issued the first version of *An Emergency Management Framework for Canada*, and four years later, in 2011, the second version was issued. The document states that the “framework supports legal and policy frameworks, programs, activities, standards and other measures in order to enable and inspire all emergency management partners in Canada to work in better collaboration to keep Canadians safe”⁷²¹.

The main purpose of the framework is to save lives, preserve the environment and protect property and the economy, and it is emphasized that saving lives is of paramount importance. The framework has defined four interdependent components, namely: prevention and mitigation, preparedness, response and recovery. In order to provide good safety to the citizens, these components have to be addressed and undertaken, either sequentially or concurrently, and the effort of provincial, territorial and federal governments has to be coordinated.

The framework lists principles which society must comply with as the basis for good emergency management; for example, roles and responsibility, clear communications and continuous improvement, to mention a few.

In 2008 a *National Disaster Mitigation Strategy* was published which was a collaborative effort between the Federal/Provincial/Territorial (FPT) governments to develop sustainable disaster-resilient communities across Canada⁷²². The focus of this strategy document was a collaborative effort, amongst the FPT governments, to develop sustainable, disaster-resilient communities across Canada. The strategy also recognises that mitigation is an important part of a robust emergency management framework.

A *National Strategy for Critical Infrastructure*, also cited by the European Commission Joint Research Centre, adopts the fundamental concepts and principles described in the emergency management framework document^{691 723}. The reason for developing such a strategy is an acknowledgement of the fact that the risks related to critical infrastructure cut across different jurisdictions and sectors. The purpose of the strategy is to *build a safer, more secure and more resilient Canada*, and it shall advance coherent and complementary actions among the initiatives on the different governmental levels. The strategy focuses especially on the following critical infrastructure sectors:

- Energy and utilities
- Finance
- Food
- Transportation
- Government

⁷²¹ Public Safety Canada (2011). *An Emergency Management Framework for Canada*, Second Edition - Ministers Responsible for Emergency Management, *Public Safety Canada*. Available at: <https://www.publicsafety.gc.ca/cnt/rsrscs/pblctns/mrgnc-mngmnt-frmwrk/mrgnc-mngmnt-frmwrk-eng.pdf>. Accessed: 2 May 2016. P. 3.

⁷²² Public Safety Canada (2008). *Canada's National Disaster Mitigation Strategy*. *Public Safety Canada*. Available at: <https://www.publicsafety.gc.ca/cnt/mrgnc-mngmnt/dsstr-prvntn-mtgn/ntnl-dsstr-mtgn-strtg-en.aspx>. Accessed: 9 May 2016.

⁷²³ Giannopoulos, G., Filippini, R. et al. (2012). *Risk Assessment Methodologies for Critical Infrastructure Protection*. Part 1: A State of the Art (No. EUR 25286 EN). *European Commission Joint Research Centre*. Available at: http://ec.europa.eu/home-affairs/doc_centre/terrorism/docs/RA-ver2.pdf. Accessed: 9 May 2016.

International Survey

- Information and communication technology
- Health
- Water
- Safety
- Manufacturing

There are three strategic objectives given in the document:

1. Build partnerships
2. Implement an all-hazard risk management approach
3. Advance the timely sharing and protection of information among partners

The strategy places responsibility, not only on governmental bodies, but also the industry/owners and operators of critical infrastructure and citizens.

Canada has also prepared a Chemical, Biological, Radiological, Nuclear and Explosives (CBRNE) Resilience Strategy, in order to be able to cope with both accidental and human-induced hazards⁷²⁴. The latter has over the last decade been of increasingly importance due to the focus of terrorist attacks on Western interests. The purpose of the strategy is “to provide the policy framework that guides the creation and maintenance of sustainable capabilities, common standards and steers investments in CBRNE policies, programs, equipment, and training in a common direction”.

The strategy is based upon five strategic objectives:

- Leadership
- Risk management
- Capability-based planning
- Effective and interoperable workforce
- Information and knowledge management

This strategy has also resulted in an action plan, which defines actions and timelines for CBRNE programs over a five-year period⁷²⁵.

4. Case Studies

4.1. Ontario

Ontario is the largest province (by population) in Canada, with 13.6 M inhabitants (2014 figures).

A report in 2010 provides details of the largest Canadian natural disasters in terms of total cost⁷²⁶. The historical event with the largest economic impact was in January 1998 where freezing rain caused a total of CAN \$5.4 billion in provinces from Ontario to New Brunswick. Hurricane Hazel (October

⁷²⁴ Government of Canada (2011). Chemical, Biological, Radiological, Nuclear and Explosives Resilience Strategy for Canada. *Public Safety Canada*. Available at: <https://www.publicsafety.gc.ca/cnt/rsrscs/pblctns/rslnc-strtg/rslnc-strtg-eng.pdf>. Accessed: 9 May 2016.

⁷²⁵ Government of Canada, 2011b. Chemical, Biological, Radiological, Nuclear and Explosives Resilience Action Plan for Canada. *Public Safety Canada*. Available at: <https://www.publicsafety.gc.ca/cnt/rsrscs/pblctns/rslnc-ctn-pln/index-en.aspx>. Accessed: 9 May 2016.

⁷²⁶ Institute for Catastrophic Loss Reduction (2010). *Canadians at Risk: Our Exposure to Natural Hazards, Canadian Assessment of Natural Hazards Project. Institute for Catastrophic Loss Reduction*. Available at : https://www.iclr.org/images/Canadians_at_Risk_2010.pdf. Accessed: 9 May 2016.

1954) caused CAN \$1.1 B (adjusted to current value) of damage in Ontario⁷²⁷. Flooding in Toronto in July 2013 cost CAN \$1 billion⁷²⁸.

The historic natural disasters with the highest fatalities in Ontario were the Great Lakes Storm of 1913, with an estimated 250 fatalities in both Canada and the US⁷²⁷, followed by the Matheson Fire of 1916, with an official estimate of 223 fatalities^{729 730}. Hurricane Hazel had the third highest number of fatalities in Ontario, with 81 deaths⁷²⁷.

A Hazard Identification and Risk Assessment (HIRA) has been published for the Province of Ontario which identifies 39 different hazards under the categories of *natural*, *technological*, and *man-made*⁷³¹. Each of the thirty nine hazards is discussed under four main headings; Definition, Description, Provincial Risk Statements, and Case Study. An analysis of the risk (a relative risk ranking) of each hazard is also provided in the document.

The Province of Ontario HIRA document presents the risk level of each hazard in two Risk Formats:

1. Risk = Consequence × Frequency;
2. Risk = Consequence × Frequency × Changing Risk.

Risk Format 1 provides an historical and current perspective on risk, while Risk Format 2 intentionally provides a future perspective.

The *Consequence* and *Frequency* parameters were scored from 1 to 6 while the *Changing Risk* parameter could be scored as 2, 3 or 4. The range of possible risk scores is therefore 1 to 36 for Risk Format 1, and 1 to 144 for Risk Format 2.

⁷²⁷ Wikipedia. "List of Disasters in Canada by Death Toll". 2016. Available at:

https://en.wikipedia.org/wiki/List_of_disasters_in_Canada_by_death_toll. Accessed: 5 February 2016.

⁷²⁸ Global News (2013). Worst Natural Disasters in Toronto's history: How They Compare. *Global News*. Available at:

<http://globalnews.ca/news/1046844/worst-natural-disasters-in-canadian-history/>. Accessed: 9 May 2016.

⁷²⁹ Ontario Heritage Foundation (2003). The Great Fire of 1916. *Ontario Heritage Foundation*. Available at:

<http://www.heritagetrust.on.ca/cmsimages/18/18f43b81-8062-45ba-a86c-10ed87b53683.pdf>. Accessed: 9 May 2016.

⁷³⁰ Alexander, M. E. (2010). "Lest we Forget": Canada's Major Wildland Fire Disasters of the Past, 1825-1938. Presented at the Proceedings of 3rd Fire Behavior and Fuels Conference. *International Association of Wildland Fire*. Available at:

<http://www.wildlandfire.com/docs/2011/lessons-learned/Alexander%20-2010-Lest-We-Forget.pdf>. Accessed: 9 May 2016.

⁷³¹ Government of Ontario (2012). Hazard and Risk Assessment for the Province of Ontario. *Emergency Management Ontario*. Available at: https://www.emergencymanagementontario.ca/english/emcommunity/ProvincialPrograms/hira/hira_2012.html Accessed: 14 March 2016.

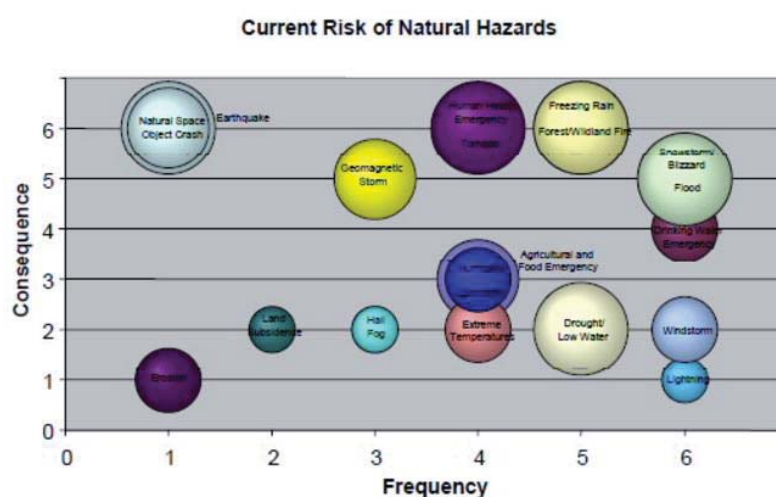
International Survey

Table 4.1. Risk ranking for hazards in Ontario based on Risk Format 2⁷³¹.

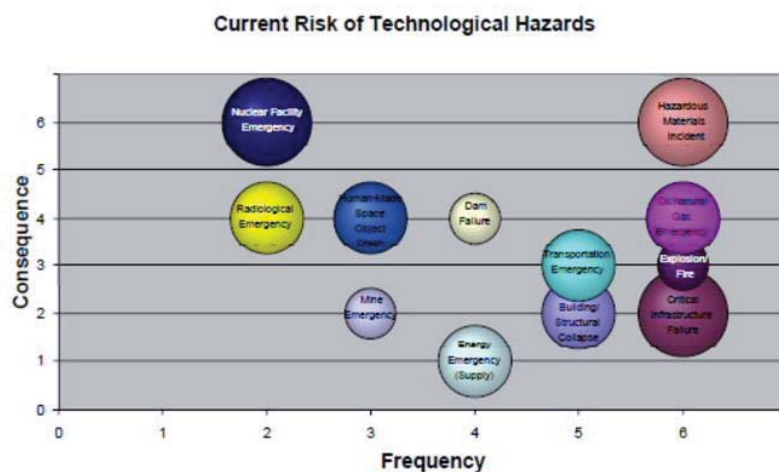
Level of Risk	Description	Hazards
>50	Extreme	Flood, Forest/Wildland Fire, Freezing Rain, Hazardous Materials Incident, Human Health Emergency, Snowstorm/Blizzard, Tornado
41 – 50	Very High	Drinking Water Emergency, Geomagnetic Storm, Oil/Natural Gas Emergency, Terrorism/CBRNE
31 – 40	High	Agricultural and Food Emergency, Critical Infrastructure Failure, Drought/Low Water, Nuclear Facility Emergency
21 – 30	Moderate	Civil Disorder, Cyber Attack, Earthquake, Human-Made Space Object Crash, Landslide, Transportation Emergency, Windstorm
11 – 20	Low	Building/Structural Collapse, Dam Failure, Explosion/Fire, Extreme Temperatures, Hurricane, Natural Space Object Crash, Radiological Emergency
<10	Very Low	Energy Emergency (Supply), Erosion, Fog, Hail, Land Subsidence, Lightning, Mine Emergency, Sabotage, Special Event, War and International Emergency

In Table 4.1 it can be seen that 7 hazards are ranked in the highest category (extreme), namely; Flood, Forest/Wildland Fire, Freezing Rain, Hazardous Materials Incident, Human Health Emergency, Snowstorm/Blizzard and Tornado, of which six are classed as natural hazards (including Human Health Emergency) and the seventh is a technological hazard.

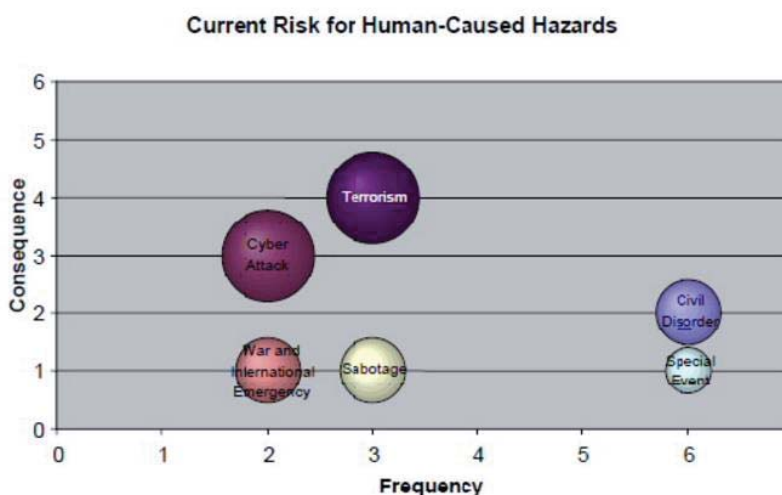
Figure 3.1 presents the information from Table 4.1 by hazard type, where the *Frequency* (x-axis) and *Consequence* (y-axis) are plotted, along with the *Changing Risk* parameter as a bubble to signify the magnitude.



(a)



(b)



(c)

Figure 4.1 Risk ranking by hazard type: (a) Natural; (b) Technological; (c) Human-Caused (Government of Ontario 2012)

The largest city in Ontario is Toronto, with a population of 2.6 M (2011 figures). The agency responsible for coordinating emergency and disaster activities is the City of Toronto Office of Emergency Management⁷³² (City of Toronto, 2016a). On the City of Toronto website, a range of hazards, relevant to Toronto, are identified; high-rise fires, extreme weather, floods, extreme heat and cold, power failures and utility disruptions, hazardous materials accidents, health emergencies, tornadoes and high speed winds, winter storms, terrorism and nuclear risk.

In its Emergency Plan, the Toronto Office of Emergency Management identifies 33 hazards of concern to the City of Toronto (Office of Emergency Management 2015 pp. 19-20) and of these 33 hazards, there are three hazards that have been prioritized by having an individual Risk Specific Plan

⁷³² City of Toronto (2016). Office of Emergency Management. *City of Toronto*. Available at: <http://www1.toronto.ca/wps/portal/contentonly?vgnextoid=4b3307ceb6f8e310VgnVCM10000071d60f89RCRD>. Accessed: 14 March 2016.

International Survey

that has been developed, covering: *Flooding, Nuclear Emergency Response Plan, and Power Disruption (Electricity)* (Office of Emergency Management 2015 pp. 29-30).

4.1.1. Concept of Resilience

Emergency Management Ontario, an agency within the Ontario Ministry of Community Safety and Correctional Services, has prepared an English-French emergency management glossary of terms, where resilience is defined as follows: The ability to resist, absorb, accommodate and recover from the effects of a hazard in a timely and efficient manner⁷³³.

The same document also has definitions for other terms associated with resilience.

CI is defined as: Interdependent, interactive, interconnected networks of institutions, services, systems and processes that meet vital human needs, sustain the economy, protect public safety and security, and maintain continuity of and confidence in government.

CI Assurance is defined as: The application of risk management and business continuity management processes and techniques for the purpose of reducing the vulnerability of CI in both the physical and cyber realms by decreasing the frequency, duration, and scope of disruptions and facilitating response and recovery.

Prevention is defined as: Actions taken to stop an emergency or disaster from occurring. Such actions may include legislative controls, zoning restrictions, improved operating standards/procedures or critical infrastructure management.

Mitigation is defined as: Actions taken to reduce the adverse impacts of an emergency or disaster. Such actions may include diversion or containment measures to lessen the impacts of a flood or a spill.

Preparedness is defined as: Actions taken prior to an emergency or disaster to ensure an effective response. These actions include the formulation of emergency response plans, business continuity/continuity of operations plans, training, exercises, and public awareness and education.

No information relating to the history of the concept of resilience in Ontario, specifically, was found.

However, some information was identified relating to the evolvement of Emergency Management practices in the Province of Ontario.

In the aftermath of the ice storms in January 1998 and the Government of Ontario's Y2K preparations, the responsible government agency in Ontario (then known as Emergency Measures Ontario) began an in-depth study of Emergency Management in the province. The report from this study was completed just before the events of September 11 2001. Amendments were made to the report to include some of the lessons learnt from September 11th, and the report was presented to the Government of Ontario in October 2011. As a result of the report, the Emergency Management and Civil Protection Act was developed and then enacted in 2003, along with one set of associated regulations (Ontario Regulation 380/04) in 2004⁷³⁴.

⁷³³ Emergency Management Ontario (2016). English-French Emergency Management Glossary of Terms. Available at : http://www.emergencymanagementontario.ca/english/emcommunity/response_resources/GlossaryOfTerms/glossary_of_terms.html. Accessed 5 February 2016.

⁷³⁴ Government of Ontario (2016). Legislation and Regulations. *Emergency Management Ontario*. Available at: http://www.emergencymanagementontario.ca/english/insideemo/legislationandregulation/handbook_EMCPA.html. Accessed: 9 March 2016.

4.1.2. Institutional Framework for Delivering Resilience

Emergency Management Ontario (EMO) is a branch of the Ministry of Community Safety and Correctional Services. EMO is responsible for monitoring, coordinating and assisting in the development and implementation of emergency management programmes throughout Ontario. Resilience is very much at the core of this government agency, with the vision statement for the organisation being “a safe, secure and resilient Ontario”, and a mission statement that “EMO will lead the coordination, development and implementation of prevention, mitigation, preparedness, response and recovery strategies to maximize safety, security and resiliency of Ontario through effective partnerships with diverse communities”⁷³⁵.

The previous Emergency Plans Act gave municipalities the authority to create emergency plans on an elective basis, whereas the new EMCPA requires municipalities to develop, implement and maintain an emergency management programme. Similar obligations were also placed on provincial government bodies under the Act.

As such, the primary responsibility for Emergency Management in Ontario rest with the 444 municipalities⁷³⁶.

The EMO website indicates that “the primary reason for an emergency management program is to improve public safety through a coordinated and pre-identified process for responding to critical situations. A realistic emergency management program will assist in protecting lives, infrastructure, and property, protect the environment, promote economic stability, and help ensure the continuance of critical assets and government”⁷³⁴. This latter statement attributed to EMO implies some connection to CIR, although not explicit.

The mandate of the EMPCA is broad, linking to the obligation that municipalities in Ontario exercise powers of good government, which is interpreted to include asset management as well as the social, economic and environmental wellbeing of the community.

Emergency Management is described as a system of partnerships in Ontario⁷³⁴. Individuals are expected to be self-sufficient for at least 72 hours in the event of a large-scale emergency. Municipalities must develop and implement and emergency management programme, and fulfil other obligations in accordance with the EMCPA. Mutual assistance agreements (cooperation with neighbouring communities) are not mandatory but encouraged. The provincial government is responsible for overall coordination of Emergency Management in Ontario. The provincial government also operates the Provincial Emergency Management Centre, which is essentially provides coordinated access to resources at a provincial and national level. At a federal level, the province can request federal assistance when the scale of an emergency warrants it.

EMO makes available a number of resources to individual citizens and municipalities through its website.

Nominated ministries within the Government of Ontario are also responsible for emergency management programmes for specific hazards, for example the Ministry of Natural Resources is responsible for floods and wildfire responses.

⁷³⁵ Government of Ontario (2016). Core Values. *Emergency Management Ontario*. Available at: http://www.emergencymanagementontario.ca/english/insideemo/CoreValues/core_values.html. Accessed: 10 March 2016.

⁷³⁶ Government of Ontario (2016). List of Ontario Municipalities. *Ministry of Municipal Affairs and housing*. Available at: <http://www.mah.gov.on.ca/Page1591.aspx>. Accessed: 10 March 2016.

International Survey

The Ontario Critical Infrastructure Assurance Program Strategy is the overarching framework for the province's Ontario Critical Infrastructure Assurance Program (OCIAP), which has the aim of increasing the resiliency of the provinces CI so that it is more sustainable during an adverse event and is administered by EMO⁷³⁷.

At a municipal level, the municipal authority is responsible for delivering resilience; for example in Ontario's largest metropolitan area, Toronto, the City of Toronto Office of Emergency Management (City of Toronto, 2016a) has this responsibility.

4.1.3. Critical Infrastructure and Technical Resilience

The PERP notes that emergency situations can threaten amongst other things critical infrastructure. The document also indicates that "emergency management consists of organized programs and activities taken to deal with actual or potential emergencies or disasters. It is based on a risk management approach and includes five components, namely *prevention*, *mitigation*, *preparedness*, *response* and *recovery*."

Both the examples of *prevention* and *mitigation* measures list amongst other things capital improvements, regulations and building codes. The *preparedness* measures list amongst other things infrastructure protection.

The Building Code Act and the associated regulations, Ontario Regulation 332/12: Building Code is therefore one mechanism in Ontario to implement technological resilience (prevention) in the built environment^{738,739}. Underpinning this regulatory framework, there are lower tier compliance documents, such as the Ministry of Municipalities and Housing Supplementary Standard SB-1 Climatic and Seismic Data, which nominates the seismic values required for the design of buildings under the Building Code.

The province's OCIAP is a province-wide initiative that identifies and assesses Ontario's key facilities, systems and networks, and their interdependencies, and that develops processes to mitigate physical and cyber threats and vulnerabilities. The OCIAP comes under the jurisdiction of Emergency Management Canada⁷³⁷.

The OCIAP defines CI assurance as "the application of risk management and business continuity management processes and techniques for the purpose of reducing the vulnerabilities of critical infrastructure in both the physical and cyber realms by decreasing the frequency, duration and scope of disruptions and facilitating response and recovery".

The OCIAP addresses CI in nine sectors: The government is responsible for the first two sectors, namely Public Safety and Security, and Continuity of Government, and the private sector is mainly responsible for the other seven, namely Food and Water, Telecommunication Systems, Electrical Power System, Gas and Oil, Financial Services, Health System, Transportation Networks.

The OCIAP incorporates the three key principles of risk management, business continuity and collaboration and the programme is integral to the five components of Emergency Management, namely prevention, mitigation, preparedness, response and recovery. EMO notes however that in

⁷³⁷ Government of Ontario (2016). Critical Infrastructure. *Emergency Management Ontario*. Available at: <https://www.emergencymanagementontario.ca/english/emcommunity/ProvincialPrograms/ci/ci.html>. Accessed: 9 May 2016.

⁷³⁸ Government of Ontario (2015). Building Code Act, 1992 - Amendment 19. *Government of Ontario*. Available at: <https://www.ontario.ca/laws/statute/92b23>. Accessed: 9 May 2016.

⁷³⁹ Government of Ontario (2016). Ontario Regulation 332/12: Building Code (Amendment 7). *Government of Ontario*. Available at: <https://www.ontario.ca/laws/regulation/120332>. Accessed: 9 May 2016.

relation to CI, the majority of activity occurs prior to an event, and hence the OCIAP focusses on prevention and mitigation.

The Ontario Government Emergency Fuel Distribution Protocol is a protocol that has been developed for fuel distribution in the event of a declared provincial emergency that involves fuel shortages⁷⁴⁰. During a declared emergency, supplies of fuel may become a government controlled commodity in order for communities and CI sectors to maintain essential services.

In the HIRA that was published by the Province of Ontario, the provincial risk statement for the man-made hazard *cyber-attack* notes that “many of Ontario’s critical infrastructure networks [...] are heavily reliant on computer technology. The severity of the impact depends on the type of cyber attack and the type of target. [...] An attack on critical infrastructure could disable that infrastructure and leave thousands without access to that infrastructure”⁷³¹. In a similar vein, the commentary on another man-made hazard, *sabotage*, nominates critical infrastructure as an example of the target for sabotage.

Ontario’s HIRA also has *critical infrastructure service disruptions/impact* as one of its six *Consequence* categories in its risk assessment procedure, defining it as “the negative consequences of the occurrence of a hazard on the interdependent, interactive, interconnected networks of institutions, services, systems and processes that meet vital human needs, sustain the economy, protect public safety and security, and maintain continuity of and confidence in government”⁷³¹. There are six *Consequence* categories utilized, namely; *social impacts*, *property damage*, *critical infrastructure service disruptions/impact*, *environmental damage*, *business/financial impact*, and *psychosocial impacts*. Each of these six factors are not weighted equally in the risk ranking process, however, with *critical infrastructure service disruptions/impact* accounting for 13 % of the total *Consequence* score, compared to the major contributor being 43 % for *social impacts*. The following four descriptors are used for the four *Consequence* categories associated with ranking CI disruption:

Table 4.2. Consequence category descriptors for critical infrastructure service disruption/impact (Government of Ontario 2012).

Consequence	Category	Description
0	None	Not likely to disrupt critical infrastructure services.
1	Minor	Could disrupt 1 critical infrastructure service.
2	Moderate	Could disrupt 2 – 3 critical infrastructure services.
3	Severe	Could disrupt more than 3 critical infrastructure services.

⁷⁴⁰ Government of Ontario (2016). Critical Infrastructure - Ontario Government Emergency Fuel Distribution Protocol. *Emergency Management Ontario*. Available at: https://www.emergencymanagementontario.ca/english/emcommunity/ProvincialPrograms/ci/emergency_fuel_distribution_protocol.html. Accessed 11 March 2016.

International Survey

4.1.4. Organisational Resilience

The service statement for EMO is as follows⁷⁴¹:

“Emergency Management Ontario is committed to providing and ensuring that appropriate programs are in place based on our legislative foundation, the Emergency Management and Civil Protection Act, that support the safety and security of Ontarians and a **robust and resilient Ontario Public Service** (emphasis added). Successful EMO emergency management programming is designed such that it ensures an engaged stakeholder constituency and partnership; transparent and comprehensive evaluation and audit processes as well as action oriented planning and program delivery. The output is excellence in emergency management in Ontario.”

In the context of organizational resilience, the reference to a robust and resilient Ontario Public Service is a governmental reference to organizational resilience. In other words, as well as being responsible for the safety and security of Ontario’s citizens, EMO is also responsible for ensuring that the Government of Ontario continues to provide essential services to citizens during and after emergency situations.

Some of the critical infrastructure services that EMO has overarching responsibility for fall outside the public sector. Of the nine sectors that the OCIAP addresses, services from seven sectors are primarily delivered by the private sector, and hence the core activities of the OCIAP focus on private sector organisations.

As such, there are a number of core activities in the OCIAP which impact organizational resilience:

1. The formation of Sector Working Groups (SWG) – a SWG is formed for each CI sector that is identified and is led by a provincial ministry representative and include private sector representatives;
2. Identify and Assess CI – each SWG identifies the key elements of their sector, identified critical elements, determines critical element dependencies and interdependencies, and assesses vulnerabilities, threats and ensuing risks to the critical elements;
3. Identify Assurance Solutions – in order to mitigate risks to CI the vulnerabilities that have been assessed form the basis for determining best practice to prevent and/or mitigate threats to sector critical elements;
4. Refine, Enhance, Promote – CI owners and operators are provided with information, the Critical Infrastructure Assurance Steering Committee facilitates R&D and EMO produces OCIAP awareness information and risk management and CI assurance tools.

At the same time there are strong linkages between the public and private sector organisations in these core OCIAP activities.

At the public sector level, EMO has set up a formal structure to ensure the consistency and comprehensiveness of the OCIAP. Each sector group reports to the Critical Infrastructure Assurance Steering Committee (CIASC), which oversees the coordination and development of the OCIAP. The CIASC in turn reports to the Emergency Management Coordinating Committee (EMCC) which is responsible for the coordination and development of emergency management programmes, policies, plans and procedures in Ontario.

Under the ENCPA, all Ontario municipalities are required to develop and implement a municipal emergency management programme. In relation to *preparedness*, one component of an emergency

⁷⁴¹ Government of Ontario (2016). Service Standards. Emergency Management Ontario. Available at: <http://www.emergencymanagementontario.ca/english/insideemo/ServiceStandards/servicestandards.html>. Accessed 10 March 2016.

management programme is a hazard identification and risk assessment (HIRA). EMO has published a HIRA Workbook for use in Ontario which provides guidance on how private sector organisations can carry out their own HIRA with respect to natural, technological and man-made hazards. The HIRA process has four steps⁷⁴²:

1. Hazard identification;
2. Risk Assessment;
3. Risk Analysis;
4. Monitor and Review.

By conducting a HIRA, an organization can proactively identify vulnerabilities and develop mitigation actions on a prioritized basis, hence improving its organizational resilience.

It is of interest to note that in the Province of Ontario's HIRA, the definition for *man-made* hazards (also called *human-caused* hazards) includes "hazards that arise from problems with organizational structure of a company, government etc."

The City of Toronto Emergency Plan provides comprehensive detail on the governance structure that comes into operation in the event of an emergency, which is an example of one aspect of organizational resilience preparedness in Toronto⁷⁴³.

The City of Toronto also has web-based emergency management resources that target businesses⁷⁴⁴. The information on the website is provided in the categories of; business continuity planning, the definition of a disaster/emergency, risk assessment, fire safety, medical emergencies, emergency supplies and IT security.

4.1.5. Social Resilience

The PERP describes five components in the EMO risk management approach to emergency management. Under the third category of *preparedness*, a number of the measures listed in the PERP are integral with societal resilience, such as training, exercises, public education, and alerting and notification systems.

In relation to *preparedness*, EMO has a comprehensive emergency preparedness strategy that is primarily aimed at individual citizens. The majority of the information for the public is available on the EMO website and includes the following elements⁷⁴⁵:

1. Information about different risks such as earthquakes, forest fires, pandemics, winter storms, extreme heat, floods, nuclear incidents, thunderstorms and tornadoes;
2. A six step Be Prepared programme that includes the following steps:
 - Make a Plan;
 - Build a Kit;
 - Be Informed;

⁷⁴² Government of Ontario (2016). Hazard Identification and Risk Assessment Workbook. *Office of Emergency Management*. Available at: http://www.emergencymanagementontario.ca/english/emcommunity/ProvincialPrograms/hira/hira_workbook/hira_workbook.html. Accessed 14 March 2016.

⁷⁴³ Office of Emergency Management (2015). The City of Toronto Emergency Plan. *Office of Emergency Management*. Available at: <http://www1.toronto.ca/wps/portal/contentonly?vgnextoid=4b3307ceb6f8e310VgnVCM10000071d60f89RCRD>. Accessed: 9 May 2016.

⁷⁴⁴ City of Toronto, 2016b. Business Partners Exchange. *Office of Emergency Management*. <http://www1.toronto.ca/wps/portal/contentonly?vgnextoid=594307ceb6f8e310VgnVCM10000071d60f89RCRD>. Accessed: 19 March 2016.

⁷⁴⁵ Government of Ontario (2016). Be Prepared - Know the Risks, Reduce them Together. *Office of Emergency Management*. Available at: <http://www.emergencymanagementontario.ca/english/beprepared/beprepared.html>. Accessed: 10 March 2016.

International Survey

- Be Social;
 - Take a Quiz;
 - Promote EP
3. An Emergency Public Alerting System that provides three types of warnings – Red Alerts, Emergency Information Advisories and Tornado Warnings⁷⁴⁶:
 - Red Alerts – issued by province to provide recommended immediate actions to protect citizens when there is an imminent threat to life, public safety or property, and include situations such as large fires or explosions, chemical leaks or spills, nuclear emergencies, transportation accidents, etc.;
 - Emergency Information Advisories issues by province to provide information about current or evolving emergency situations;
 - Tornado Warnings – distributed in partnership with Environment Canada, which issues the warnings for the whole of Canada.
 4. Training programmes to increase awareness and applied knowledge of emergency management practices, including public education tools;
 5. Guidance for the development of exercise programmes, for use by communities to conduct annual exercises.

The City of Toronto provides a list of 11 risks in Toronto on its website, and for each risk advice is provided to residents on what to do if caught in an event, and what precautions to take beforehand⁷⁴⁷ (City of Toronto, 2016c). The City of Toronto website also has a range of information available to its citizens about preparedness, response and recovery under the headings; *Preparing for an Emergency*, *Coping with Emergencies*, and *Recovering from an Emergency*⁷⁴⁸.

4.1.6. Economic Resilience

Many of the official government documents relating to emergency management in Ontario refer to the consequences of hazards in terms of economic impact. For example, the Province of Ontario's HIRA refers to the potential economic impact that a cyber-attack could have stating that "a cyber attack could have significant financial repercussions for a business or organization. An attack on the stock market could have large scale financial repercussions"⁷³¹.

Ontario's HIRA also has *business/financial impact* as one of its six *Consequence* categories in its risk assessment procedure, defining it as "the negative economic consequences of the occurrence of a hazard"⁷³¹. There are six *Consequence* categories utilized, namely; *social impacts*, *property damage*, *critical infrastructure service disruptions/impact*, *environmental damage*, *business/financial impact*, and *psychosocial impacts*. Each of these six factors are not weighted equally in the risk ranking process, however, with *business/financial impact* accounting for only 9% of the total *Consequence* score, compared to the major contributor being 43% for *social impacts*.

⁷⁴⁶ Government of Ontario (2016). Public Alerting in Ontario *Office of Emergency Management*. Available at: http://www.emergencymanagementontario.ca/english/ontariowarnings/public_alerting_fact_sheet.html. Accessed: 11 March 2016.

⁷⁴⁷ City of Toronto (2016). Risks in Toronto. *Office of Emergency Management*. Available at: <http://www1.toronto.ca/wps/portal/contentonly?vgnextoid=ba296cbd2b95a410VgnVCM10000071d60f89RCRD>. Accessed 14 March 2016.

⁷⁴⁸ City of Toronto (2016). Get Emergency Ready. *Office of Emergency Management*. Available at: <http://www1.toronto.ca/wps/portal/contentonly?vgnextoid=e0d36cbd2b95a410VgnVCM10000071d60f89RCRD> Accessed 19 March 2016.

4.1.7. Resilience Related Official Documents

The closest example that could be found of an official document on resilience is the Ontario Critical Infrastructure Assurance Program Strategy, which has the vision that “Ontario’s CI will become disaster resilient and sustainable during threats from all hazards through the collaborative effort of government and the private sector”⁷⁴⁹.

In addition, one piece of legislation was found that relates indirectly to resilience.

The Emergency Management and Civil Protection Act (EMCPA)⁷⁵⁰ came into force in the Province of Ontario in 2003 and replaced the previous legislation, the Emergency Plans Act. In 2004, Ontario Regulation 380/04 also came into force under the EMCPA⁷⁵¹.

One of the requirements of the EMCPA is that a Provincial Emergency Response Plan (PERP) be formulated, with the current version being dated 2008⁷⁵². Importantly, the Foreword to this document states that “while the focus of this plan is on emergency response, it also recognizes the important link to prevention, mitigation, preparedness (plans, training, public education, exercises, and emergency information), and recovery, as proactive components that are critical elements in any emergency response”. This statement therefore makes an unequivocal connection between Emergency Management and CIR.

5. Conclusions

The study of resilience concepts in Canada provides useful insights for the current project IMPROVER. Although the country does not have official state-level definition of critical infrastructure resilience, it nevertheless lists a number of steps and initiatives aimed at increasing resilience of national critical infrastructures. Case study on the province of Ontario introduces the concept of critical infrastructure assurance, which is also relevant in the context of the current project.

⁷⁴⁹ Government of Ontario (2016). Critical Infrastructure - Ontario Critical Infrastructure Assurance Programme Strategy. *Office of Emergency Management*. Available at: http://www.emergencymanagementontario.ca/english/emcommunity/ProvincialPrograms/ci/ociap_strategy.html Accessed 11 March 2016.

⁷⁵⁰ Government of Ontario (2003). Emergency Management and Civil Protection Act, Amendment 7 2009. *Government of Ontario*. Available at: <https://www.ontario.ca/laws/statute/90e09>. Accessed: 9 May 2016.

⁷⁵¹ Government of Ontario (2004). Ontario Regulation 380/04: Standards. *Government of Ontario*. Available at: <https://www.ontario.ca/laws/regulation/040380>

⁷⁵² Government of Ontario (2016). Emergency Response Plans. *Emergency Management Office*. Available at: http://www.emergencymanagementontario.ca/english/emcommunity/response_resources/plans/provincial_emergency_response_plan.html Accessed 11 March 2016.



IMPROVED RISK EVALUATION AND IMPLEMENTATION OF RESILIENCE CONCEPTS
TO CRITICAL INFRASTRUCTURE

Appendix 7 - Resilience Concepts in Oceania

Editor:

L. MELKUNAITE (DBI)

Authors (in alphabetic order)

K. ERIKSSON (SP)

D. HONFI (SP)

D. LANGE (SP)

L. PETERSEN (EMSC)

Deliverable Number: D1.1

Date of delivery: May 31, 2016

Month of delivery: M12



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 653390

Coordinator:	David Lange at SP Sveriges Tekniska Forskningsinstitut (SP Technical Research Institute of Sweden)

Table of Contents

1	Executive Summary	226
2	Nomenclature	226
3	Resilience Concepts in Oceania	228
3.1.	Regional Overview	228
3.1.1.	PACC Programme	228
3.1.2.	Strategy for Climate and Disaster Resilient Development in the Pacific (SRDP)	229
3.1.3.	Pacific Regional Framework for Action 2005-2015: Building the resilience of nations and communities to disasters	229
4	Case Studies	231
4.1.	Australia	231
4.1.1.	Concept of Resilience	232
4.1.2.	Institutional Framework for Delivering Resilience	233
4.1.3.	Critical Infrastructure and Technical Resilience	233
4.1.4.	Organisational Resilience	236
4.1.5.	Social Resilience	239
4.1.6.	Economic Resilience	241
4.1.7.	Resilience Related Official Documents	243
4.2.	New Zealand	244
4.2.1.	Concept of Resilience	244
4.2.2.	Institutional Framework for Delivering Resilience	246
4.2.3.	Critical Infrastructure and Technical Resilience	247
4.2.4.	Organisational Resilience	249
4.2.5.	Social Resilience	251
4.2.6.	Economic Resilience	253
4.2.7.	Resilience Related Official Documents	253
4.3.	Fiji	254
4.3.1.	Concept of Resilience	255
4.3.2.	Institutional Framework for Delivering Resilience	256
4.3.3.	Critical Infrastructure and Technical Resilience	256
4.3.4.	Organisational Resilience	257
4.3.5.	Social Resilience	257
4.3.6.	Economic Resilience	258
4.3.7.	Resilience Related Official Documents	259
4.4.	Kiribati	259
4.4.1.	Concept of Resilience	260
4.4.2.	Institutional Framework for Delivering Resilience	261
4.4.3.	Critical Infrastructure and Technical Resilience	261
4.4.4.	Organisational Resilience	261
4.4.5.	Social Resilience	262
4.4.6.	Economic Resilience	262
4.4.7.	Resilience Related Official Documents	262
4.5.	The Republic of the Marshall Islands (RMI)	262
4.5.1.	Concept of Resilience	263
4.5.2.	Institutional Framework for Delivering Resilience	263
4.5.3.	Critical Infrastructure and Technical Resilience	263
4.5.4.	Organisational Resilience	264
4.5.5.	Social Resilience	264
4.5.6.	Economic Resilience	264

International Survey

4.5.7.	Resilience Related Official Documents	264
4.6.	Federal States of Micronesia (FSM)	265
4.6.1.	Concept of Resilience	265
4.6.2.	Institutional Framework for Delivering Resilience	266
4.6.3.	Critical Infrastructure and Technical Resilience	266
4.6.4.	Organisational Resilience	266
4.6.5.	Social Resilience	266
4.6.6.	Economic Resilience	266
4.6.7.	Resilience Related Official Documents	266
4.7.	Nauru	266
4.7.1.	Concept of Resilience	266
4.7.2.	Institutional Framework for Delivering Resilience	267
4.7.3.	Critical Infrastructure and Technical Resilience	267
4.7.4.	Organisational Resilience	267
4.7.5.	Social Resilience	267
4.7.6.	Economic Resilience	268
4.7.7.	Resilience Related Official Documents	268
4.8.	Palau	268
4.8.1.	Concept of Resilience	270
4.8.2.	Institutional Framework for Delivering Resilience	271
4.8.3.	Critical Infrastructure and Technical Resilience	271
4.8.4.	Organisational Resilience	272
4.8.5.	Social Resilience	272
4.8.6.	Economic Resilience	273
4.8.7.	Resilience Related Official Documents	273
4.9.	Papua New Guinea	273
4.9.1.	Concept of Resilience	274
4.9.2.	Institutional Framework for Delivering Resilience	276
4.9.3.	Critical Infrastructure and Technical Resilience	276
4.9.4.	Organisational Resilience	277
4.9.5.	Social Resilience	277
4.9.6.	Economic Resilience	278
4.9.7.	Resilience Related Official Documents	278
4.10.	Samoa	278
4.10.1.	Concept of Resilience	279
4.10.2.	Institutional Framework for Delivering Resilience	281
4.10.3.	Critical Infrastructure and Technical Resilience	281
4.10.4.	Organisational Resilience	281
4.10.5.	Social Resilience	281
4.10.6.	Economic Resilience	281
4.10.7.	Resilience Related Official Documents	281
4.11.	Solomon Islands	282
4.11.1.	Concept of Resilience	282
4.11.2.	Institutional Framework for Delivering Resilience	283
4.11.3.	Critical Infrastructure and Technical Resilience	283
4.11.4.	Organisational Resilience	283
4.11.5.	Social Resilience	283
4.11.6.	Economic Resilience	283
4.11.7.	Resilience Related Official Documents	283
4.12.	Vanuatu	283
4.12.1.	Concept of Resilience	285
4.12.2.	Institutional Framework for Delivering Resilience	286
4.12.3.	Critical Infrastructure and Technical Resilience	286
4.12.4.	Organisational Resilience	286
4.12.5.	Social Resilience	286

4.12.6.	Economic Resilience	287
4.12.7.	Resilience Related Official Documents	287
5	Conclusions	287

1 Executive Summary

The report provides information on resilience concepts in 12 countries, namely Australia, New Zealand, Fiji, Kiribati, The Republic of the Marshall Islands, Federal States of Micronesia, Nauru, Palau, Papua New Guinea, Samoa, Solomon Islands, Vanuatu. The collected information indicates rather different maturity of the concept and practice of resilience in analysed countries. Case studies on Australia and New Zealand provides information that is particularly relevant in the context of the current project. Australian government focuses on organisational resilience in order to achieve critical infrastructure resilience. In New Zealand, critical infrastructure resilience is built on the 4R's approach.

2 Nomenclature

ASPI	Australian Strategic Policy Institute
AUSAID	Australian Agency for International Development
BAU	Business as Usual
BRCC	Building Resilience to Climate Change
CCA	Climate Change Adaptation
CCDS	Climate-compatible Development Strategy
CDEM	Civil defence Emergency Management
CHARM	Comprehensive Hazard and Risk Management
CI	Critical infrastructure
CIP	Critical Infrastructure Protection
CIPMA	Critical Infrastructure Protection Modelling and Analysis
CIR	Critical Infrastructure Resilience
COAG	Council of Australian Governments
COIFS	Commission of Inquiry into Financial Services
CRIP	Climate Resilience Investment Programme
CRISP	Community Resilience to Climate and Disaster Risk in Solomon Islands Project
CSO	Chief Secretary's Office
DM	Disaster Management
DPLLGA	Department of Provincial and Local Level Government Affairs
DREE	Disaster Response Exercise and Exchange
DRM	The Disaster Risk Management
DRR	Disaster Risk Reduction
DSP	Development Strategy Plan
EAC	Emergency assistance centres
EFF	Export Finance Facility
EoRI	The Economics of Resilient Infrastructure
EVI	The Environmental Vulnerability Index
FAO	Food and Agriculture Organization of the United Nations
FICI	Food Import Capability Index
FSAP	Financial Sector Assessment Programme
FSI	Financial Soundness Indicators
FSM	Federal States of Micronesia

GIS	Geographic Information System
HFA	Hyogo Framework for Action
ICCRIFS	Integration of Climate Change Risks and Resilience into Forestry Management in Samoa
IMF	International Monetary Fund
IPCC	Intergovernmental Panel on Climate Change
JNAP	The Joint National Action Plan
KJIP	Kiribati Joint Implementation Plan
MCDEM	Ministry of Civil Defence & Emergency Management
MDPAC	Ministry of Development Planning and Aid Coordination
MECDM	the Ministry of Environment, Climate Change, Disaster Management and Meteorology
MOP	ministry strategies, operational plans
MTDP	Medium Term Development Plan
NACCC	National Advisory Committee on Climate Change
NAP	National Action Plan
NC3	National Climate Change Committee
NCCDMP	National Climate Compatible Development Management Policy
NDA	the National Disaster Act
NDC	National Disaster committee
NDMO	The National Disaster Management Organisation
NDMO	The National Disaster Management Office
NEC	National Emergency Committee
NEMO	National Emergency Management Office
NGO	Non-governmental organization
NIU	National Infrastructure Unit
NSDS	National Sustainable Development Strategy
NTF	National Action Plan Task Force
NZAID	New Zealand Agency for International Development
OCCD	Office of Climate Change and Development
OEPPC	Office of Environmental Planning and Policy Co-ordination
OLPLLG	Organic Law on Provincial and Local Level Government
PACC	Pacific Adaptation to Climate Change
PACCSAP	Pacific-Australia Climate Change Science and Adaptation Planning Program
PIP	Public Investment Plan
PNG	Papua New Guinea
PPCR	The Pilot Programme for Climate Resilience
PRRP	The Pacific Risk Resilience Programme
PAA	Priorities and Action Agenda
RCC	The disaster Recovery Coordination Committee
REAG	Resilience Expert Advisory Group
RMI	The Republic of the Marshall Islands
RONAdapt	Republic of Nauru's Framework for Climate Change Adaptation and Disaster Risk Reduction
RTGS	the Fiji Real Time Gross Settlement
SME	Small and medium-sized enterprises
SOP	Standard Operating Procedures

International Survey

SOPAC	South Pacific Applied Geoscience Commission
SPC	The Pacific Community
SPCR	Strategic Programme for Climate Resilience
SPREP	Secretariat of the Pacific Regional Environment Programme
SRDP	Strategy for Climate and Disaster Resilient Development in the Pacific
TISN	The Trusted Information Sharing Network
UNCRD	United Nations Centre for Regional Development
UNDESA	the United Nations Department of Economic and Social Affairs
UNDP	United Nations Development Programme
UNISDR	The United Nations Office for Disaster Risk Reduction
UNOCHA	United Nations Office for the Coordination of Humanitarian Affairs
USARPAC	U.S. Army Pacific Command
WREMO	Wellington Region Emergency Management Office's

3 Resilience Concepts in Oceania

3.1. Regional Overview

3.1.1. PACC Programme

The Pacific Adaptation to Climate Change (PACC) programme is a regional response to increase climate change resilience, regrouping 14 Pacific Island countries and territories (Cook Islands, Federated States of Micronesia, Fiji, Marshall Islands, Nauru, Niue, Palau, Papua New Guinea, Solomon Islands, Samoa, Tokelau, Tonga, Tuvalu and Vanuatu) and was founded in 2009. It has four main objectives: “(1) demonstrating practical ‘on the ground’ measures; (2) promoting climate-sensitive national policy; (3) strengthening community or municipality coping capacity; and (4) building resilience at the level of national and state economies⁷⁵³.”

The PACC programme **defines resilience** as follows:

“Resilience can be defined as the ability of a system (human or environmental) to resist, absorb and recover from the effects of hazards in a timely and efficient manner, preserving or restoring its essential basic structures, functions and identity (CARE International, 2010). A resilient community is well-placed to manage hazards, to quickly respond to and recover from any negative impacts, resulting in a similar or improved state as compared to before the hazard occurred. There are strong linkages between resilience and adaptive capacity. It should also be noted that resilience can vary for different groups within a community.⁷⁵⁴”

There is no specific part of the PACC programme dealing exclusively with Critical Infrastructure Resilience; however a few projects do deal with coastal infrastructure, as discussed below.

⁷⁵³ Secretariat of the Pacific Regional Environment Programme. (2013). “Adapting to Climate Change in the Pacific: The PACC programme.”. *SPREP*. Available at: https://www.sprep.org/attachments/Publications/CC/PACC_Programme.pdf. Accessed: 4 January 2016.

⁷⁵⁴ Secretariat of the Pacific Regional Environment Programme. (2014). “Mainstreaming Climate Change into Development in the Pacific: a practical guide.”. *SPREP*. Available at: https://www.sprep.org/attachments/Publications/CC/PACC_Mainstreaming_2014.pdf. Accessed: 4 January 2016.

A project in the Federated States of Micronesia is focusing on climate-proofing a coastal road and “pioneering resilient coastal infrastructure”⁷⁵³. Vulnerable parts of the island’s main transport route are being elevated and new drainage measures are being put in place. Furthermore, a sea level tide gauge and a rainfall gauge are being installed. The project has also been raising awareness about the need to build resilience to climate change.

The “enhancing resilience of coastal infrastructure and community assets” PACC project in Vanuatu focused on building community capacity with training on soft engineering options for coastal protection. New roads were designed in coordination with PACC experts and the local community members, and the roads will be built by the communities themselves.

The PACC programme emphasises the importance of community engagement and capacity building in delivering resilience in the region.

3.1.2. Strategy for Climate and Disaster Resilient Development in the Pacific (SRDP)

The Strategy for Climate and Disaster Resilient Development in the Pacific (SRDP) is a document under development that is going to describe a single integrated regional strategy on climate change and disaster risk management in the Pacific region. The idea is to develop a single framework instead of the separate frameworks on climate change and disaster risk management (the *Pacific Disaster Risk Reduction and Disaster Management Framework for Action*, and the *Pacific Framework for Action on Climate Change*) that expire in 2015.

In the SRDP resilience is defined as “The ability of a system, community or society exposed to hazards, and/or climate change, to resist, absorb, accommodate, and recover from the consequences of a hazard event or of climate change in a timely and efficient manner. This includes through the preservation and restoration of its essential basic structures and functions.” This is the same definition that UNISDR uses in their terminology document⁷⁵⁵.

3.1.3. Pacific Regional Framework for Action 2005-2015: Building the resilience of nations and communities to disasters

The Pacific Regional Framework for Action adapted the Hyogo Framework for Action (HFA) to the Pacific region and was endorsed by Pacific leaders in October 2005. It develops an all hazards approach to disaster risk reduction and risk management, and focuses on increasing resilience to disasters.

The vision of the Regional Framework for Action is a “safer, more resilient Pacific island nations and communities to disasters, so that Pacific peoples may achieve sustainable livelihoods and lead free and worthwhile lives”⁷⁵⁶.

The mission of the Regional Framework for Action is to build capacity via the acceleration of implementation of disaster risk reduction and disaster management policies, by three main means:

- a) “development and strengthening of disaster risk reduction and disaster management, including mitigation, preparedness, response and relief/recovery systems;
- b) Integration of disaster risk reduction and disaster management into national sustainable development planning and decision-making processes at all levels; and

⁷⁵⁵ UNISDR (2009) Terminology on disaster risk reduction. *The United Nations Office for Disaster Risk Reduction*. Available at: <https://www.unisdr.org/we/inform/terminology>. Accessed: 15 April 2016.

⁷⁵⁶ SOPAC (2005). An Investment for Sustainable Development in the Pacific Island Countries, Disaster Risk Reduction and Disaster Management; A Framework for Action 2005 – 2015: Building the Resilience of Nations and Communities to Disasters.. SOPAC. Available at: http://www.preventionweb.net/files/34617_mr06131.pdf. Accessed: 4 January 2016.

International Survey

- c) Strengthening partnerships between all stakeholders in disaster risk reduction and disaster management⁷⁵⁶.”

It contains 6 themes, which are made up of guiding principles, expected outcomes, and key activities. Themes include governance; knowledge, information, public awareness and education; analysis and evaluation of hazards, vulnerabilities and elements at risk; etc.

While the word “resilience” is used multiple times throughout the Regional Framework for Action, no official definition of resilience is given.

The Framework states that “national government has the primary role in disaster risk reduction and disaster management⁷⁵⁶. However, it is a shared responsibility requiring effective partnership between all levels of government and other stakeholders⁷⁵⁶.”

3.1.3.1. Critical Infrastructure and Technical Resilience

There is no specific part of the Regional Framework for Action dealing exclusively with critical infrastructure resilience.

However, key activities in for technological resilience include:

- “Adopt and apply the Comprehensive Hazard and Risk Management (CHARM) process to assist decision making in disaster risk reduction and disaster management planning (*for more on CHARM, see FIJI*);
- Conduct hazard and vulnerability assessments and mapping at all levels, which will include the collection of required baseline data;
- Collect and analyse comprehensive data on the direct and indirect impacts of disasters on development in both the short and long-term;
- Research and compile statistical information and data on disaster risks and impacts including time series and cross-sectoral data at national and regional level;
- Strengthen technical and scientific capacity and resources to enhance data collection, collation, analysis, synthesis, dissemination, maintenance, data sharing, protocols, and E-networking;
- Upgrade or redesign existing national forecasting or early warning systems to cater for major hazards⁷⁵⁶.”

3.1.3.2. Organisational Resilience

Key activities include:

- “Integrate the management of economic, social and environment risks into national planning and budgetary processes;
- Coordinate and harmonise development partner assistance to ensure effective use of resources;
- Develop guidelines for appropriate indicators for monitoring and evaluating disaster risk reduction and disaster management activities at regional, national and local levels;
- Review and strengthen disaster management planning arrangements ensuring clearly-defined roles and responsibilities, and an integrated approach involving all stakeholders;
- Determine, establish and maintain effective and sustainable emergency communications systems;
- Establish a contingency stockpile of emergency relief items;
- Establish and/or strengthen institutional capacities to ensure early warning systems are integrated into governmental policies, decision-making processes and emergency management systems at both national and community levels⁷⁵⁶.”

3.1.3.3. Social Resilience

Key activities include:

- “Strengthen training programmes to enhance professional development in disaster risk reduction and disaster management amongst all stakeholders;
- Expand and focus public awareness and education programmes to enhance community resilience through community-driven approaches, initiatives and information sharing;
- Develop resources for, and delivery of, media-based public awareness and education programmes;
- Integrate traditional knowledge into information management systems;
- Develop and implement a comprehensive programme for community awareness and preparedness⁷⁵⁶.”

3.1.3.4. Economic Resilience

There are no economic resilience related key activities.

4 Case Studies

4.1. Australia

Australia is a country that is prone to disasters, especially to tropical cyclones, bushfires and droughts⁷⁵⁷. Climate change will make these types of events more frequent, more intense, and occur in areas previous unaffected⁷⁵⁷.

The Black Saturday bushfires took place in Victoria, Australia, around the 7 February 2009, and are considered to be Australia’s worst bushfires, due to extremely high temperatures and fast winds. The Black Saturday Bushfires resulted in the highest loss of human life to date, with 173 people dead and 414 injured⁷⁵⁸. After the fires, a Royal Commission was conducted in order to review the government’s bushfire strategy. The 2009 Victorian Bushfires Royal Commission Final Report⁷⁵⁹ established 67 recommendations and led to changes at local, state, and national levels. An updated fire rating system was introduced, urging residents to leave on high risk days⁷⁶⁰, which effectively modified the previously existing “stay and defend” policy.

Appendix A Case studies from the National Strategy for Disaster Resilience⁷⁶¹ provides 7 examples of resilience in the face of recent disasters. The first case study looks at the flood response measures taken in September 2010 in the rural city of Wangaratta. Due to the prediction of adverse weather, local authorities were placed on standby and flood preparations were put in place. More than 150 residents were contacted multiple times to not only assure their wellbeing but also to provide them with information. A review following the event demonstrated community leaders’ commitment to

⁷⁵⁷ Torrens Resilience Institute (2009). National Challenge. *Torrens Resilience Institute*. Available at: <http://www.torrensresilience.org/national-challenge>. Accessed: 21 October 2015.

⁷⁵⁸ Victoria Police (2009). Press conference: Bushfires death toll revised to 173. *Victoria Police*. Available at: http://www.police.vic.gov.au/content.asp?Document_ID=20350. Accessed: 17 December 2015.

⁷⁵⁹ Victorian Bushfires Royal Commission (2010). The 2009 Victorian Bushfires Royal Commission Final Report Summary. *Victorian Bushfires Royal Commission*. Available at: http://www.royalcommission.vic.gov.au/finaldocuments/summary/PF/VBRC_Summary_PF.pdf. Accessed: 17 December 2015.

⁷⁶⁰ Siebert, K. (2015). Black Saturday and Bush fires: Melbourne’s Living Lesson on Resilience. *100 Resilient Cities*. Available at: <http://www.100resilientcities.org/blog/entry/melbourne-black-saturday-resilience#/-/>. Accessed: 18 December 2015.

⁷⁶¹ Council of Australian Governments (2011). National Strategy for Disaster Resilience. . Available at: https://www.coag.gov.au/sites/default/files/national_strategy_disaster_resilience.pdf. Accessed: 18 December 2015.

International Survey

continuous improvement. This, as well as the high level of community understanding and participation, demonstrates how to build a more disaster resilient Australia.

Other case studies focused on the importance of clearly understanding risks and communicating information about risks in order to build a more resilient country. For example, the city of Clarence is at risk from erosion and flooding resulting from sea level rise. However, when the city learned that its residents were unaware of the potential impacts of such risks, the city, along with the Tasmanian State Emergency Service and Australian Government Department of Climate Change, undertook a preliminary assessment of the risks for 18 coastal locations around Clarence.

4.1.1. Concept of Resilience

The concept of resilience is an established concept used by the Australian government to deal with disasters and critical infrastructure. Resilience is a word used in many disciplines in Australia, from engineering to psychology, and is also employed by the government, emergency services and the media to describe how the nation is able to cope in the face of adversity, accommodating and adapting to unexpected catastrophic events⁷⁶². The Australian Government tends to focus on both disaster and critical infrastructure (CI) resilience, while also employing the word resilience to describe the desired state of the financial sector.

Disaster resilience is defined as the ability of government, communities, businesses and individuals to “prepare for, respond to, and manage potential hazards and disasters, thereby minimising impacts and rapidly recovering to emerge stronger and better able to cope with future disaster events⁷⁶³.” The Australian National Strategy for Disaster Resilience defines resilient communities, individuals and organisations as being able to function well while under stress, being able to successfully adapt, being self-reliant and socially capable.⁷⁶⁴

In order to achieve disaster resilience, Australia has developed a disaster resilience strategy, which focuses on enhanced partnerships, shared responsibility, understanding risks and disaster impacts, and an adaptive and empowered community.

The key finding of the Australian Government’s review of their Critical Infrastructure Protection Program, undertaken in 2007, was that the government should shift focus from protection to resilience. In 2008, the Prime Minister Kevin Rudd furthered this idea by using the word resilience three times in his first national security statement to parliament, stating that community and collective responsibility are what allow Australia to be resilient in the face of security threats⁷⁶⁵. Also in 2008, the Ministerial Council for Police and Emergency Management agreed that the future of emergency management in Australia should be based on achieving community and organisational resilience⁷⁶¹.

Then in 2009, the Council of Australian Governments (COAG) agreed to adopt a whole-of-nation, resilience-based approach to disaster management and the National Security Resilience Policy Division at the Attorney General’s Department was also created. In 2011, The National Strategy for

⁷⁶² Torrens Resilience Institute (2009). What is resilience? Available at: <http://www.torrensresilience.org/what-is-resilience>. Accessed: 21 October 2015.

⁷⁶³ Queensland Government (Udd.). Queensland Strategy for Disaster Resilience; to make Queensland the most disaster resilient State in Australia. *Queensland Government*. Available at: <http://www.dilgp.qld.gov.au/resources/plan/local-government/queensland-strategy-or-disaster-resilience.pdf>. Accessed: 26 October 2015.

⁷⁶⁴ Council of Australian Governments (2011). National Strategy for Disaster Resilience. *Council of Australian Governments*. Available at: https://www.coag.gov.au/sites/default/files/national_strategy_disaster_resilience.pdf. Accessed: 18 December 2015. P. 4.

⁷⁶⁵ ASPI (2014). Special Report, Working as one. A road map to disaster resilience for Australia.” October 2014. *Australian Strategic Policy Institute*. Available at: https://www.aspi.org.au/publications/working-as-one-a-road-map-to-disaster-resilience-for-australia/SR73_disaster_resilience2014.pdf. Accessed: 22 October 2015.

Disaster Resilience was adopted, providing high level guidance on disaster management and identifying seven priority outcomes to enhance disaster resilience⁷⁶⁵.

The Attorney-General launched the Australian Government's Critical Infrastructure Resilience (CIR) Strategy in 2010 and announced the establishment of the Resilience Expert Advisory Group (REAG)⁷⁷⁹. The CIR Strategy is expected to undergo a review in 2015, and REAG are in the process of creating a resilience maturity model⁷⁷⁹. The Critical Infrastructure Resilience Strategy: Plan was published in 2015, outlining core activities to be undertaken in order to achieve the objectives set out in the CIR Strategy⁷⁶⁶.

4.1.2. Institutional Framework for Delivering Resilience

Responsibility for resilience is considered a "shared responsibility" in Australia, meaning that there must be increased responsibility for all, including all levels of government (Australian, state, territory, and local), communities, individuals, households, the not-for-profit sector, and businesses⁷⁶¹.

In order to enhance the resilience of critical infrastructure, the Australian Government has partnered with owners and operators of critical infrastructure to develop a business-government partnership⁷⁶⁷. As such, the responsibility is seen as a team effort. The Trusted Information Sharing Network (TISN) was established in 2003 by the Australian government as part of the business-government partnership and is also responsible for resilience by providing an environment for information sharing⁷⁶⁷.

4.1.3. Critical Infrastructure and Technical Resilience

Concerning critical infrastructure specifically, Australia has defined resilience to mean "coordinated planning across sectors and networks; responsive, flexible and timely recovery measures; and the development of an organisational culture that has the ability to provide a minimum level of service during interruptions, emergencies and disasters, and return to full operations quickly"⁷⁶⁸. Furthermore, resilience allows for organisations to learn and adapt from an event⁷⁶⁸. The Australian government has therefore chosen to focus on organisational resilience in order to achieve critical infrastructure resilience and not technical resilience.

When further analysing the concept of critical infrastructure resilience, the distinction between the Critical Infrastructure Protection (CIP) and resilience (CIR) is made. At the national level, the concept of CIP is used only to describe actions or measures undertaken to mitigate the specific threat of terrorism. On the other hand, CIR is the term used to describe an all hazards approach to critical infrastructure and includes activities across the spectrum of prevention, preparedness, response and recovery, for all types of hazards, including natural disasters, pandemics, negligence, criminal activity, computer network attack and terrorism.⁷⁶⁹ It is further argued that "the application of protective security measures is not always the most appropriate nor feasible measure to mitigate risks. For example, it is not possible to protect every kilometre of linear assets such as pipelines or high voltage electricity transmission cables. Therefore, the all hazards approach to CIR requires an intelligence and information led, risk informed methodology, where the application of protective security measures is

⁷⁶⁶ Australian Commonwealth (2015). "Critical Infrastructure Resilience Strategy: Plan. *Australian Commonwealth*. Available at: <http://www.tisn.gov.au/Documents/CriticalInfrastructureResilienceStrategyPlan.PDF>. Accessed: 26 October 2015.

⁷⁶⁷ TISN for critical infrastructure resilience. "CIR: Whose responsibility is it?". Available at: <http://www.tisn.gov.au/Documents/CIR+-+Whose+Responsibility+is+it+-+Fact+Sheet.pdf>. Accessed: 26 October 2015.

⁷⁶⁸ Commonwealth of Australia (2010). Critical Infrastructure Resilience Strategy. *Commonwealth of Australia*. Available at: http://www.emergency.qld.gov.au/publications/pdf/Critical_Infrastructure_Resilience_Strategy.pdf. Accessed: 22 October 2015.

⁷⁶⁹ Australia-New Zealand Counter-Terrorism Committee (2015). National Guidelines for Protecting Critical Infrastructure from Terrorism. *National Security*. Available at: <https://www.nationalsecurity.gov.au/Media-and-publications/Publications/Documents/national-guidelines-protection-critical-infrastructure-from-terrorism.pdf>. Accessed: 18 April 2016. P. 3.

International Survey

regarded as contributing to a more complex and dynamic equation for adequately managing the risks to critical infrastructure”⁷⁷⁰.

In Australia critical infrastructure is defined as “those physical facilities, supply chains, information technologies and communication networks which, if destroyed, degraded or rendered unavailable for an extended period, would significantly impact the social or economic wellbeing of the nation or affect Australia’s ability to conduct national defence and ensure national security”⁷⁶⁹. The Australian Government has produced the *Critical Infrastructure Protection Risk Management Framework for the Identification and Prioritisation of Critical Infrastructure*. This Framework identifies and prioritises critical infrastructure in terms of criticality from a national perspective and places it in one of the five categories: vital, major, significant, low, unknown.

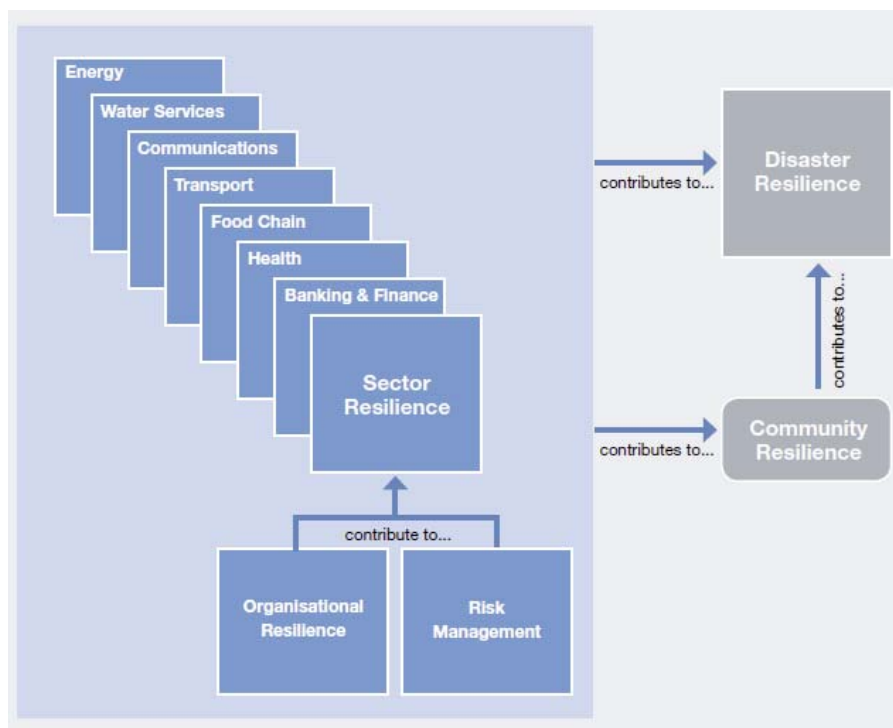


Figure 4.1 Relationship between Critical Infrastructure Resilience, Disaster Resilience and Community Resilience⁷⁷¹

While there does not seem to be many official documents, guidelines, training etc. dedicated solely to technical resilience, aspects of technical resilience are mentioned in regards to other types of resilience. For example, the National Strategy for Disaster Resilience describes a disaster resilient community as using resilience-based emergency management plans, having businesses and other service providers undertake wide-reaching business continuity planning, and using land use planning systems and building control arrangements to reduce community exposure to unreasonable risks⁷⁶¹. However it does not go into details on how to implement the technical resilience strategies.

⁷⁷⁰ Commonwealth of Australia (2010). Critical Infrastructure Resilience Strategy. *Commonwealth of Australia*. Available at: http://www.emergency.qld.gov.au/publications/pdf/Critical_Infrastructure_Resilience_Strategy.pdf. Accessed: 18 April 2016. P. 12.

⁷⁷¹ Commonwealth of Australia (2010). Critical Infrastructure Resilience Strategy. *Commonwealth of Australia*. Available at: http://www.emergency.qld.gov.au/publications/pdf/Critical_Infrastructure_Resilience_Strategy.pdf. Accessed: 18 April 2016. P. 10.

Reducing risks in the built environment is also covered by the National Strategy for Disaster Resilience, but once again does not go into details on how to achieve resilience. Instead it emphasizes using planning approaches such as responsible land use planning policies, development design, and building standards that adequately mitigate identified risks⁷⁶¹.

As part of the Implementation Plan of the National Strategy for Disaster Resilience, the National Review of Land Use Planning and Buildings Codes project was established in order to “enhance disaster resilience in the built environment by establishing a common understanding of land use planning and building polices, regulations and codes across Australia” and their roadmap to enhancing disaster resilience in the built environment was published in 2012⁷⁷². It focused on seven priority areas: technology, legislation and policy, processes, governance, education, vendor disclosure, and inter-jurisdictional collaboration⁷⁷².

In 2013, the Australian Sustainable Built Environment Council developed the following ten point framework⁷⁷³ to improve resilience and deliver comprehensive adaptation strategies:

1. Engage with industry;
2. Lead by example;
3. Sponsor applied research;
4. Provide better access to information and tools;
5. Invest in education;
6. Provide incentives;
7. Reform and improve regulation;
8. Review building codes and standards;
9. Improve planning systems and outcomes;
10. Improve insurance and financial services.

The Australian Government takes a non-regulatory approach to critical infrastructure. Based on this approach, the owners and operators of critical infrastructure are best in place to manage risks to their operations and determine the most effective mitigation strategies. Australia has generally rather loose regulations regarding critical infrastructure as the identification of minimum security benchmarks or regulations across industry can be rather difficult, even within specific sectors.⁷⁷⁴

Australia has also a tool aimed at evaluating critical infrastructure resilience in the country. The Critical Infrastructure Protection Modelling and Analysis (CIPMA) is part of the Australian Government’s Critical Infrastructure Resilience Strategy and is identified as a key component in the Australian Government’s plans to improve the security of the country’s critical infrastructure. Although resilience is not among the main targets of the program, it is implicitly included through the investment to mitigation strategies. Furthermore, according to the developers of this tool, the aim is to assist recovery therefore resilience is partially assessed⁷⁷⁵. The CIPMA program aims to improve an insight into the effects, in terms of service disruption, of natural or human-sourced disasters⁷⁷⁶. The

⁷⁷² National Emergency Management Committee Land Use Planning and Building Codes Taskforce (2012). Enhancing Disaster Resilience in the Built Environment Roadmap. *Plandevbs*. Available at: <http://www.plandevbs.com.au/wp-content/uploads/2012/11/Roadmap-LUPBCT-Disaster-Resilience-FINAL.pdf>. Accessed: 27 October 2015.

⁷⁷³ ASBEC (2013). 2013: A Sustainable and Resilient Built Environment. *Australian Sustainable Built Environment Council*. Available at: <http://www.asbec.asn.au/wordpress/wp-content/uploads/2013/07/130628-ASBEC-Policies-for-a-Sustainable-Built-Environment-Final.pdf>. Accessed: 27 October 2015.

⁷⁷⁴ Commonwealth of Australia (2010). Critical Infrastructure Resilience Strategy. *Commonwealth of Australia*. Available at: http://www.emergency.qld.gov.au/publications/pdf/Critical_Infrastructure_Resilience_Strategy.pdf. Accessed: 18 April 2016. P. 14.

⁷⁷⁵ Giannopoulos, G., Filippini, R. et al. (2012). Risk assessment methodologies for Critical Infrastructure Protection. *Joint Research Center*. Available at: http://ec.europa.eu/home-affairs/doc_centre/terrorism/docs/RA-ver2.pdf. Accessed: 20 May 2016.

⁷⁷⁶ Buxton, R. (2013). Critical Infrastructure Interdependency modelling, a comparison of approaches used by CIPMA, SMART and GNS Science. *GNS Science*. Available at: http://www.gns.cri.nz/static/pubs/2013/SR_2013-036.pdf. Accessed: 20 May 2016.

International Survey

outcome of this program is a software tool that combines simulation models, databases, GIS and economic models. CIPMA is restricted to a rather limited range of critical infrastructure sectors, namely Energy, Telecommunications, Banking and Finance. Geographic Information System (GIS) functionality is at the core of CIPMA⁷⁷⁵. GIS is used for data gathering, modelling, and visualisation of the results. The methodology is focused on four main areas:

- CI failure consequences: Economy and population consequences with GIS visualisation of the results, duration of failure, dynamics of critical infrastructure systems;
- Single points of failure: Identification of particularly vulnerable points that can trigger important cascading effects;
- Risks: Elaboration of risk maps;
- Investment and mitigation strategies.

It is intended that CIPMA should provide guidance on helping to avoid failures, with preparedness and planning as well as aid in recovery from disasters. It should be noted that when the CIPMA team undertake a program of study, each case is treated separately. There is no standard format that would be applicable for all the cases; rather each is tailored to the purposes of the project (Buxton 2013, 15). The information needed for modelling and analysis is elicited via workshops.

The Australian Government also puts an emphasis on cyber resilience. In 2009 it launched its inaugural Cyber Security Strategy, with the explicit aim of maintaining resilient, secure and trusted electronic operating environment that supports country's national security and maximises the benefits of the digital economy.⁷⁷⁷ However the Strategy does not provide the definition of cyber resilience.⁷⁷⁸

4.1.4. Organisational Resilience

As it was already mentioned, the Australian government has chosen to focus on organisational resilience in order to achieve critical infrastructure resilience as resilience "is seen as an outcome and a fundamental part of the governance of an organisation"⁷⁷⁹. Resilience helps manage unexpected risks, or risks never experienced before by an organisation, and as such said risks are not part of formal risk management processes or business continuity exercises previously used by organisations⁷⁷⁹. According to the Critical Infrastructure Resilience Strategy, "the Australian Government approach to CIR goes beyond risk management and business continuity planning [...] to also address hazards and risks that are unforeseen or unexpected. The resilience approach builds capacity within organisations to not only effectively respond to a crisis, but also be able to learn and adapt from an event"⁷⁸⁰. It is further argued that CIR is achieved undertaking traditional risk management/business continuity practices and organisational resilience initiatives.

Organisational resilience is defined as ability of organisations to absorb event that necessitates change, adapt and continue to maintain competitive edge and profitability.⁷⁸¹ Information sharing is considered to be of key importance to achieving CIR. It is necessary 'to partner with owners and operators to

⁷⁷⁷ Australian Government (2015). The Australian Government's Critical Infrastructure Resilience Strategy: Plan. *Australian Government*. Available at: <http://www.tisn.gov.au/Documents/CriticalInfrastructureResilienceStrategyPlan.doc> Accessed: 18 April 2016. P. 20.

⁷⁷⁸ Australian Government (2009). "Cyber Security Strategy. *Australian Government*. Available at: <https://www.ag.gov.au/RightsAndProtections/CyberSecurity/Documents/AG%20Cyber%20Security%20Strategy%20-%20for%20website.pdf>. Accessed: 18 April 2016.

⁷⁷⁹ Australian Government (2011). Organisational resilience: a position paper for critical infrastructure. *Australian Government*. Available at: <http://www.organisationalresilience.gov.au/resources/Documents/organisational-resilience-position-paper-for-critical-infrastructure-australian-case-studies.pdf>. Accessed: 22 October 2015.

⁷⁸⁰ Commonwealth of Australia (2010). Critical Infrastructure Resilience Strategy. *Commonwealth of Australia*. Available at: http://www.emergency.qld.gov.au/publications/pdf/Critical_Infrastructure_Resilience_Strategy.pdf. Accessed: 18 April 2016. P. 13.

⁷⁸¹ Ibid. P. 18.

share information, raise the awareness of dependencies and vulnerabilities, and facilitate collaboration to address any impediments” via the creation of the Trusted Information Sharing Network (TISN)⁷⁶⁸. The TISN was established by the Australian Government in 2003 and provides a secure environment in which critical infrastructure owners and operators across seven sector groups meet regularly to share information and cooperate within and across sectors to address security and business continuity challenges.⁷⁸² The Trusted Information Sharing Network for Critical Infrastructure Protection defines resilient organisations as organisations which are able to “continue meeting key objectives when faced with significantly challenging circumstances in their operating context/environment”⁷⁸³.

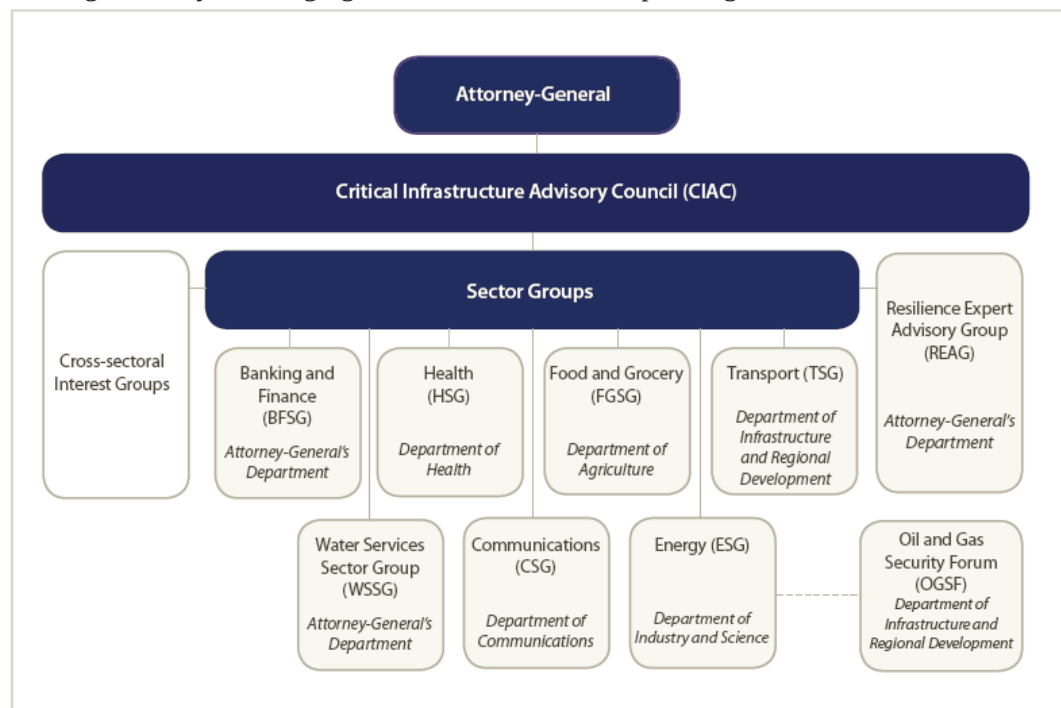


Figure 4.2 Governance structure for the TISN.⁷⁸²

The CIR Strategy lays out the following aims and objectives:⁷⁶⁸

- “operate an effective business-government partnership with critical infrastructure owners and operators;
- develop and promote an organisational resilience body of knowledge and a common understanding of organisational resilience;
- assist owners and operators of critical infrastructure to identify, analyse and manage cross-sectoral dependencies;
- provide timely and high quality policy advice on issues relating to critical infrastructure resilience
- implement the Australian Government’s Cyber Security Strategy to maintain a secure, resilient and trusted electronic operating environment, including for critical infrastructure owners and operators; and
- support the critical infrastructure resilience programs delivered by Australian States and Territories, as agreed and as appropriate.”

⁷⁸² Australian Government (2015). The Australian Government’s Critical Infrastructure Resilience Strategy: Plan *Australian Government*. Available at: <http://www.tisn.gov.au/Documents/CriticalInfrastructureResilienceStrategyPlan.doc>. Accessed: 18 April 2016. P. 2.

⁷⁸³ Trusted information Sharing Network for Critical Infrastructure Protection, Resilience Community of Interest (2008) Executive guide: Resilience. Available at: <http://www.tisn.gov.au/Documents/Executive+Guide+to+Resilience+final.pdf>. Accessed: 26 October 2015.

International Survey

It is further argued that the success of the Strategy will be measures by: ⁷⁶⁸

- “effective engagement between governments and industry, both within and outside the TISN, for the exchange of information and intelligence, and the development solutions to relevant security issues, on a sectoral and cross-sectoral basis;
- Sector Groups being well supported by government and responsive to changes in the environment, individually and collectively;
- business and governments collaborating to develop and promote best practice in CIR and resilience capabilities being integrated into everyday business activities;
- the need for investment in resilient, robust infrastructure being considered in market regulation decisions;
- business and governments collaborating to identify key cross-sectoral dependencies and vulnerabilities with respect to both cyber and physical infrastructure;
- business and governments collaborating to progress national research and development in CIR;
- a positive and robust relationship between the different levels of government on CIR, and a level of national consistency and coordination while also supporting the different approaches of governments;
- CIR issues and implications for owners and operators of critical infrastructure being considered in Australian Government policy development processes;
- lessons from exercise activities and real life events being propagated to all Sector Groups to enhance organisations’ understanding of resilience and improve planning arrangements;
- owners and operators being integrated into the implementation of the Cyber Security Strategy and having useful engagement with CERT Australia, and
- Australian Government international engagement being coordinated with updates being provided to NCIRC as required”.

The Organisation Resilience Position Paper acknowledges that resilience is not a one off program or management system but is an approach to assist organisations in “effectively managing adverse/disruptive situations and capture or realise any presenting opportunities⁷⁷⁹.” The paper also sets out the following five core resilience principals:

- Resilience needs to be defined not only as an ability to “bounce back” from disaster, but also as an ability to “bounce forward” – i.e. creating positive change after the disaster;
- Resilience is dynamic and emerges from the complex interaction between a wide range of organisational attributes;
- Diversity in CI organisations means that different mixes of resilience attributes may be needed to achieve optimal resiliency. This mix is best determined by CI operators and owners;
- An all hazards, all threats approach better prepares for unforeseen events;
- Resilience in mature organisational systems may require a cultural change and active strategies to develop and foster resilience attributes may be necessary.

Furthermore, three overarching behavioural attributes of resilience are also identified; leadership and culture (organisational culture of enthusiasm for challenge, flexibility, adaptive capacity, innovation and taking opportunity; promotion of the commitment to resilience; empowerment of employees), networks (understanding of community interconnectedness and vulnerabilities; encouraging open communication; and establishing relationships and mutual aid arrangements), and change ready (proactive anticipation and preparation for future challenges; development of a forewarning of disruption threats and their effects through sourcing a diversity of views, increasing sensitivity and alertness, and understanding social vulnerability; promotion of critical reflective learning, lesson retention, knowledge sharing and continuous improvement)⁷⁷⁹.

Another resilience strategy developed in the position paper is that of protection, performance and adaptation, whereby protection is defined by robust systems, performance is defined by getting things

right the first time and moving quickly to correct any errors, and adaptation is defined as demanding a change in the business focus, structure and processes when circumstances change⁷⁷⁹.

The Australian Government's Organisational Resilience website⁷⁸⁴ offers an **Organisational Resilience Health Check**, which allows for the development of a shared understanding of the organisation's progress towards resilience and identifies possible treatment actions and inhibitors. It uses **13 indicators** divided between the three behavioural attributes to evaluate resilience. They are: leadership, employee engagement, situational awareness, decision making, innovation and creativity, effective partnerships, leveraging knowledge, breaking silos, internal resources, unity of purpose, proactive posture, planning strategies, and stress testing plans.⁷⁸⁵

Indicator	Low resilience indicator	ANSWER				High resilience indicator	Your score	Possible max score	
		Low 1234 High							
Leadership and culture attribute									
Strong leadership to provide good management and decision making during times of challenge and adversity, as well as continuous evaluation of strategies and work programs against organisational goals.									
1.1 Leadership	L1	Leaders display behaviours fearful of adversity					Leaders display decisive leadership, innovation and seek opportunity, including in times of adversity	0	28
	L2	Leaders do not 'walk the talk' nor demonstrate behaviours aligned with the organisation's values					Leaders 'walk the talk' and demonstrate behaviours aligned to the values of the organisation		
	L3	Leaders are reactive and act under duress					Leaders are balanced and strategically focussed to ensure the organisation is acting with control and foresight		
	L4	Leaders are compliance driven, process focused					Leaders are outcome driven / results focused		
	L5	Leaders are oblivious to the needs of people working below them					Leaders care for the wellbeing of their people and their ability to thrive in times of adversity		
	L6	Leaders are afraid or unwilling to make decisions without permission from senior management					Leaders are empowered to make decisions and are supported in doing so by senior management		
	L7	Lack of visible executive and management buy-in to the need for resilience					Highly visible executive/senior management resilience champions and leader advocacy of the resilience agenda		

Figure 4.3 Organisational Resilience HealthCheck online tool.⁷⁸⁶

4.1.5. Social Resilience

The National Strategy for Disaster Resilience describes disaster resilient communities as communities where:⁷⁶¹

- People understand the risks that may affect them and others in their community and they take action to prepare for disasters and are adaptive and flexible to respond appropriately during emergencies;

⁷⁸⁴ See: <http://www.organisationalresilience.gov.au/>.

⁷⁸⁵ A detailed description of the indicators is provided in the section analysing organisational resilience in New Zealand (see the next case study). Also see <http://www.organisationalresilience.gov.au/HealthCheck/Pages/default.aspx#> for the questionnaire of the tool.

⁷⁸⁶ Organisational Resilience HealthCheck tool is available at: <http://www.organisationalresilience.gov.au/HealthCheck/Pages/default.aspx#>.

International Survey

- People have taken steps to anticipate disasters and to protect themselves, their assets, and their livelihoods;
- People work together with local leaders, using their knowledge and resources to prepare for and deal with disasters, and use existing community networks. Strong social networks that offer support to individuals and families in a time of crisis lead to resilient communities;
- Work in partnership with emergency services;
- The emergency management volunteer sector is strong;
- Businesses have wide reaching business continuity planning;
- Land use planning reduces community exposure to known hazards;
- And people understand the mechanisms and processes through which recovery assistance may be made available and they appreciate that support is designed to be offered in the first instance to the most vulnerable community members.

The National Strategy for Disaster Resilience also notes the importance of community engagement, defined as the “process of stakeholders working together to build resilience through collaborative action, shared capacity building and the development of strong relationships built on mutual trust and respect,” and a separate Community Engagement Framework was published in 2013 by the Australian Emergency Management Institute (part of the Commonwealth Attorney-General’s Department) as part of the implementation of the National Strategy for Disaster Resilience.⁷⁶¹

Common characteristics of resilient communities are: individuals and organisations functioning well while under stress; successful adaptation; self-reliance; and social capacity⁷⁷⁹.

The Community Engagement Framework “focuses on strengthening existing social networks and assets fundamental to community resilience⁷⁸⁷” and sets out the following three fundamental principles for community engagement in the emergency management context:

- Understand the community (its capacity, strengths and priorities);
- Recognise complexity;
- Partner with the community to support existing networks and resources.

It acknowledges that building partnerships between community and emergency management agencies and organisations requires long-term commitment.

Framework also incorporates a Community Engagement Model for Emergency Management (Figure 4.4), which “makes clear that for all types of engagement it is essential to be guided by community engagement principles, to understand the broader context of the engagement, and have a clear purpose for engaging the community in the first place⁷⁸⁷.”

⁷⁸⁷ Australian Emergency Management Institute part of the Commonwealth Attorney-General’s Department (2013). Community engagement Framework. *Australian Emergency Management*. Available at: <https://www.ag.gov.au/EmergencyManagement/Tools-and-resources/Publications/Documents/Handbook-series/handbook-6-community-engagement-framework.pdf>. Accessed 27 October 2015.

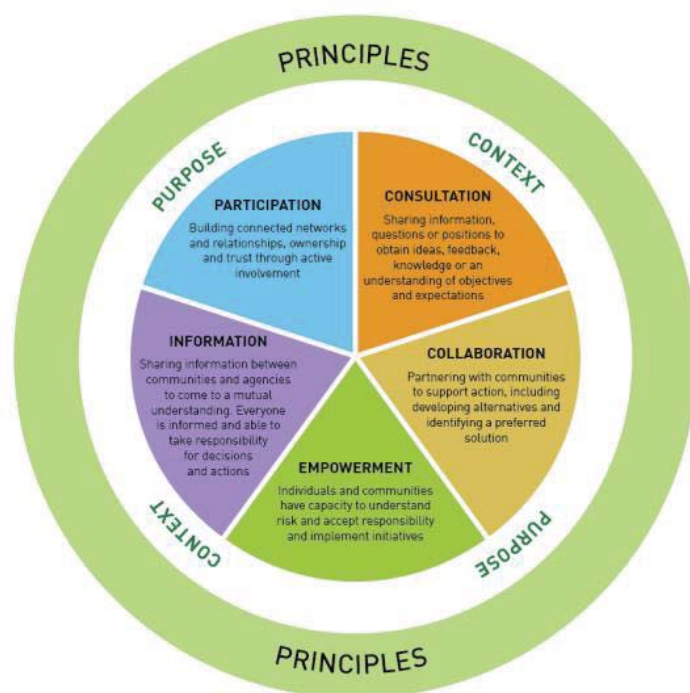


Figure 4.4 Community Engagement Model for Emergency Management.

4.1.6. Economic Resilience

The Australian Treasury also uses the word resilience to describe the financial sector. They define resilience as “the financial system’s capacity to adjust to both the normal business cycle and a severe economic shock. A resilient system does not preclude failure, nor necessarily imply price stability. Rather, a resilient system can adjust to changing circumstances while continuing to provide core economic functions, even during severe but plausible shocks. In a resilient system, individual institutions in distress should be resolvable with minimal costs to depositors, policy holders, taxpayers and the real economy⁷⁸⁸.”

The fact that the Australian economy performed better than other advanced economies during the global financial crisis is attributed to its already existing resilience, thanks to a strong Commonwealth fiscal position, effective monetary policy, ongoing demand for commodity exports and a prudent and well-managed financial system⁷⁸⁸. The Australian government, however, is still using the global financial crisis as a jumping off point to examine why Australia’s economy is more resilient and ways in which to improve it.

In the Financial System Inquiry undertaken by the Australian Government Treasury, principles and recommendations are laid out in order to maintain and increase the financial system’s resilience to institutional failure. It also underlines the fact that the “Australian community depends on the financial system being able to continue to provide its core economic functions, even in times of financial stress⁷⁸⁸.”

The following nine principles should be followed to ensure future policy is at least as if not more resilient than current policy:

⁷⁸⁸ The Australian Government the Treasury (2014). Financial System inquiry Final Report. *The Australian Government the Treasury*. Available at: http://fsi.gov.au/files/2014/12/FSI_Final_Report_Consolidated20141210.pdf. Accessed: 27 October 2015.

International Survey

1. Responsibility for sound governance, robust risk management and adequate financial soundness rests primarily with a financial institution's management and its board. Financial institutions have a responsibility to operate with integrity to build and protect trust and confidence in the financial system;
2. Minimising the risk of instability, or its impact where unavoidable, is a worthwhile investment;
3. Government should not generally guarantee the ongoing solvency and operations of individual financial institutions;
4. System stability should be promoted while giving due regard to the importance of balancing potential reductions in competition and efficiency. Where possible, regulation should be risk-based;
5. In implanting regulation, Australia should build on global frameworks while reflecting features of the Australian system;
6. The CFR has a shared responsibility for the stability of the financial system and monitoring system risks, while the member regulators retain ultimate responsibility and accountability for their respective mandates.

The Financial System Inquiry then lays out the following eight recommendations:

1. Capital levels: set capital standards such that Australian authorised deposit-taking institution capital ratios are unquestionably strong;
2. Narrow mortgage risk weight differences: Raise the average internal ratings-based IRB mortgage risk weight to narrow the difference between average mortgage risk weights for authorised deposit-taking institutions using IRB risk-weight models and those using standardised risk weights;
3. Loss absorbing and recapitalisation capacity: implement a framework for minimum loss absorbing and recapitalisation capacity in line with emerging international practice, sufficient to facilitate orderly resolution of Australian authorised deposit-taking institutions and minimise taxpayer support;
4. Transparent reporting: Develop a reporting template for Australian authorised deposit-taking institution capital ratios that is transparent against the minimum Basel capital framework;
5. Crisis management toolkit: Complete the existing processes for strengthening crisis management powers that have been on hold pending the outcome of the Inquiry;
6. Financial Claims Scheme: Maintain the ex post funding structure of the Financial Claims Scheme for authorised deposit-taking institutions;
7. Leverage ratio: Introduce a leverage ratio that acts as a backstop to authorised deposit-taking institutions' risk-weighted capital positions;
8. Direct borrowing by superannuation funds: Remove the exception to the general prohibition on direct borrowing for limited recourse borrowing arrangements by superannuation funds.

The Australian Bureau of Statistics measures the resilience of the Australian economy over time. They use multifactor productivity, which measures growth in output relative to the growth in inputs, as their headline progress indicator for a resilient economy as “an economy with a lower level of productivity is less capable at withstanding and recovering from economic downturns⁷⁸⁹.”

Other indicators used are flexibility, measured by the average duration of unemployment, stability, measured by consumer price index, and prudent finance measured by total capital base ratio.

⁷⁸⁹ The Australian Bureau of Statistics (2013). Measures of Australia's Progress, 2013 - A resilient economy. *The Australian Bureau of Statistics*. Available at: <http://www.abs.gov.au/ausstats/abs@.nsf/Lookup/1370.0main+features382013>. Accessed: 27 October 2015.

4.1.7. Resilience Related Official Documents

National level:

- Australian Government. Executive guide: Resilience. July 2008. Available at: <http://www.tisn.gov.au/Documents/Executive+Guide+to+Resilience+final.pdf>;
- Australian Government. 2010. Critical Infrastructure Resilience Strategy. Available at: http://www.emergency.qld.gov.au/publications/pdf/Critical_Infrastructure_Resilience_Strategy.pdf
- Australian Government. 2011. National Strategy for Disaster Resilience, building our nation's resilience to disasters. Available at: https://www.coag.gov.au/sites/default/files/national_strategy_disaster_resilience.pdf;
- Australian Government. 2011. Organisational resilience: a position paper for critical infrastructure. Available at: <http://www.organisationalresilience.gov.au/resources/Documents/organisational-resilience-position-paper-for-critical-infrastructure-australian-case-studies.pdf>;
- Australian Government. 2012. National Strategy for Disaster Resilience companion Booklet. Available at: http://www.ses.tas.gov.au/assets/files/EM%20Publications/disaster_resilience/NationalStrategyforDisasterResilience-CompanionBooklet.pdf;
- Australian Government. 2013. National Strategy for Disaster Resilience Community Engagement Framework. Available at: http://www.ses.tas.gov.au/assets/files/EM%20Publications/disaster_resilience/National%20Strategy%20for%20Disaster%20Resilience%20Community%20Engagement%20Framework.pdf;
- The Australian Government the Treasury. Financial System inquiry Final Report. November 2014. Available at: http://fsi.gov.au/files/2014/12/FSI_Final_Report_Consolidated20141210.pdf.
- CIR: Whose responsibility is it? Available at: <http://www.tisn.gov.au/Documents/CIR+-+Whose+Responsibility+is+it+-+Fact+Sheet.pdf>.

State level:

Victoria

- Ministerial Guidelines for Critical Infrastructure Resilience. 2015. Available at: <http://fire-com-live-wp.s3.amazonaws.com/wp-content/uploads/Ministerial-Guidelines-for-Critical-Infrastructure-Resilience1.pdf>;
- Critical Infrastructure Resilience Strategy. July 2015. Available at: http://fire-com-live-wp.s3.amazonaws.com/wp-content/uploads/EMV-CIRS_Web1.pdf.

Queensland

- Queensland Resilience Index. <https://data.qld.gov.au/dataset/queensland-resilience-index>;
- Rebuilding a stronger, more resilient Queensland. <http://qldreconstruction.org.au/u/lib/cms2/rebuilding-resilient-qld-full.pdf>;
- Queensland Strategy for Disaster Resilience <http://www.dilgp.qld.gov.au/resources/plan/local-government/queensland-strategy-or-disaster-resilience.pdf>.

South Australia

- Resilient South Regional Climate Change Adaptation Plan. <http://onkaparingacity.com/public/download.jsp?id=64891>.

4.2. New Zealand

New Zealand is frequently shaken by earthquakes, and some have caused major damage and deaths. Other hazards, identified in the National Civil defence Emergency Management plan, are volcanic hazards, landslides, tsunamis, floods, severe winds, wild fires, droughts, animal and plant pests and diseases, food safety incidents and terrorism.

In 2011, a 6.3 magnitude earthquake struck 10 km south-east of central Christchurch at a depth of only 5 km. The death toll was 185, making it New Zealand's worst natural disaster in terms of loss of life since 1931. The earthquake brought down many buildings that had been damaged in an earlier earthquake in September 2010, especially older brick and mortar buildings. Many heritage buildings were heavily damaged, including the Provincial Council Chambers, Lyttelton's Timeball Station, and both the Anglican Christchurch Cathedral and the Catholic Cathedral of the Blessed Sacrament. Among the modern buildings irrevocably damaged was Christchurch's tallest building, the Hotel Grand Chancellor. More than half of the buildings in the central business district have had to be demolished.

The government immediately activated its National Crisis Management Centre, and a national state of emergency was declared the day after the quake. Christchurch's central business district, the worst affected part of the city, was quickly cordoned off. Electricity was restored to 75% of the city within three days, this was largely possible as a result of upgrades to the power grid which had been undertaken in the preceding decade, but re-establishing water supplies and sewerage systems took much longer. In order to recover sewage systems to some functional level, some 35 000 portable toilets provided relief to residents⁷⁹⁰. Many of these came from as far afield as Australia⁷⁹¹ or the USA⁷⁹².

The cordon around the central business district was progressively reduced over the next two years but not completely removed until June 2013. It is expected to take several years to completely restore the city's electricity and water networks to pre-earthquake standards. Many areas in the condemned 'Red Zone' will not have services restored to this standard, but temporary repairs have been made while residents remain.⁷⁹³

4.2.1. Concept of Resilience

Resilience is a well-established and developed concept in New Zealand, largely as a result of and in response to the ever present earthquake hazard which the country is exposed to. Each of the regions in New Zealand has a lifelines group, with responsibility for critical infrastructure protection and these report their own, not incompatible, definitions of resilience. Some of these are listed below.

Resilient: Able to effectively respond to and recover from an emergency event and return to pre-event conditions or better.⁷⁹⁴

⁷⁹⁰ The New Zealand Herald (2014). Last chemical toilet removed from Christchurch. *The New Zealand Herald*. Available at: http://www.nzherald.co.nz/nz/news/article.cfm?c_id=1&objectid=11193564. Accessed: 20 August 2015.

⁷⁹¹ Potangaroa, R., Wilkinson, S. et al. (2011). The management of portable toilets in the eastern suburbs of Christchurch after the February 22, 2011 earthquake. *Australasian Journal of Disaster and Trauma Studies*. P. 35–48.

⁷⁹² The New Zealand Herald (2011). Christchurch earthquake: Many face weeks of temporary toilets. *The New Zealand Herald*. Available at: http://www.nzherald.co.nz/nz/news/article.cfm?c_id=1&objectid=10710263. Accessed: 20 August 2015.

⁷⁹³ New Zealand History (2011). Christchurch earthquake kills 185. *The New Zealand Herald*. Available at: <http://www.nzhistory.net.nz/page/christchurch-earthquake-kills-185>. Accessed: 19 April 2016.

⁷⁹⁴ Wellington Region Emergency Management Group (2013). Wellington Region Civil Defence Emergency Management Group Plan 2013-2018. *Wellington Region Emergency Management Group*. Available at: <http://www.getprepared.org.nz/sites/default/files/uploads/2013%20-%202018%20Group%20Plan.pdf>. Accessed: 19 April 2016.

Resilience is how we withstand, adapt and ‘bounce back’ in response to a disaster. A resilient community is one which expects and is well prepared for an adverse event; they can cope well with the disruption and recover quickly. Everyone has a role to play in creating a resilient community.⁷⁹⁵

Resilience is an “adaptive capacity” — that is, society’s capability to draw on its individual, collective and institutional resources and competencies to cope with, adapt to and develop from the demands, challenges and changes encountered before, during and after a disaster.⁷⁹⁶

Community resilience is the capability to anticipate risk, limit impact, and bounce back rapidly through survival, adaptability, evolution, and growth in the face of turbulent change. This is consistent with WREMO’s vision statement: A resilient community, ready and capable.⁷⁹⁷

In addition to this, the ResOrgs project defines resilient organisations:

Resilient organisations are those that are able to not only survive, but thrive in this world of uncertainty. Resilience integrates the concepts of Risk, Crisis Management, Business Continuity Planning, and Organisational Leadership to provide a platform for developing more robust and agile organisations.⁷⁹⁸

Concerning critical infrastructure, locally called Lifelines, these are defined in the Civil defence Emergency Management (CDEM) Act 2002⁷⁹⁹ as essential infrastructure and services that support the life of [the] community. In New Zealand, Lifeline groups have been in existence and coordinating regional activity in reducing vulnerability to emergencies since the early 1990’s with the first project based in Wellington in 1991⁸⁰⁰, with national activity since 1999. There is an excellent summary of the impetus for the work and the work undertaken in it⁸⁰¹.

Regional lifelines groups exist in most of the regions of New Zealand and national activity between these groups is coordinated by the New Zealand Lifelines Committee, a group of 9 organisations which represent different national infrastructure sectors; including transportation, power, and business; and government agencies⁸⁰².

The Auckland Engineering Lifelines Group, as an example, has a definition of significance levels for incidents which could negatively affect their lifelines (see Figure 4.5).

⁷⁹⁵ Hawke’s Bay Emergency Management Group (2014). Hawke’s Bay Civil Defence Emergency Management Group Plan 2014-2019. *Wellington Region Emergency Management Group*. Available at: <http://www.hbemergency.govt.nz/assets/Documents/Operative-HBCDEM-Group-Plan-as-at-20-June-2014.pdf>. Accessed: 19 April 2016.

⁷⁹⁶ Emergency Management Canterbury (2014). Canterbury Civil Defence Emergency Management Group plan. *Emergency Management Canterbury*. Available at: <http://ecan.govt.nz/publications/General/cdem-group-plan.pdf>. Accessed: 19 April 2016.

⁷⁹⁷ Wellington Region Emergency Management Office (2012). Community Resilience Strategy. *Wellington Region Emergency Management Office*. Available at: <http://www.getprepared.org.nz/sites/default/files/uploads/WREMO%20Community%20Resilience%20Strategy%202nd%20edition.pdf>. Accessed: 19 April 2016.

⁷⁹⁸ Resilient Organizations. Available at: <http://www.resorgs.org.nz/>. Accessed: 2 February 2016.

⁷⁹⁹ Parliamentary counsel office New Zealand Legislation (2002). Civil Defense Emergency Management Act 2002. *Parliamentary counsel office New Zealand Legislation*. Available at: <http://www.legislation.govt.nz/act/public/2002/0033/latest/DLM149789.html>. Accessed: 19 April 2016.

⁸⁰⁰ Hopkins, D. C., Lumsden, J. L. et al. (1993). Lifelines in earthquakes-a case study based on Wellington. *Bulletin of the New Zealand National Society for Earthquake Engineering*. P. 208-221.

⁸⁰¹ Brunsdon, David; Seville, Erica; Vargo, John; Resilient New Zealand; Think outside the risk; Aon benfields hazards conference, 22 – 24 September 2013

⁸⁰² NZLC (Udd.). NZLC Lifelines brochure. *The New Zealand Lifelines committee*. Available at: <http://www.civildefence.govt.nz/assets/Uploads/publications/nzlc-brochure.pdf>. Accessed: 19 April 2016.

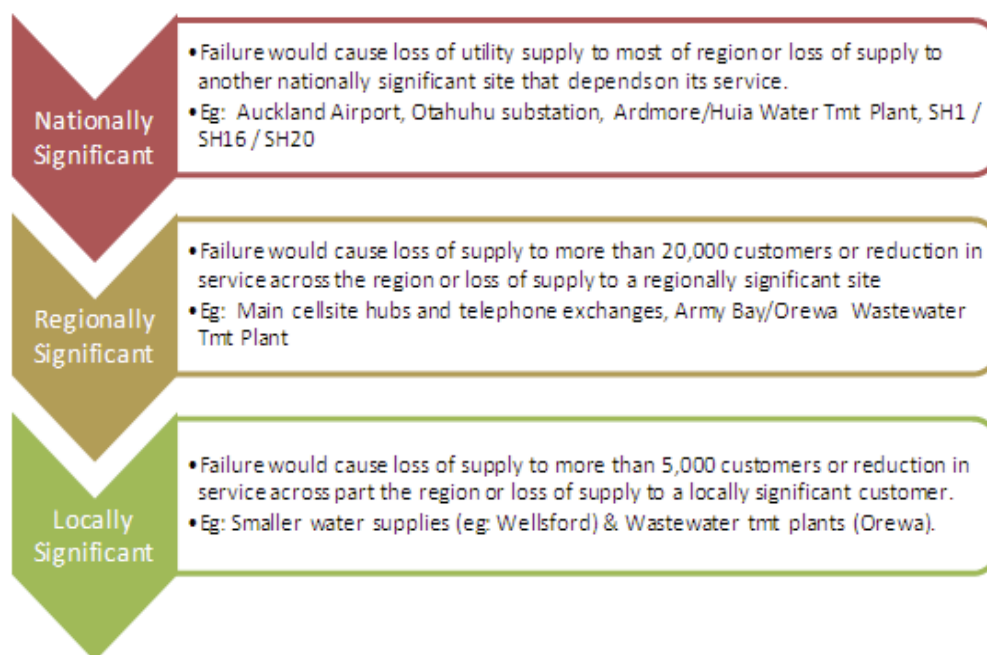


Figure 4.5 Auckland Engineering Lifelines Group Significance Levels.⁸⁰³

4.2.2. Institutional Framework for Delivering Resilience

New Zealand's Civil Defence Emergency Management (CDEM) arrangements are everybody's responsibility, and the National CDEM strategy is a strategy for all New Zealanders.

The Strategy provides an overarching framework for CDEM planning in New Zealand. It is supported by the National CDEM Plan, and CDEM group, business, community and individual plans. Work plan (action) items, including targets, are incorporated in these plans where relevant.

While the Ministry of Civil Defence & Emergency Management (MCDEM) has a leadership role in CDEM, the Act stipulates the CDEM roles and responsibilities of other central government agencies, local authorities, emergency services and lifeline utilities. All of these organisations are expected to routinely incorporate CDEM and business continuity arrangements into their business planning and risk management processes, and to regularly monitor and report on their progress as appropriate.

The Government expects that all other infrastructure providers, businesses and individuals will come to understand that they too, have an important role to play in achieving the vision of Resilient New Zealand and will plan accordingly.

It should be noted that the CDEM documents do not have a clear focus on resilience, and are lacking a clear definition of what resilience actually is. However, while the 2005 National CDEM Plan does not even mention the word resilience, the 2015 National CDEM Plan states that the purpose is to build resilience towards present hazards and risks⁸⁰⁴.

⁸⁰³ AELG significance levels, private communication from David Brunson, chairman of the NZLC.

⁸⁰⁴ Parliamentary counsel office New Zealand Legislation (2015). National Civil Defence Emergency Management Plan Order 2015. Parliamentary counsel office New Zealand Legislation. Available at: <http://www.civildefence.govt.nz/cdem-sector/cdem-framework/national-civil-defence-emergency-management-plan/>. Accessed: 19 April 2016.

As already discussed, resilience on a regional level is the responsibility of the regional CDEM planning groups. Each of these has a group plan which outlines the emergency management strategy and planning activities for the next 5 years.

4.2.3. Critical Infrastructure and Technical Resilience

In New Zealand, infrastructure has been identified as one of the six key drivers of economic growth. It has been defined as “the fixed, long-lived structures that facilitate the production of goods and services and underpin many aspects of quality of life. Infrastructure refers to physical networks, principally transport, water, energy and communications”⁸⁰⁵.

Infrastructure is identified as an important contributor to improving living standards for all New Zealanders.⁸⁰⁶ Thus, the Government of New Zealand expresses the vision that “by 2030 New Zealand’s infrastructure is resilient and coordinated and contributes to economic growth and increased quality of life”⁸⁰⁷. New Zealand defines resilient infrastructure as being “able to deal with significant disruption and changing circumstances”⁸⁰⁸.

In the aforementioned CDME act the main focus is placed on the ‘4Rs’ approach to infrastructure, namely risk **reduction**, **readiness**, **response** and **recovery**:

- “Reduction [refers to] identifying and analysing risks to life and property from hazards, taking steps to eliminate those risks if practicable, and, if not, reducing the magnitude of their impact and the likelihood of their occurrence to an acceptable level;
- Readiness [refers to] developing operational systems and capabilities before an emergency happens, including self-help and response programmes for the general public and specific programmes for emergency services, lifeline utilities, and other agencies;
- Response [refers to] actions taken immediately before, during, or directly after an emergency to save lives and property, and to help communities recover;
- Recovery [refers to] the co-ordinated efforts and processes used to bring about the immediate, medium-term, and long-term holistic regeneration and enhancement of a community following an emergency”⁸⁰⁹.

In 2008, the New Zealand treasury established the National Infrastructure Unit (NIU) that is charged with integrating infrastructure resilience in strategic planning. In 2015, the NIU published the thirty years National Infrastructure Plan.⁸¹⁰ The document defines infrastructure resilience in relation to 8 attributes:

⁸⁰⁵ National Infrastructure Unit (2011). New Zealand Infrastructure Plan. *National Infrastructure Unit*. Available at: <http://www.infrastructure.govt.nz/plan/2011>. Accessed: 19 April 2016. P. 1.

⁸⁰⁶ New Zealand Government, Treasury (2013). Higher Living Standards. *New Zealand Government, Treasury*. Available at: <http://www.treasury.govt.nz/abouttreasury/higherlivingstandards>. Accessed: 19 April 2016.

⁸⁰⁷ National Infrastructure Unit (2011). New Zealand Infrastructure Plan. *National Infrastructure Unit*. Available at: <http://www.infrastructure.govt.nz/plan/2011>. Accessed: 19 April 2016. P. 12.

⁸⁰⁸ Ibid. P. 12.

⁸⁰⁹ Parliamentary counsel office New Zealand Legislation (2015). National Civil Defence Emergency Management Plan Order 2015. *Parliamentary counsel office New Zealand Legislation*. Available at: <http://www.civildefence.govt.nz/cdem-sector/cdem-framework/national-civil-defence-emergency-management-plan/>. Accessed: 19 April 2016. P. 8-9.

⁸¹⁰ National Infrastructure Unit (2011). New Zealand Infrastructure Plan. *National Infrastructure Unit*. Available at: <http://www.infrastructure.govt.nz/plan/2011>. Accessed: 19 April 2016.

International Survey



Figure 4.6 Resilience Attributes.⁸¹¹

Implementation of resilience concepts in the context of infrastructure is built upon three principles. The Plan details that “to respond to the challenges and realise the opportunities infrastructure provides, we need to better understand the services to deliver in the future, improve how we manage our existing assets, and ensure we have the right settings to make better investment decisions in the future”⁸¹².

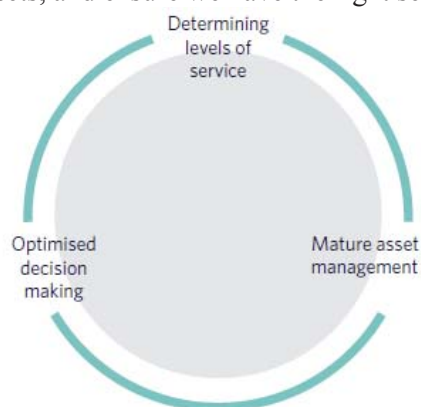


Figure 4.7 Principles for achieving a more efficient infrastructure setup in New Zealand.⁸¹²

1. **Increasing understanding of levels of service and future drivers of demand.** It is argued that in New Zealand large parts of infrastructure network planning remains ‘asset-driven’, with assets designed and built without fully considering the service being delivered. The Plan lists **five factors** involved in determining levels of service, namely: effective collaboration between infrastructure providers and other relevant stakeholders; better integrated land use planning; clear and detailed vision to guide investment decisions; ensuring clear alignment between individual investment decisions and economic goals; considering whole-of-life infrastructure costs.⁸¹³
2. **Strengthening asset management practices.** In the Plan it is argued that effective asset management should bring together key disciplines beyond engineering, including financial and spatial planning, so that organisations can plan with affordability limits and optimise

⁸¹¹ Ibid. P. 48.

⁸¹² Ibid. P. 46.

⁸¹³ Ibid. P. 46-47.

urban planning. It is also argued that “[...] asset management practices need to include a stronger understanding of the **resilience** of our infrastructure networks at a national, regional and local level, especially key pinch-points and the degree to which different parts of the networks are critical to overall performance. There is a need to increase the sophistication of how we think about resilience, shifting beyond a narrow focus on shock events or infrastructure failures and thinking more about interdependencies, levels of service and community preparedness. [...] Importantly, increased resilience is not necessarily about making things stronger or invest more, and is quite often achieved by operational changes.”⁸¹⁴

3. **Optimising decision-making.** This includes having the right governance and management structures in place, an effective regulatory regime, and new ways of engaging with communities on decisions, levels of service and the trade-offs inherent in any decision.⁸¹⁵

The country’s regulatory system for buildings is defined in the Building Act 2004⁸¹⁶. This includes provisions for addressing the earthquake hazard to all types of buildings, and even allows councils to instruct the strengthening or demolition of the existing building stock on the basis of its susceptibility to earthquake.

The requirement of the CDEM that all lifelines are able to function was well illustrated following the Canterbury earthquakes. The following illustrative examples of technological resilience are all taken from the same report.⁸⁰¹

- Seismic retrofitting was undertaken on some of the highway infrastructure in New Zealand prior to the 2010 and 2011 earthquakes. This comprised reinforcing bridge piers and tying bridge spans to the piers and abutments. This contributed to the overall robustness of the transportation infrastructure of Christchurch.
- Resilience upgrades to the power grid, started in 2006 and costing 6 million NZD is estimated to have saved 10 times that much when the earthquake struck.
- The use of MDPE in gas pipelines contributed to their robustness when exposed to ground movement.

4.2.4. Organisational Resilience

Organisational resilience is well-developed concept in New Zealand. The country has its own initiative to promote organisational resilience.⁸¹⁷ This is collaboration between research universities, with the support of industrial partners and advisors, and the backing of the Natural Hazards Research Platform in New Zealand. The output of the ResOrgs team influences policy and practice and promotes resilience of organisations in New Zealand. **Organisational resilience** is perceived as a strategic capability implying “[...] the foresight and situation awareness to prevent potential crises emerging; and an ability to turn crises into a source of strategic opportunity”⁸¹⁸.

The initiative of Resilient Organisations developed **13 indicators** aimed at assessing the resilience of an organisation:

- **“Leadership:** Strong crisis leadership to provide good management and decision making during times of crisis, as well as continuous evaluation of strategies and work programs against organisational goals.

⁸¹⁴ Ibid. P. 47.

⁸¹⁵ Ibid. P. 48.

⁸¹⁶ Parliamentary counsel office New Zealand Legislation (2004). The Building Act 2004. *Parliamentary counsel office New Zealand Legislation*. Available at: <http://www.legislation.govt.nz/act/public/2004/0072/latest/whole.html>. Accessed: 20 April 2016.

⁸¹⁷ See: <http://www.resorgs.org.nz/>.

⁸¹⁸ Resilient Organizations. (Udd.) About Resilience. *Resilient Organizations*. Available at: <http://www.resorgs.org.nz/Content/what-is-resilience.html>. Accessed: 20 April 2016.

International Survey

- **Staff Engagement:** The engagement and involvement of staff who understand the link between their own work, the organisation's resilience, and its long term success. Staff are empowered and use their skills to solve problems.
- **Situation Awareness:** Staff are encouraged to be vigilant about the organisation, its performance and potential problems. Staff are rewarded for sharing good and bad news about the organisation including early warning signals and these are quickly reported to organisational leaders.
- **Decision Making:** Staff have the appropriate authority to make decisions related to their work and authority is clearly delegated to enable a crisis response. Highly skilled staff are involved, or are able to make, decisions where their specific knowledge adds significant value, or where their involvement will aid implementation.
- **Innovation and Creativity:** Staff are encouraged and rewarded for using their knowledge in novel ways to solve new and existing problems, and for utilising innovative and creative approaches to developing solutions.
- **Effective Partnerships:** An understanding of the relationships and resources the organisation might need to access from other organisations during a crisis, and planning and management to ensure this access.
- **Leveraging Knowledge:** Critical information is stored in a number of formats and locations and staff have access to expert opinions when needed. Roles are shared and staff are trained so that someone will always be able to fill key roles.
- **Breaking Silos:** Minimisation of divisive social, cultural and behavioural barriers, which are most often manifested as communication barriers creating disjointed, disconnected and detrimental ways of working.
- **Internal Resources:** The management and mobilisation of the organisation's resources to ensure its ability to operate during business as usual, as well as being able to provide the extra capacity required during a crisis.
- **Unity of Purpose:** An organisation wide awareness of what the organisation's priorities would be following a crisis, clearly defined at the organisation level, as well as an understanding of the organisation's minimum operating requirements.
- **Proactive Posture:** A strategic and behavioural readiness to respond to early warning signals of change in the organisation's internal and external environment before they escalate into crisis.
- **Planning Strategies:** The development and evaluation of plans and strategies to manage vulnerabilities in relation to the business environment and its stakeholders.
- **Stress Testing Plans:** The participation of staff in simulations or scenarios designed to practice response arrangements and validate plans.⁸¹⁸



Figure 4.8 Organisational resilience indicators.⁸¹⁸

In 2014, Resilient Organisations developed a Benchmark Resilience Tool with a list of indicators for measuring organisational resilience.⁸¹⁹ “It can be used to support internal resilience initiatives, as well as cross-sector or supply-chain resilience initiatives. It is also a research tool for improving our understanding of resilience and its impact on organisational performance. The Benchmark Resilience tool is a survey intended to measure the resilience of an organisation, allowing them to benchmark against other organisations in the same or related industries. Such benchmarking can support sector and supply-chain resilience initiatives as well as provide the organisation with a self-analysis of resilience strengths and weaknesses to support the Business Case for internal resilience initiatives.”⁸²⁰ Organisational resilience is defined as “[...] the ability of an organisation to survive a crisis and thrive in a world of uncertainty. Resilience consists of three interdependent attributes (1) Leadership and Culture; (2) Networks and (3) Change Ready processes that build Business as Usual (BAU) effectiveness as well as robust and agile response and recovery from crises.”⁸¹⁹

Lee et al. also developed a tool for assessing organisational resilience in New Zealand⁸²¹. Their tool uses **Resilience Ethos**, **Situation Awareness**, and **Adaptive Capacity** as indicators for organisational resilience.

Examples of organisational resilience in practice are the telecommunications emergency forum and the Lyttelton port, both of which were affected by the Canterbury earthquakes in 2010 and 2011. However the cooperation of the telecommunications network companies following the earthquakes and the good disaster preparation of the port resulted in an uninterrupted telecommunications service and a rapid recovery of port facilities⁸⁰¹.

4.2.5. Social Resilience

The Wellington Community Resilience Strategy describes resilient communities as communities that are able to plan for, respond to and thrive after a disastrous event⁷⁹⁷. At the heart of a resilient community is a robust set of social networks which help people address the challenges in their day-to-day lives, as well as those that occur in times of extreme stress.

The Resilience Team acts a primary lead and facilitator in areas directly related to disaster resilience, while supporting the activities of other organisations and groups working to build strong communities outside the Emergency Management space. The strategy states that the communities of the Wellington region will be resilient if these attributes are present before, during and after an emergency event:

- Communities are connected and work together toward shared goals;
- Individuals and social structures are engaged and empowered to make a difference;
- Communities have clear channels of communication to link into physical and social resources;
- Communities have realistic expectations of the levels of support available during an event;
- Communities take actions to reduce the impacts of hazards;
- Communities have strong and trusting partnerships with each other and with WREMO;
- Private, public and community sectors are prepared to respond effectively and return to business quickly;
- The region’s local governments have the capacity and capability to effectively manage a large response and recovery while supporting community-driven efforts;
- People feel a sense of place and belonging in their community. In times of stress people want to stay.

⁸¹⁹ A detailed list of all the indicators as well as questions used to assess organizational resilience is available here: <http://www.resorgs.org.nz/images/stories/pdfs/resiliencebenchmarksmanager.pdf>. Accessed: 20 April 2016.

⁸²⁰ Resilient Organizations (Udd.). Benchmark Resilience Tool. *Resilient Organizations*. Available at: <http://www.resorgs.org.nz/Resources/benchmark-resilience-tool.html>. Accessed: 20 April 2016.

⁸²¹ Lee, A. V, Vargo, J. et al. (2013). Developing a Tool to Measure and Compare Organizations’ Resilience. *Natural Hazards Review*. Available at: [http://doi.org/10.1061/\(ASCE\)NH.1527-6996.0000075](http://doi.org/10.1061/(ASCE)NH.1527-6996.0000075). P. 29–41. Accessed: 20 May 2016.

International Survey

The strategy outlines how the Wellington Region Emergency Management Office's (WREMO) Community Resilience Team will engage with its diverse communities and apply a wide-range of tools to help empower them to survive and thrive after an emergency event. It is broadly driven by three strategic objectives which are **Build capacity**, **Increase connectedness**, and **Foster cooperation**.

Build capacity:

Build and improve knowledge, skills and resources that are valuable before, during and after an emergency event, to improve communities' ability to anticipate risk, limit impact, and bounce back rapidly after an emergency event.

Some examples of tools for building capacity are:

- CD Volunteer training - training provides CDEM knowledge and skills to a wide range of individuals and organisations across communities of place and interest.
- Public education – preparedness guides for households, neighbours and businesses to enable understanding of hazards, risks and easy mitigation strategies.
- Preparedness enablers – partnerships with the private sector to facilitate the availability of affordable and quality products that improve preparedness, e.g. emergency kits and home rainwater tanks.
- Tsunami blue lines – the maximum run-up height of local tsunami is clearly marked, which raise awareness of tsunami and act as a clear evacuation point after a large earthquake.
- Emergency text alert – a free service that is easy to sign up to and can provide a quick heads up to individuals.

Increase connectedness

Support traditional, non-emergency related community development activities that create and strengthen relationships throughout diverse communities that build and improve social capital

Some examples of tools for increasing connectedness are:

- Community events – the resilience team supports and promotes community events and projects that lead to increased social capital and resilience, e.g. street BBQs, Neighbour's day, graffiti clean-ups and school galas.
- Social media – WREMO uses its Facebook page to promote opportunities and events that build strong communities.
- Resilience and crisis mapping – building the framework to develop an online tool with community leaders to map out a range of local activities and resources in their area. Online maps will allow for visual representations of resources and relationships in a community before, during and after an emergency event.

Foster cooperation

Lead activities that foster trust, reciprocity, and interdependence by facilitating opportunities to improve resilience, by improving social capital and aid in the preparation for, response to and recovery from an emergency event.

Some examples of tools for fostering cooperation are:

- Community-driven response planning – bringing community leaders, asset holders and other local drivers of change together from a geographic community to plan how they will coordinate and address the challenges caused by a devastating earthquake. The leaders meet each other, define their community values, identify their community's strengths, weaknesses, opportunities and challenges, create a shared response framework and identify ongoing community projects that will maintain the relationships and advance resilience efforts.

- It's easy: Prepared Neighbours – provides a series of prompts for 10-15 neighbours to meet each other, self-organise, record each other's details and prepare for an emergency at the street level using local social and physical resources.
- Emergency assistance centres (EAC) - If an event requires the official provision of emergency welfare to affected people, the community can support the response through lending their buildings to councils as an EAC. As a result of working closely with community groups, the Team connects owners or operators of suitable buildings to local council Welfare Teams to create a wide range of choices that suit the requirements of the response and community needs. Further, by creating a way for the private and community sectors to contribute before a response, additional pathways are created for these groups to become better connected and prepared in other ways.
- The outputs from the lifelines groups work often facilitate communication with the communities which assists in their planning⁸⁰².

4.2.6. Economic Resilience

The New Zealand Treasury has overall responsibility for assessing the economic resilience of New Zealand and for recommending policy changes which can improve resilience. In a recent working paper, *Assessing New Zealand's resilience*⁸²², the treasury investigated whether the resilience of the economy during the global financial crisis could be expected to continue. They concluded that despite high private debts, possibly encouraged by national policy settings, the country's economy was not in any immediate danger of a financial crisis.

The Economics of Resilient Infrastructure (EoRI) project is a government funded research project which focusses on the cities of Auckland and Christchurch. The objectives of the project are to develop a tool which can be used to quantify the economic impact of infrastructure failure.⁸²³

In terms of economic resilience, one interesting aspect is that the slow insurance settlements as a result of complications surrounding the multiple event nature of the Canterbury earthquakes have in fact slowed recovery.⁸⁰¹

4.2.7. Resilience Related Official Documents

- National Civil Defence Emergency Management Strategy 2007. Available at: <http://www.civildefence.govt.nz/assets/Uploads/publications/national-CDEM-strategy-2008.pdf>;
- National Civil Defence Emergency Management Plan Order 2005. Available at: <http://www.legislation.govt.nz/regulation/public/2005/0295/latest/DLM356569.html>;
- The Guide to the National Civil Defence Emergency Management Plan 2006. Available at: <http://www.civildefence.govt.nz/assets/Uploads/publications/The-Guide-v1.3-complete-web.pdf>;
- National Civil Defence Emergency Management Plan Order 2015 (not yet in force, until December 2015). Available at: <http://www.legislation.govt.nz/regulation/public/2015/0140/latest/DLM6486453.html?src=qs>;
- National infrastructure unit New Zealand infrastructure plans. Available at: <http://www.infrastructure.govt.nz/plan>.

⁸²² New Zealand Treasury (2011). *Economic Imbalances: New Zealand's Structural Challenge*. Working Paper 11/03. *New Zealand Treasury*. Available at: <http://www.treasury.govt.nz/publications/research-policy/wp/2011/11-03/15.htm>. Accessed: 3 February 2016.

⁸²³ Resilient Organisations. "Economics of Resilient Infrastructure". Available at: <http://www.resorgs.org.nz/Current-Research/economics-of-resilient-infrastructure.html>. Accessed: 3 February 2016.

International Survey

Regional level:

- Community Resilience Strategy, Wellington Region Emergency Management Office. Available at: <http://www.getprepared.org.nz/sites/default/files/uploads/WREMO%20Community%20Resilience%20Strategy%202nd%20edition.pdf>;
- Wellington Civil Defence Emergency Management Group Plan 2013-2018. Available at <http://www.getprepared.org.nz/sites/default/files/uploads/2013%20-%202018%20Group%20Plan.pdf>;
- Auckland Civil Defence Emergency Management Group Plan 2011-2016. Available at http://www.aucklandcivildefence.org.nz/media/45880/AC-0162-CDEM-Group-Plan_WEB.PDF;
- Bay of Plenty Civil Defence Emergency Management Group Plan 2012-2017. Available at: <https://www.boprc.govt.nz/media/456976/2013-04-civil-defence-publication-bay-of-plenty-civil-defence-emergency-management-group-plan-2012-2017-v2-pdf.pdf>;
- Hawke's Bay Civil Defence Emergency Management Group Plan 2014-2019. Available at: <http://www.hbemergency.govt.nz/assets/Documents/Operative-HBCDEM-Group-Plan-as-at-24-March-20151.pdf>;
- Manawatu-Wanganui Civil Defence Emergency Management Group plan 2009-2014. Available at: <http://www.horizons.govt.nz/assets/keeping-people-safe-publications/Manawatu-Wanganui-CDEM-Group-Plan-2009-2014-approved-v1-15.pdf>;
- Taranaki Civil Defence Emergency Management Group Plan 2012. Available at: <http://www.trc.govt.nz/assets/Publications/taranaki-cdem-publications/CDEMGpPlan-Nov2012.pdf>;
- Nelson Tasman Civil Defence Emergency Management Group Plan 2012. Available at: <http://www.nelsontasmancivildefence.co.nz/assets/Uploads/RADn1133914v4AdoptedNelsonTasmanCDEMGpPlanAugust2012.pdf>;
- Marlborough Civil Defence Emergency Management Group Plan 2011-2016. Available at: [file:///C:/Users/Davidwi/Downloads/MCDEM_Plan%2020112016.MCDEM_pLAN%202011-2016%20\(1\).pdf](file:///C:/Users/Davidwi/Downloads/MCDEM_Plan%2020112016.MCDEM_pLAN%202011-2016%20(1).pdf);
- West Coast Civil Defence Emergency Management Group Plan 2010. Available at: <http://www.wcrc.govt.nz/Documents/Other%20Plans%20and%20Strategies/Civil%20Defence%20Emergency%20Management%20Group%20Plan.pdf>;
- Canterbury Civil Defence Emergency Management Group Plan 2014. Available at: <http://ecan.govt.nz/publications/General/cdem-group-plan.pdf>;
- Otago Civil Defence Emergency Management Group Plan 2012-2017. Available at: <http://www.otagocdem.govt.nz/assets/Uploads/Otago-Civil-Defence-Emergency-Management-Group-Plan.pdf>;
- Southland Civil Defence Emergency Management Group Plan 2012. Available at: <http://www.civildefence.co.nz/uploads/documents/Southland%20%20CDEM%20Group%20Plan%20%202012.pdf>;
- Waikato Civil Defence Emergency Management Group plan 2011-2015. Available at: <http://www.waikatoregioncdemg.govt.nz/PageFiles/18/Waikato%20CDEM%20GP%202011-15.pdf>.

4.3. Fiji

Natural disasters that can affect Fiji are cyclones, floods, earthquakes, tsunamis, whirlwind/freak wind, landslide, forest fire, and drought⁸²⁴. Fiji has a population of 850,000 and a GDP of \$4.25

⁸²⁴ The National Disaster Management Council of the Government of Fiji. "National Disaster Management Plan." January 1995. Accessed: 29 October 2015.

billion. Every year, one or two cyclones hits the country, and the damage caused over the last decade has been estimated at more than \$500 million with over 100 lives lost⁸²⁵.

Tropical Cyclone Ami is considered as one of the worst cyclones to ever hit Fiji, bringing floodwaters, tidal waves, and wind gusts up to 115 miles per hour⁸²⁶, and causing “major damage to houses, crops and infrastructure including schools, telecommunications and electricity supply⁸²⁷.” 14 people died from drowning⁸²⁷. In the official report, the then Minister for Regional Development and Chair National Disaster Management Council, Ilaitia Tuisese, commented that “Government’s efforts have been substantially enhanced by the resilience and initiative displayed by the victims themselves. They have moved on and have rebuilt their lives⁸²⁷.”

Several major cyclone and flood events from 2009 to 2012 were used as opportunities for “the Government to build back better, improving the resilience of communities especially in vulnerable rural and maritime communities⁸³¹.”

The minister for Local Government, Urban Development, Housing and Environment cited the zero death toll from recent cyclones as demonstrating “the resilience by Fijians and the change in mind set towards cyclones and natural disasters⁸²⁸.”

4.3.1. Concept of Resilience

Resilience is a rather new concept used in Fiji, and as such the Fijian government does not appear to have an official definition of the concept. The word “resilience” appears in official literature rarely and is seen as an outcome of the legislation on disaster risk management. Neither the National Disaster Management Act of 1998 nor the National Disaster Management Plan of 1995 employs the word resilience. However, the National Disaster Management Office (NDMO) states that these two legal instruments are the tools that allow them to “ensure the delivery and maintenance of disaster management programs that yield in building the national resilience to disasters⁸²⁹.” They are also considered as the framework and platform for building resilience at all levels (from the national level to individual households)⁸²⁹.

The Roadmap for Democracy and Sustainable Socioeconomic Development, published in 2009, sets the national goal for disaster risk reduction and disaster management to “building national resilience to disasters and adapting to climate change” and while it does set out a few strategies, a definition of resilience is not given.

The latest national progress report on the implementation of the Hyogo Framework for Action furthers this goal by establishing that “Building National Resilience to Disasters, Reducing Vulnerability and

⁸²⁵ Ministry of National Planning (2009) Roadmap for Democracy and Sustainable Socio-economic Development 2010-2014 – A Better Fiji For All. *Ministry of National Planning*. Available at: <http://www.fiji.gov.fj/getattachment/Govt--Publications/Peoples-Charter/RSED.pdf.aspx>. Accessed: 29 October 2015.

⁸²⁶ ReliefWeb (2003). Cyclone Ami Rips Through Fiji. *ReliefWeb*. Available at: <http://reliefweb.int/report/fiji/cyclone-ami-rips-through-fiji>. Accessed: 18 December 2015.

⁸²⁷ National Disaster Management Office (2003) Report on Tropical Cyclone Ami. *National Disaster Management Office*. Available at: <http://www.pacificdisaster.net/pdnadmin/data/documents/10964.html>. Accessed: 18 December 2015.

⁸²⁸ The Fijian Government (2013). Fiji Needs to Strengthen Disaster Resilient Communities. *The Fijian Government*. Available at: <http://www.fiji.gov.fj/Media-Center/Press-Releases/FIJI-NEEDS-TO-STRENGTHEN-DISASTER-RESILIENT-COMMUN.aspx>. Accessed: 30 October 2015.

⁸²⁹ NDMO (2014) Vision & Mission. *National Disaster Management Office*. Available at: <http://www.ndmo.gov.fj/ndrm-arrangements/vision-mission>. Accessed: 29 October 2015.

International Survey

Risks and Adapting to Climate Change is to be reflected in each ministry strategies, operational plans (MOPs) and Standard Operating Procedures (SOP's)⁸³⁰."

4.3.2. Institutional Framework for Delivering Resilience

The National Disaster Management Organisation (NDMO) is responsible for disaster resilience at all levels. Disaster Management Committees also exist at a divisional and district levels. Villages/settlements/communities, private sector organisations, and local emergency response agencies are also actors in resilience. The Fijian government also calls up "the whole population of Fiji" to build resilience⁸³¹.

The NDMO is able to coordinate and build resilience through the support of their partners:

- International partners
 - the United Nation organisations, UNOCHA, UNDP, UNCRD, UNDESA
 - International Red Cross
 - European Union
 - World Bank
 - World Health Organisation
 - Food and Agriculture Organisation
 - Foreign Embassies and Missions,
 - And all the International NGOs
- National and regional partners
 - AUSAID
 - NZAID
 - SOPAC
 - SPC
 - SPREP

4.3.3. Critical Infrastructure and Technical Resilience

The Fijian government relies on their disaster risk management strategy in order to achieve resilience, and does not focus on critical infrastructure resilience.

They implement the Comprehensive Hazard and Risk Management (CHARM) system, which is an all-hazard, all-country approach. CHARM "is defined as a comprehensive hazard and risk management tool for use within an integrated national development planning process"⁸³²."

CHARM is made up the following of five main steps, and as can be seen in Figure 4.9:

- Establish the context
- Identify risks
- Analyse risks
- Evaluate risks
- Treat risks

⁸³⁰ NDMO (2014) National progress report on implementation of the Hyogo Framework for Action (2013-2015) – Interim. *National Disaster Management Office*. Available at: http://www.preventionweb.net/files/41004_FJI_NationalHFAprogress_2013-15.pdf. Accessed: 29 October 2015.

⁸³¹ NDMO (Udd.). Overview Report on the National Disaster Management Office. *National Disaster Management Office*. Available at: [http://www.un-spider.org/sites/default/files/Fiji%20Disaster%20Management%20Office%20\(NDMO\).pdf](http://www.un-spider.org/sites/default/files/Fiji%20Disaster%20Management%20Office%20(NDMO).pdf). Accessed: 29 October 2015.

⁸³² UNFCCC (2014). Compendium on methods and tools to evaluate impacts of, and vulnerability and adaptation to, climate change. *United Nations Framework Convention on Climate Change*. Available at: http://unfccc.int/adaptation/nairobi_work_programme/knowledge_resources_and_publications/items/5345.php. Accessed: 29 October 2015.

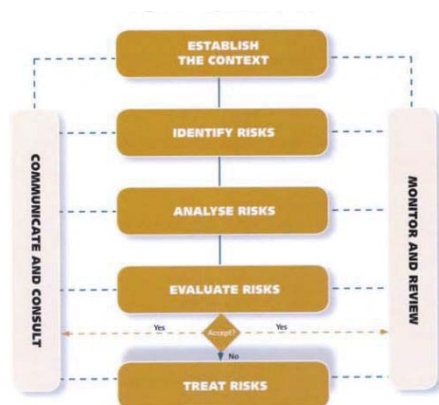


Figure 4.9 CHARM main steps.⁸³³

The NDMO also specifies on their website the following ways in which they are increasing resilience to disasters:

- “coordinating and managing disaster preparedness efforts at all levels;
- coordinating and managing disaster mitigation efforts at all levels;
- coordinating and managing disaster operation efforts at all levels;
- coordinating and managing disaster response efforts at all levels;
- coordinating and managing disaster relief efforts at all levels;
- coordinating and managing disaster rehabilitation efforts at all levels;
- and managing disaster efforts for the before, during and after phases⁸³⁴.”

4.3.4. Organisational Resilience

No official documents related to the concept of organisational resilience were found.

4.3.5. Social Resilience

In the Roadmap for Democracy and Sustainable Socioeconomic Development, the goal of “building national resilience to disasters and adapting to climate change” is brought about via the policy objective of “communities are better protected from the risks of disasters and are better able to cope with their consequences⁸²⁵”.

The Roadmap also sets out the following strategies and key performance indicators to achieve the policy objective:

- Strategies
 - Identify and implement effective risk reduction projects;
 - Improve community response capacity in dealing with disasters and risks with effective, integrated and people-focused early warning systems on all hazards;
 - Enhance analysis and evaluation of hazards vulnerabilities and risks;
 - Promote and strengthen food security programme to enhance community based disaster reduction initiatives;

⁸³³ Sopac. (). Comprehensive Hazard and Risk Management (CHARM) Guidelines for Pacific Island Countries. Available at: <http://ict.sopac.org/VirLib/DM0044.pdf>. Accessed: 29 October 2015.

⁸³⁴ NDMO (Udd.). NDMO arrangements 1. *National Disaster Management Office*. Available at: <http://www.ndmo.gov.fj/ndrm-arrangements/ndmo-arrangements-1>. Accessed: 28 October 2015.

International Survey

- Strengthen organizational institutional policy and decision making frameworks;
 - Enhance knowledge, information, public awareness and education;
 - Strengthen effective planning, response and recovery;
 - And ensure availability of adequate necessary germplasm to support recovery.
- Key performance indicators
 - Government responds to disaster situation within the first 24 hours;
 - Casualties reduced from 30 per year to none;
 - Everybody to receive timely warning;
 - One third of all villages and settlements in Fiji have disaster plans and committees in 2010;
 - Models of best practice developed and adopted to support disaster risk reduction;
 - And costs for disaster emergency relief food ration reduced by 20% by 2012.

As part of the strategy to enhance knowledge, information, public awareness and education, the National Disaster Management Office's Training, Education and Awareness Unit helps build national resilience through raising awareness to disasters via the development and printing of pamphlets, handouts, manuals, etc. to support training and education the general public⁸³⁵. They also plan, prepare and stage the National Disaster Awareness Week⁸³⁵.

Furthermore, NDMO recognises the importance of “incorporating traditional coping mechanisms and local knowledge [to] enhance individual and community resilience⁸³¹.” The NDMO also provides formal disaster risk reduction and disaster management training at the community level via education programmes in order for the public to be motivated to take actions and be able to identify disaster risk reduction priorities.

The strategy to “promote and strengthen food security programme” is key for implementing societal resilience in Fiji, especially in areas prone to drought, flooding and other hazards than can weaken livelihoods⁸³⁴. In order to achieve food security, several strategies⁸²⁵ are being implemented, including:

- Improving synergies of public enterprises in agricultural production/processing to ensure food security;
- Putting in place proper programmes and infrastructure to support the production capacity of local farmers and improving the quality and standards of agricultural produce ;
- Partnerships with private sector involved in the supply and value chain will be harnessed through provision of appropriate incentives and support;
- And putting into place sustainable fisheries resource management.

The FAO's Food Import Capability Index (FICI) is used as the indicator for food security vulnerability⁸³⁵.

4.3.6. Economic Resilience

In order to achieve economic resilience, Fiji's key strategies are the implementation of the recommendations of the Commission of Inquiry into Financial Services (COIFS), IMF/ World Bank Financial Sector Assessment Programme (2007 FSAP), Export Finance Facility (EFF), and the superannuation sector study and the introduction of the Fiji Real Time Gross Settlement (RTGS), FIJICLEAR⁸²⁵.

Further measures required for achieving economic resilience according to the Roadmap include:

⁸³⁵ NDMO (Udd.). Core Functions & Responsibilities. *National Disaster Management Office*. Available at: <http://www.ndmo.gov.fj/ndrm-arrangements/core-functions-responsibilities>. Accessed: 29 October 2015.

- improved efficiency in resource allocation and institutional arrangement for processes of financial intermediation;
- on-going alignment of domestic prudential regulation to latest international sound and best practices;
- enhanced stability and soundness of the financial system to include prudential supervision arrangements particularly for deposit-taking institutions like credit unions;
- consistent use of relevant indicators such as Financial Soundness Indicators (FSI) and stress testing, to assist in the assessment of strengths and vulnerabilities of financial systems and also serve as critical inputs for policy formulation;
- ensure that developments in the financial markets support the ongoing developments of the real sector;
- extending financial services to those living in rural areas and outer islands and the importance of this to poverty reduction;
- and pursuing supervisory arrangements for capital markets.

4.3.7. Resilience Related Official Documents

Fijian government does not appear to have any official documents on resilience and instead focuses on disaster and risk management. The word “resilience” appears in official literature rarely and is seen as an outcome of the legislation on disaster risk management.

4.4. Kiribati

The Islands of Kiribati are prone to both natural and human-induced disaster events, and are affected by climate change. Natural disasters include inundation, tsunamis, drought and plague or epidemic⁸³⁶. Human-induced disasters include maritime disaster (including oil spill), fire or explosion and aircraft accidents, with societal crisis such as rapid population growth and HIV/AIDS also being a concern⁸³⁶.

The people of Kiribati are very vulnerable to disasters with high social and economic ramifications due to a lack of infrastructure, low human development indicators, and a high population growth rate⁸³⁶.

In 1999, Kiribati suffered a major drought that affected 84,000 people⁸³⁷. Villages which rely completely on rain water tanks for fresh water were the areas most affected⁸³⁸. A nationwide state of emergency was declared, and the population was prone to disease during this time⁸³⁹.

The 2014 King Tides impacted five islands, damaging 44 homes, sea walls and causeways. Evacuees were sheltered in community halls⁸⁴⁰. Groundwater sources were contaminated and as such access to clean drinking water was a concern⁸⁴⁰. The Government joined with Kiribati Red Cross Society in order to perform an initial damage assessment⁸⁴⁰.

⁸³⁶ Republic of Kiribati (2012). National Disaster Risk Management Plan October 2012 Part 1 Structure & Framework. *Republic of Kiribati*. Available at: http://www.pacificdisaster.net/pdnadmin/data/original/KIR_2012_DRM_Plan.pdf. Accessed: 4 November 2015.

⁸³⁷ OCHA (Udd.). Kiribati. *Office for the Coordination of Humanitarian Affairs*. Available at: <http://www.unocha.org/pacific/country-profiles/kiribati>. Accessed: 18 December 2015.

⁸³⁸ OCHA (1999). Kiribati – Drought OCHA Situation Report No. 1. *Office for the Coordination of Humanitarian Affairs*. Available at: <http://reliefweb.int/report/kiribati/kiribati-drought-ocha-situation-report-no-1>. Accessed 18 December 2015.

⁸³⁹ Agence France-Presse (1999) Kiribati: Central Pacific nation declares state of emergency. *Agence France-Presse*. Available at: <http://reliefweb.int/report/kiribati/kiribati-central-pacific-nation-declares-state-emergency>. Accessed: 18 December 2015.

⁸⁴⁰ Reliefweb (2014). Marshall Islands/Kiribati: King Tides. *ReliefWeb*. Available at: [http://reliefweb.int/disaster/ss-2014-000032-mhl?advanced-search=\(PC132\)#content](http://reliefweb.int/disaster/ss-2014-000032-mhl?advanced-search=(PC132)#content). Accessed: 5 January 2016.

International Survey

The village of Tebunginako, located on the Abaiang Island, has suffered from sea level rise and increasing storm surges over the past 40 years⁸⁴¹. Spring tides have also become more frequent and forceful. These disasters have led to land loss, floods and a lack of food supply as plant life is overdosing on salt water, and sea water has contaminated fresh water ponds, killing off the milkfish, which previously sustained the village. While the village was already rebuilt 15 years ago, moving it farther away from the shore, the sea has caught up to them once again. The government has decided to relocate the village.

4.4.1. Concept of Resilience

The concept of resilience is rather new. It appears in official literature rarely and is mostly seen as an outcome of the legislation on disaster risk management and climate change adaptation.

The Kiribati Adaptation Project Phase II describes resilient institutions as being capable of “accommodating a sufficiently broad range of externally driven changes to be able to maintain the system in a long-term, sustainable manner⁸⁴².”

The National Disaster Risk Management Plan 2012 states that the “ability to measure vulnerability is increasingly being seen as a key step towards effective risk reduction and the promotion of a culture of disaster resilience⁸⁴¹.”

While not using the word resilience as such, the National Disaster Risk Management Plan incorporates resilience concepts. For sudden onset events, it establishes 5 stages of disaster response, two of which relate to resilience. The fourth stage is “response, relief & early recovery” and contains many elements similar to resilience concepts, such as “the restoration of basic services, livelihoods, shelter, governance, security and rule of law, environment and social dimensions, including the reintegration of displaced population⁸³⁶.” It also aims to stabilize human security and address “underlying risks that contributed to crises, preventing a recurrence and creating conditions for future development⁸³⁶.” The fifth stage, known as “long term recovery”, encompasses the resilience concept of bounce forward, or as referred to in the document, “to build back better⁸³⁶”, and aims to “reduce the pre-disaster risks inherent in the community and infrastructure⁸³⁶.”

The goal of the Kiribati Joint Implementation Plan for Climate Change and Disaster Risk Management (KJIP) 2014-2023 is “to increase resilience through sustainable climate change adaptation and disaster risk reduction using a whole of country approach.” It defines resilience in its glossary as “the capacity of a community, society or natural system to maintain its structure and functioning through stress or change⁸⁴³.”

From 2003 – 2011, the Kiribati Adaptation Program⁸⁴⁴’s focus was on building capacity, reducing vulnerability, and recovery from disasters. Starting in 2012, with the Phase III of the Kiribati Adaptation Program, the word resilience starts to be used (for example, “maintain resilient coastal infrastructure”), but lacks an official definition. Overall, focus remains on risk management and adaptation measures.

⁸⁴¹ Kiribati Climate Change (Udd.). Tebunginako Village. *Office of the President of Kiribati*. Available at: <http://www.climate.gov.ki/case-studies/abaiang/>. Accessed: 4 November 2015.

⁸⁴² Kay, R. (2008.) Development of an Integrated Climate Change Adaptation Risk Diagnosis and Planning Process: Final Report. Available at: <http://www.climate.gov.ki/wp-content/uploads/2013/05/Development-of-an-Integrated-Climate-Change-Adaptation-Based-Risk-Diagnosis-and-Response-Process.pdf>. Accessed: 20 April 2016.

⁸⁴³ Government of Kiribati (2014). Kiribati Joint Implementation Plan for Climate Change and Disaster Risk Management (JRIP) 2014-2023. *Government of Kiribati*. Available at: <http://www.spc.int/images/news/20140901/KJIP-BOOK.pdf>. Accessed: 5 November 2015.

⁸⁴⁴ For more information on the Kiribati Adaptation Program, see <http://www.climate.gov.ki/category/action/adaptation/kiribati-adaptation-program/>.

Kiribati's National Disaster Risk Management Plan 2012 is consistent with the themes within the Pacific Regional Framework for Action for Building Resilience of the Nations and Communities to Disasters 2005 -2015, and employs the word resilience/resilient a few times. It has an all hazards approach. The adoption of the disaster risk management principles laid out in the National Disaster Risk Management Plan 2012 is meant to strength government and community resilience⁸³⁶. It is based on the following six principles:

1. "Communities must be educated, trained and empowered to make a contribution to the national strategy in planning, responding and recovering from disasters;
2. Government must identify its key partners in developing a robust DRM framework and develop formal relationships in which outcomes are aligned to broader government objectives;
3. To effectively deliver the government DRM strategy it is acknowledged that the acquisition and maintenance of DRM and related management skills is a fundamental requirement;
4. A National Disaster Risk Management Office must be adequately resourced to perform a disaster coordination role on behalf of government;
5. Existing government committee structures should be utilized when implementing a DRM framework; and
6. To ensure good governance practices are being maintained and stated DRM outcomes achieved, an annual audit will be conducted by a third party⁸³⁶."

In 2014, the Kiribati Joint Implementation Plan for Climate Change and Disaster Risk Management (KJIP) 2014-2023 was published and defined resilience. It lays out the following 12 major strategies in order to increase resilience:

1. "Strengthening good governance, policies, strategies and legislation;
2. Improving knowledge and information generation, management and sharing;
3. Strengthening and greening the private sector, including small-scale business;
4. Increasing water and food security with integrated and sector-specific approaches and promoting healthy and resilient ecosystems;
5. Strengthening health service delivery to address climate change impacts;
6. Promoting sound and reliable infrastructure development and land management;
7. Delivering appropriate education, training and awareness programs;
8. Increasing effectiveness and efficiency of early warnings and disaster and emergency management;
9. Promoting the use of sustainable, renewable sources of energy and energy efficiency;
10. Strengthening capacity to access finance, monitor expenditures and maintain strong partnerships;
11. Maintaining the existing sovereignty and unique identity of Kiribati; and
12. Enhancing the participation and resilience of vulnerable groups⁸⁴³."

4.4.2. Institutional Framework for Delivering Resilience

The Kiribati national government, NGOs (including Kiribati Red Cross Society), National Disaster Risk Management Office, Disaster Management Control Agencies (police, fire services, etc.), and local communities, are all considered key actors for delivering disaster risk management and climate change adaptation.

4.4.3. Critical Infrastructure and Technical Resilience

No known documents on technical resilience.

4.4.4. Organisational Resilience

No known documents on organisational resilience.

International Survey

4.4.5. Social Resilience

No known documents on social resilience.

4.4.6. Economic Resilience

No known documents on economic resilience.

4.4.7. Resilience Related Official Documents

No documents on resilience alone, however the main documents contributing to strengthening resilience are:

- The National Disaster Risk Management Plan 2012. Available at: http://www.pacificdisaster.net/pdnadmin/data/original/KIR_2012_DRM_Plan.pdf;
- The Kiribati Joint Implementation Plan for Climate Change and Disaster Risk Management (KJIP) 2014-2023. Available at: <http://www.spc.int/images/news/20140901/KJIP-BOOK.pdf>.

4.5. The Republic of the Marshall Islands (RMI)

Key natural hazards are tropical storms and typhoons, sea swells coinciding with king tides, drought, and tsunami⁸⁴⁵. Key human-induced hazards are fire, contamination of water supply, outbreak of epidemic diseases, and commercial transport accidents⁸⁴⁵. However, it is “predominantly hydro meteorological natural hazards that have the potential to impacts all sectors of the RMI⁸⁴⁵.”

Climate change impacts include accelerated sea level rise, which may increase vulnerability and exposure to shocks and stresses, and an increase the intensity of extreme events⁸⁴⁵.

Recent disaster events affecting the RMI can be seen in the following table⁸⁴⁵:

Table 4.1 Recent disaster events in RMI.

Year	Event	Area(s) affected
2013	Drought	15 atolls/islands north of Majuro
2013	Sea swell, King Tide	Majuro
2008	Sea swell, King Tide	Numerous Pacific locations including the RMI
2008	State of economic emergency	All of RMI
2007	Severe drought	Majuro, Utrik, Wotho, Lae, Namu, Ailuk
1998	Severe drought	All of RMI
1997	Typhoon Paka	Majuro, Aillinglapalap, Namu
1994	High surf wave action	Ajeltake
1992	Typhoon Gay	Majit
1992	Tropical storm Axel	All of RMI
1991	Typhoon Zelda	All of RMI
1988	Tropical storm Randy	Kwajalein
1979	Sea swell	Majuro

The Government declared a state of emergency for the 2013 Drought due to a prolonged dry season and drought, leading to damage or destruction of agriculture on many of the northern atolls and the deterioration of health⁸⁴⁶. The RMI issued an Intermediate Response Plan which required US\$4.6 million to meet the needs of the 6,384 affected people⁸⁴⁶.

⁸⁴⁵ Republic of the Marshall Islands (Udd.). Joint National Action Plan for climate Change Adaptation & Disaster Risk Management 2014-2018. *Republic of the Marshall Islands*. Available at: http://media.wix.com/ugd/23908d_7552c4a1f89a4b7aab7410fb8d6eea0a.pdf. Accessed: 30 October 2015.

⁸⁴⁶ Reliefweb (2013). Marshall Islands: Drought – May 2013. *Reliefweb*. Available at: <http://reliefweb.int/disaster/dr-2013-000053-mhl>. Accessed: 5 January 2016.

After the 2013 drought, the Pacific Adaptation to Climate Change (PACC) Programme has been working with RMI's Office of Environmental Planning and Policy Coordination Office to increase the availability and quality of drinking water via the collection and storage of rainwater in the Majuro reservoir⁸⁴⁷. During the drought, the airport runway, which already had a reservoir and catchment system, was unable to keep up with demand⁸⁴⁷. Since then, the capacity has been increased (from 121 million litres to 138 million litres), a new lining and cover fitted, and loss from seepage and evaporation have been reduced, resulting in an increase in water reserves from 3-4 weeks to 3-4 months⁸⁴⁷. This project is seen as an increase in the resilience of the RMI.

4.5.1. Concept of Resilience

While the RMI does not appear to have an official definition of resilience, their disaster risk management and climate change adaptation plans are expected to develop and increase resilience. RMI has an all-hazards risk management plan. Resilience seems to be synonymous with sustainable, risk reduction, and adaptation. According to RMI government, "disaster risk management and climate change adaptation [...] aim to achieve the same thing: reducing vulnerability and enhancing resilience⁸⁴⁵".

The Joint National Action Plan (JNAP) for Climate Change Adaptation & Disaster Risk Management 2014-2018's aim is to enhance resilience via "providing all stakeholders, from communities, to national and international levels, with a nationally owned and driven guiding action plan that identifies key national priorities for reducing risk and vulnerability in the RMI; and developing strong and productive partnerships between communities, non-government organizations (NGOs) and local government, civil society, traditional leaders, the private sector, national government and regional and international organizations⁸⁴⁵".

4.5.2. Institutional Framework for Delivering Resilience

The JNAP lists the following key actors for delivering disaster risk management and climate change adaptation⁸⁴⁵:

- President and Cabinet;
- Chief Secretary's Office (CSO);
- Office of Environmental Planning and Policy Co-ordination (OEPPC);
- National Climate Change Committee (NC3);
- National Disaster committee (NDC);
- JNAP Unit;
- Government ministries and agencies;
- NGOs;
- Red Cross;
- Local Government and Traditional Leaders;
- Faith based organisations;
- Existing Task Forces and Committees;
- Communities;
- Development Partners and Donors, and Regional Agencies.

4.5.3. Critical Infrastructure and Technical Resilience

While not referred to as technical resilience and instead thought of disaster risk management and climate change adaptation, the 6th goal of the JNAP, "integrated approach to development planning including consideration of climate change and disaster risks" sets out various actions on ways to

⁸⁴⁷ UNDP (Udd.). Protecting drinking water from droughts and sea level rise in the Marshall Islands. *United Nations Development Programme*. Available at: http://www.asia-pacific.undp.org/content/rbap/en/home/ourwork/climate-and-disaster-resilience/successstories/Protecting_drinking_water_from_drought_and_sealevel_rise.html. Accessed: 30 October 2015.

International Survey

achieve land-use planning and building codes, with an indicator of “Degree of damage to infrastructure post extreme weather and disaster events.”

With regards to critical infrastructure, the JNAP acknowledges that “sea level rise and associated impacts such as coastal erosion and inundation threatens infrastructure... [and an] increase in frequency and/or intensity of tropical storms or typhoons also poses a risk to infrastructure, much of which is built with little/no regard for construction standards⁸⁴⁵”.

4.5.4. Organisational Resilience

No known official documents on organisational resilience.

4.5.5. Social Resilience

The 5th goal of the JNAP is “enhanced local livelihoods and community resilience for all Marshall Islands people.” It establishes five outcomes:

- All households have reliable access to clean, fresh water;
- The resilience of community livelihoods (including health and wellbeing) and vulnerable groups including youth and children are strengthened;
- Vulnerability to water and food related hazards and shortages resulting from hazards and climate change impacts is reduced;
- Reduced vulnerability to coastal hazards;
- Effective management of coastal resources including land and marine biodiversity.

It sets out over 35 actions to be undertaken in order to achieve the goal, such as “conduct assessment on the potential impact of climate change on health, including vector borne diseases such as dengue fever,” or “supply all households in Marshall Islands with rainwater catchment tanks.”

While not referred to as societal/community resilience, the JNAP’s Goal 2 deals with community outreach and awareness, stating “public education and awareness of effective DRM/CCA responses from local to national level.” Some relevant actions are:

- Integrate DRM/CCA into the school curriculum;
- Conduct ongoing public awareness campaign on basic emergency response procedures (e.g. location of safe shelters, need to save official documents, etc.) and ensuring the incorporation of IDRL principles and practices; and
- Develop a program to record traditional knowledge / preserve vulnerable cultural resources and through consultation, identify appropriate mechanisms to integrate traditional knowledge in DRM/CCA at the appropriate level.

4.5.6. Economic Resilience

No known documents on economic resilience.

4.5.7. Resilience Related Official Documents

No documents on resilience alone, however two main documents that are contributing to RMI resilience are:

- Joint National Action Plan (JNAP) for Climate Change Adaptation & Disaster Risk Management 2014-2018. Available at: http://media.wix.com/ugd/23908d_7552c4a1f89a4b7aab7410fb8d6eea0a.pdf
- National Strategic Plan 2015-2017. Available at: http://media.wix.com/ugd/23908d_43515761fdca44fd829edfb9565ec137.pdf
- The National Climate Change Policy Framework is considered “a blueprint to build resilience⁸⁴⁵”. Available at: http://www.sprep.org/attachments/Climate_Change/RMI_NCCP.pdf.

4.6. Federal States of Micronesia (FSM)

Disasters likely to occur in the Federated States of Micronesia (FSM) are: coastal erosion, rising sea level, storm surge, and tsunami; dam failure; drought; earthquake; epidemic; flood; rain-induced landslide; tropical cyclone; wildfire; and man-made hazards (hazardous materials incident and terrorism)⁸⁴⁸.

The Typhoon Maysak hit the FSM in 2015, severely affecting the states of Yap and Chuuk. FSM has a total population of 106,100, and the storm affected 29,700 people, displaced 1,500 people, and caused 4 fatalities⁸⁴⁹. The storm also damaged 80% of agriculture and cut power to certain areas⁸⁵⁰.

Two other typhoons hit the country as well in 2015, prompting Micronesia to review its disaster response and hold the Second FSM Disaster Risk Management Platform from 8-12 June 2015⁸⁵¹. Each State is expected to develop a disaster response work plan in the 12 months following the platform⁸⁵¹.

At the Platform, the States established recommendations⁸⁵² for improving disaster response, such as:

- Integrate Micronesia Red Cross Society in disaster preparedness, response and relief;
- Conduct more training and simulation exercises;
- Awareness raising and emergency warnings to be distributed to all media outlets (TV, private radio, SMS) and not only state radio stations;
- Develop community disaster plans; and
- Document traditional practices, skills and knowledge to be shared with future generations.

4.6.1. Concept of Resilience

The concept is not highly developed and the word “resilience” does not appear in any official documents. It is mainly used as an adjective to describe the Micronesian people in their response to disasters.

In 2006, the then President of the Federated States of Micronesia used the word resilience in his speech for the 20th Anniversary of Independence, saying that “one thing, though, that always stand out most about our people is their resilience” and that resilience is part of their natural heritage⁸⁵³.

FSM is part of the The Pacific Adaptation to Climate Change (PACC) project, which was founded in 2009 and has the goal of increasing resilience in the face of climate change.

The Second Annual FSM Platform for Disaster Risk Management was held on the 8-12th June 2015 and had for the theme “Enhancing Safety and Resilience of FSM Communities from Disaster and Climate Change Impacts.”

⁸⁴⁸ NEMO (2005). Final Report: Mutli-State Multi-Hazard Mitigation Plan for the Federated States of Micronesia. *National Emergency Management Office*. Available at: [http://www.preventionweb.net/files/27083_finalfsmmultihmplan\[1\].pdf](http://www.preventionweb.net/files/27083_finalfsmmultihmplan[1].pdf). Accessed: 5 November 2015.

⁸⁴⁹ USAID (2015). Micronesia - Typhoon Maysak Fact Sheet #5. *United States Agency for International Development*. Available at: https://www.usaid.gov/sites/default/files/documents/1866/micronesia_fs05_09-02-2015.pdf. Accessed: 5 November 2015.

⁸⁵⁰ Office of Environment & Emergency Management (2015). Event Typhoon Maysak Situations Report No. 1. *Office Of Environment & Emergency Management*. Available at: <http://reliefweb.int/sites/reliefweb.int/files/resources/Typhoon%20Maysak%20STREP%20%231.pdf>. Accessed: 5 November 2015.

⁸⁵¹ PreventionWeb (2015). Federated States of Micronesia reviews disaster risk management lessons from typhoons. *PreventionWeb*. Available at: <http://www.preventionweb.net/english/professional/news/v.php?id=44732>. Accessed: 5 November 2015.

⁸⁵² Second Annual Federated States of Micronesia Platform for Disaster Risk Management (2015). Meeting Statement adopted by the participants. 8-12 June 2015.

⁸⁵³ Urusemal, J. (2006). On the Occasion of the 20th Anniversary of Independence. *Government of the Federated States of Micronesia*. Available at: http://www.fsmgov.org/ind_d06.htm. Accessed: 5 November 2015.

International Survey

4.6.2. Institutional Framework for Delivering Resilience

Information could not be found.

4.6.3. Critical Infrastructure and Technical Resilience

No known documents on technical resilience.

4.6.4. Organisational Resilience

No known documents on organisational resilience.

4.6.5. Social Resilience

No known documents on social resilience.

4.6.6. Economic Resilience

No known documents on economic resilience.

4.6.7. Resilience Related Official Documents

No official documents on resilience.

4.7. Nauru

Nauru has a population of 9,488 and is only 21 square kilometres in area, making it the third smallest state in the world. In the 1960s and early 70s, Nauru had the highest per-capita income of any sovereign state due to its phosphate rock mining. However, as soon as the resource was exhausted, the islands wealth diminished, with a gross domestic product per capita of \$2,500 in 2007⁸⁵⁴. Over 70% of the population is obese⁸⁵⁵.

Natural disasters affecting Nauru include drought (leading to water shortages), coastal erosion and flooding⁸⁵⁶. Unlike other Pacific Island countries, Nauru is not at risk for typhoons⁸⁵⁶.

Human-induced disasters are made worse by Nauru's geographic isolation and include supply chain disruption, especially for fuel (power outages) and food, fires, fuel and oil spills, and critical infrastructure damage (including medical care)⁸⁵⁶.

4.7.1. Concept of Resilience

The concept of resilience is rather new. Resilience is defined in the Government of the Republic of Nauru's Framework for Climate Change Adaptation and Disaster Risk Reduction (RONAdapt) as "the ability of communities and ecosystems to cope with, withstand and absorb stress"⁸⁵⁶. The document

⁸⁵⁴ Asian Development bank (2007). Country Economic Report Nauru. *Asian Development bank*. Available at: <http://web.archive.org/web/20110607064452/http://www.adb.org/Documents/CERs/NAU/CER-NAU-2007.pdf>. Accessed: 6 November 2015.

⁸⁵⁵ WHO (2014). Profils des pays pour les maladies non transmissibles (MNT). *World Health Organisation*. Available at: http://www.who.int/nmh/countries/nru_fr.pdf?ua=1. Accessed: 6 November 2015.

⁸⁵⁶ Government of the Republic of Nauru (2015). Framework for Climate Change Adaptation and Disaster Risk Reduction (RONAdapt). *Government of the Republic of Nauru*. Available at: http://reliefweb.int/sites/reliefweb.int/files/resources/NRU_2015_RONAdapt_Framework.pdf. Accessed: 6 November 2015.

also states that adaptation and building capacity are part of resilience, and that “resilience as a goal does not imply there is no need to change⁸⁵⁶.”

While the word resilience is not used in the original National Sustainable Development Strategy 2005-2025, it does appear in the National Sustainable Development Strategy 2005-2025 as revised 2009 (NSDS). Reasons for updating the document included “the need to build resilience to climate change⁸⁵⁷.” However, the word is not defined, nor are any strategies established for how to build resilience.

The same document also states that being a small country, in times of global economic crisis they cannot rely on stimulus packages and must “look to other solutions to weather the storm and develop resilience in our economy⁸⁵⁷.” It lays out several strategies on how to obtain its economic sector goals.

The concept of resilience is greatly elaborated on in the 2015 RONAdapt Framework, where the word is defined and a strategy is laid out on how to achieve greater resilience. The RONAdapt Framework is meant to aid in the achieving of the NSDS goals.

RONAdapt lays out six over-arching resilience goals: water security, energy security, food security, a healthy environment, a healthy people, and productive and secure land resources. It also establishes priority actions, or activities that contribute to achieving multiple goals, such as the rehabilitation of land contributing to: a healthy environment (through increased habitat for biodiversity), food security (through having more land for agriculture), water security (through more land for water catchment and storage), etc.⁸⁵⁶

There is also a strong emphasis on building human capacity, as the skills needed to carry out the RONAdapt are currently lacking in the Nauru population.

4.7.2. Institutional Framework for Delivering Resilience

According to the NSDS, some key actors for delivering resilience include national government, communities, private sector, and international NGOs. Nauru is very reliant on outside help and expertise for implementing their strategy to build resilience, but part of that strategy includes the transfer of knowledge to Nauruans.

4.7.3. Critical Infrastructure and Technical Resilience

No known documents on technical resilience.

4.7.4. Organisational Resilience

No known documents on organisational resilience.

4.7.5. Social Resilience

No known documents on social resilience.

The NSDS establishes that “education is an important factor in developing the human capacity necessary for sustainable development and for building resilience to climate change and to potential disasters⁸⁵⁷.”

⁸⁵⁷ Government of the Republic of Nauru (2009). National Sustainable Development Strategy 2005-2025 as revised 2009 (NSDS). *Government of the Republic of Nauru*. Available at: <http://www.adb.org/sites/default/files/linked-documents/cobp-nau-2016-2018-nsds.pdf> Accessed : 6 November 2015.

International Survey

Examples of capacity building strategies include:

- Skills transfer to local Nauruans during development projects;
- Strengthen communities;
- Improve community preparedness and response systems;
- Build human capacity of health services.

4.7.6. Economic Resilience

No known documents on economic resilience.

The NSDS establishes economic sector goals in order to develop resilience in the economy, and also lays out a strategy for how to achieve those goals.

The goals are:

- Macroeconomic management: A stable macroeconomic environment conducive to private investment established;
- Agriculture: Increased level of domestic agricultural production aimed at addressing food security and healthy livelihoods;
- Fisheries: Enhance development and sustainable management of marine and fisheries resources to provide sustainable economic returns;
- Mining & Quarrying: Efficient and effective use of mining and quarrying resources;
- Commerce, Industry & Business Development: Promote development of small and micro enterprises, foreign investment and economic integration into the global economy;
- Tourism: Promote development of small-scale sustainable eco-tourism;
- Financial Services: An effective, competitive and stable financial system that will enhance economic growth and development.

Strategies range from “development of a coherent strategy to deal with Government debt” to “develop local food and agricultural production⁸⁵⁷” and “promote development of small and micro enterprise (SME) business⁸⁵⁷”.

4.7.7. Resilience Related Official Documents

No documents on resilience alone, however the main documents contributing to strengthening resilience are:

- Framework for Climate change Adaptation and Disaster Risk Reduction (RONAdapt). Available at: http://reliefweb.int/sites/reliefweb.int/files/resources/NRU_2015_RONAdapt_Framework.pdf;
- National Sustainable Development Strategy 2005-2025 as revised 2009 (NSDS). Available at: <http://www.adb.org/sites/default/files/linked-documents/cobp-nau-2016-2018-nsds.pdf>.

4.8. Palau

The Republic of Palau is prone to disasters, both natural and human-induced, and is also affected by climate change. The following table⁸⁵⁸ identifies the risks most likely to affect Palau:

⁸⁵⁸ Republic of Palau (2010). National Disaster Risk Management Framework 2010. *Republic of Palau*. Available at: <http://reliefweb.int/sites/reliefweb.int/files/resources/National%20Disaster%20Risk%20management%20Framework%202010.pdf>. Accessed: 9 November 2015.

Table 4.2 Most likely disasters in Palau.

Natural Hazards	Level of Risk
Storm Surge	High
Drought	High
Typhoon	High
Sea-level rise (sea-water intrusion/soil saline/coastal inundation & erosion)	High
Tsunami	Low
Earthquake	Low
Landslides	Low
Human-induced and other Hazards	
Oil spill	High
Water contamination including sewerage	High
Solid waste disposal	High
Wildlife behaviour (affecting aircraft movement)	High
Increased sedimentation of watershed/coastal waters	High
Fire (industrial areas)	High
Fire (residential areas)	Medium
Invasive species	Medium
Hazardous substances spill	Medium
Emerging/infectious disease	High
Terrorism	Low
Airport/port incidents	Low
Civil uprising	Low
Political instability	Low

On December 3rd, 2012, Typhoon Bopha passed over Palau. Before the event, the National Emergency Management Office (NEMO) issued over ten detailed Public announcements in order to warn residents of the typhoon's approach, which precautionary measures to take, and that evacuations

International Survey

centers were open (45 in total)⁸⁵⁹. In all, 112 houses were completely destroyed, 136 houses endured major damages, with extensive damage done to taro patches, banana farms and other crops, but no fatalities⁸⁶⁰.

4.8.1. Concept of Resilience

While the concept of resilience appears to be well known in Palau, an official definition is not available at this time and resilience is mostly seen as an outcome of the legislation on disaster risk management and climate change policy.

The Achieving Resilient Agriculture and Aquaculture: A national policy for strengthening food security in Palau as a priority climate change adaptation measure (Food Security Policy) establishes the cornerstones of resilience as resilient communities, resilient institutions, resilient ecosystems, and resilient economies. It does not define resilience, however.

In 2005 Palau endorsed the Madang Framework and the Pacific Islands Framework of Action on Climate Change, 2006–2015, which is the Pacific’s adaption of the Hyogo Framework for Action⁸⁵⁸.

The vision of the National Disaster Risk Management Framework 2010 is “safe, resilient and prepared communities in Palau⁸⁵⁸.” Palau has an all-hazards, whole-of-government and whole-of-country approach to disaster risk reduction and disaster risk management and establishes risk management as “an ongoing process to strengthen resilience⁸⁵⁸”.

In 2014, Palau was the first island nation to start work on The National Broadcasters Climate and Disaster Resilience Plan Project, a project to develop climate and disaster resilience plans for national broadcasters, teaching them about Palau’s national emergency management plan and how to develop Standard Operating Procedures for disasters⁸⁶¹.

The Climate Change Policy for Climate and Disaster Resilient Low Emissions Development 2015 (Climate Change Policy) has a vision of “happy, healthy, sustainable and resilient communities in a changing world⁸⁶²”. The Climate Change Policy lays out three objects: “1) enhance adaptation and resilience, 2) manage disasters and minimize disaster risk, and 3) mitigate global climate change by working towards low emission development⁸⁶³.” It aims to build resilience within ecosystems, the economy, and society⁸⁶³.

The Achieving Resilient Agriculture and Aquaculture: A national policy for strengthening food security in Palau as a priority climate change adaptation measure (Food Security Policy) focuses on food security as one of the corner stones of resilience, especially for economic resilience. The primary

⁸⁵⁹ OCHA (2012). Palau: Typhoon Bopha Situation Report No. 1 (as of 3 December 2012). *Office for the Coordination of Humanitarian Affairs*. Available at: [http://reliefweb.int/sites/reliefweb.int/files/resources/Palau%20Typhoon%20Bopha%20Situation%20Report%20No.%201%20\(a\)s%20of%203%20December%202012\).pdf](http://reliefweb.int/sites/reliefweb.int/files/resources/Palau%20Typhoon%20Bopha%20Situation%20Report%20No.%201%20(a)s%20of%203%20December%202012).pdf). Accessed: 10 November 2015.

⁸⁶⁰ OCHA (2012). Palau: Typhoon Bopha Situation Report No. 3 (as of 11 December 2012). *Office for the Coordination of Humanitarian Affairs*. Available at: http://reliefweb.int/sites/reliefweb.int/files/resources/TyphoonBopha_SitRep3_12Dec2012.pdf. Accessed: 10 November 2015.

⁸⁶¹ SPREP (2014). Palau first to start work on national broadcasters’ climate and disaster resilience plan. *Secretariat of the Pacific Regional Environment Programme*. Available at: <https://www.sprep.org/climate-change/palau-first-to-start-work-on-national-broadcasters-climate-and-disaster-resilience-plan>. Accessed: 10 November 2015.

⁸⁶² SPC (2015). Time for global action on climate change says Palau’s President. *Secretariat of the Pacific Community*. Available at: <http://www.spc.int/en/media-releases/2257-time-for-global-action-on-climate-change-says-palau-president.html>. Accessed: 9 November 2015.

⁸⁶³ Government of Palau (2015). Palau Climate Change Policy for Climate and Disaster Resilient Low Emissions Development 2015. *Government of Palau*. Provided to author by government officials.

vision, or policy statement, of the Food Security Policy is “a resilient, sustainable and food secured Palau⁸⁶⁴.”

4.8.2. Institutional Framework for Delivering Resilience

In the National Disaster Management Framework, Palau’s then President Johnson Toribiong states that “this responsibility [of disaster management and resilience building] should be shared with communities, the private sector, and everybody⁸⁵⁸.” The Framework also “requires the commitment of all levels of civil society to engage in the conscious management of risk as an ongoing process to strengthen resilience⁸⁵⁸.”

It establishes the National Emergency Management Office (NEMO) as being responsible for coordinating disaster preparedness activities, and lists their partners as: NEC (National Emergency Committee) working groups, all government departments, NGOs, churches, the private sector, community groups and regional partners⁸⁵⁸.

4.8.3. Critical Infrastructure and Technical Resilience

No known documents on technical resilience as Palau rely on their disaster risk management strategy, climate change policy and food security policy in order to achieve resilience.

The Disaster Risk Management (DRM) model used by Palau consists of both Disaster Risk Reduction and Disaster Risk Management, as can be seen in Figure 4.10.

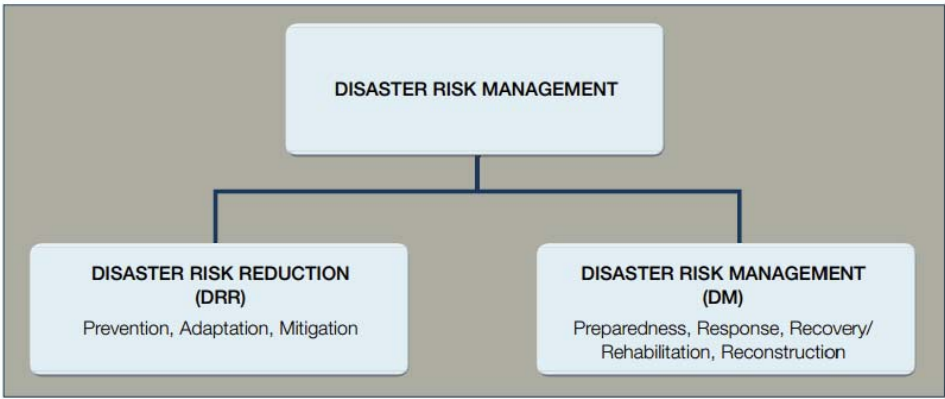


Figure 4.10 Palau DRM model

DRM is defined as “all forms of activities, including structural and non-structural measures, to avoid (prevention) or to limit (mitigation and preparedness) risks so as to lessen the impacts of natural hazards and related environmental and technological disasters⁸⁵⁸.”

Disaster risk reduction is defined as reducing vulnerabilities, disaster risks and adverse impacts from hazards “within the broad context of sustainable development⁸⁵⁸” and is made up of three components: prevention, adaptation and mitigation.

Disaster risk management is defined as “the organization and management of resources and responsibilities for dealing with all aspects of emergencies/disasters, in particular preparedness, response and recovery⁸⁵⁸,” and is made up of four components: preparedness, response, recovery/rehabilitation, reconstruction.

⁸⁶⁴ Government of Palau (2015). Achieving Resilient Agriculture and Aquaculture: A national policy for strengthening food security in Palau as a priority climate change adaptation measure. *Government of Palau*. Provided to author by government officials.

International Survey

In regards to critical infrastructure, the Climate Change Policy establishes a vision of “resilient infrastructure that fosters preparedness and adaptive capacity to address the impacts of climate change in Palau” and a 2020 goal of “strengthen[ing] resilience of critical infrastructure while reducing the carbon footprint from infrastructure⁸⁶³.”

It lays out 4 policy interventions, with one to three actions each. For example, Intervention 2, “undertake site-specific risk assessments and develop risk management plans for vulnerable infrastructure” is made up of three actions, “1) carry out risk assessments to identify vulnerable infrastructure and develop appropriate risk management plans, 2) prioritize and identify costs for each infrastructure, and 3) relocate national hospital⁸⁶³.”

The Food Security Policy’s focus on institution resilience emphasizes the importance of integrated land-use planning as “a critical component of building resilience⁸⁶⁴.”

It also states that “assets, values and opportunities are lost when public infrastructure and equipment is incomplete, poorly built, or poorly maintained⁸⁶⁴,” and that reliable public infrastructure is paramount to achieving resilience, especially during extreme events, where access to food is a critical first step. It lays out projects such as improving buildings, roads and transportation equipment and infrastructure as keys to improving resilience.

Furthermore, it establishes increasing water reserves and local food production as a priority action, laying out activities such as increasing water catchment and storage systems and surplus local food.

4.8.4. Organisational Resilience

No known documents on organisational resilience. In the Food Security Policy, it is established that an adaptive management approach should be used in cases of conflicting information.

4.8.5. Social Resilience

No known documents on societal resilience, however the Climate Change Policy and the Food Security Policy address the topic.

The Climate Change Policy states that the goal of all priority interventions is to “build safe, resilient, and disaster-prepared communities.” The Climate Change Policy sees community resilience as being part of health, society and culture, and education. For each sector, the Climate Change Policy lays out priority interventions and actions in order to achieve the goal of resilient communities.

For health, the goal is to increase community resilience through improved access to health services. The priority interventions are to “strengthen the capacity and resilience of existing health infrastructure, strengthen resilience within vulnerable communities including persons with disabilities, and improve health services communication systems and preventative health services to build resilience to water-borne and vector-borne diseases⁸⁶³.” Indicators used include number and type of health centers with improved equipment, number and type of health communications and preventative services offered increases, etc.

Concerning society and culture, the goal is to strengthen community resilience via “the establishment of sound institutional arrangements that are based on dynamic traditional systems, improved capacity building, a robust labour force, and effective emergency preparedness⁸⁶³.” Indicators used include number of centers able to serve as shelters, emergency support system in place for vulnerable members of society, strengthened immigration laws, etc.

Lastly, in education, the goal is to strengthen community resilience via coordinated disaster risk and climate change information in its school curriculum and educational outreach to the broader community as well. Indicators used include teacher training modules for curriculum implementation

developed, number of scholarships offered and awarded for climate change and disaster management, etc.

The Food Security Policy states that “functional social systems (such as traditional governance, customs and practices) are essential to effectively strengthening⁸⁶⁴.”

4.8.6. Economic Resilience

No known documents on economic resilience, however the Food Security Policy addresses the topic.

Economic resilience is achieved through maintaining a strong subsistence economy for local food production and by enabling an environment for farmers to effectively commercialize, which the Food Security Policy states “can be achieved through financial incentives and entrepreneurial training and services⁸⁶⁴.” It also acknowledges that current information gaps concerning economic information needed in order to monitor economic resilience exist and sets out an action to fill in the those gaps.

Furthermore, it sets an action to train and build business (financial management) knowledge and skills, establishing capacity building as an important aspect of economic resilience.

4.8.7. Resilience Related Official Documents

No documents on resilience alone, however the main documents contributing to strengthening resilience are:

- “Palau Climate Change Policy for Climate and Disaster Resilient Low Emissions Development 2015.” Provided by the Palauan government.
- “Achieving Resilient Agriculture and Aquaculture: A national policy for strengthening food security in Palau as a priority climate change adaptation measure.” Provided to author by government officials.
- “National Disaster Risk Management Framework 2010.” Available at: <http://reliefweb.int/sites/reliefweb.int/files/resources/National%20Disaster%20Risk%20management%20Framework%202010.pdf>.

4.9. Papua New Guinea

Papua New Guinea (PNG) is sensitive to several natural hazards, including earthquakes, volcanic eruptions, tsunamis, cyclones, coastal flooding, inland flooding, coastal erosion, landslides, droughts and frost.^{865,866} PNG has the highest percentage of population exposed to severe volcanic risk and is in the top six countries for the highest percentage of population exposed to earthquakes.

PNG has experienced at least 13 severe droughts over the last 120 years⁸⁶⁷; however, serious problems are caused by heavy precipitation as well. Heavy rains often lead to damage to road infrastructure and livelihoods, as well as economic losses. In 2012 the total damages and losses amounted to approximately US\$28 million. The government provided more than US\$300,000 for humanitarian aid and US\$1.5 million to restore access to the damaged roads.⁸⁶⁵

PNG is experiencing the effects of climate change in terms of increased extreme weather events and the resulting economic impacts e.g.:⁸⁶⁸

⁸⁶⁵ Country profile Papua New Guinea, <https://www.gfdr.org/>

⁸⁶⁶ Papua New Guinea’s Strategic Program for Climate Resilience, 2012, <https://www-cif.climateinvestmentfunds.org/>

⁸⁶⁷ Papua New Guinea, PACC Country Brief, Pacific Adaptation to Climate Change

⁸⁶⁸ National Climate Compatible Development Management Policy, 2014

International Survey

- The king tides in 2008 which affected coastal provinces of Sandaun, East Sepik, Kavieng and Manus;
- Sea level rise in Caterets Island resulting in the relocation of people (climate change refugees) to Tinputz, in the Autonomous Region of Bougainville;
- Cyclone Guba which devastated parts of Oro Province;
- The landslide in Koma, Southern Highlands;
- Coastal erosion in coastal provinces;
- Food and water security.

4.9.1. Concept of Resilience

Despite of the high severity and frequency of volcanic disasters, human groups persisted in the region over millennia exhibiting a high level of resilience. Following disasters some regions were abandoned for a considerable time period, but then re-occupied.⁸⁶⁹ This was most likely enabled by established social ties between communities unaffected by the actual disaster, which provided shelter and access to resources for the refugees.

In modern times recent urbanization calls for a systematic approach to ensure resilience of the communities and infrastructure, especially in the light of climate change; therefore, together with other countries in the region, PNG was among the first nations to adopt the Hyogo Framework for Action in 2005.

In 2009 the National Strategic Plan Taskforce developed a strategic vision, Vision 2050⁸⁷⁰ on behalf of PNG's government. Vision 2050 defines short and long term development strategies aiming sustainable development through Disaster Risk Management (DRM) and Climate Change Adaptation (CCA). A major objective of this strategic plan is “sustainable development measures developed in all sectors to increase resilience to the impacts of climate change and environmental changes”. What resilience means and how it is measured is not detailed in the document.

To implement the strategy defined in Vision 2050, the Office of Climate Change and Development (OCCD) developed a Climate-compatible Development Strategy for Papua New Guinea (CCDS)⁸⁷¹ that outlines key measures that will, besides mitigating greenhouse gas emissions, “shape the development to be more climate-resilient”. The key components of the CCDS, launched in 2010, are shown in Figure 4.11.

⁸⁶⁹ Robin Torrence, Social resilience and long-term adaptation to volcanic disasters: The archaeology of continuity and innovation in the Willaumez Peninsula, Papua New Guinea, Quaternary International, Available online 5 May 2014, ISSN 1040-6182.

⁸⁷⁰ The Independent State Of Papua New Guinea (2009). Papua New Guinea Vision 2050. *National Strategic Plan Taskforce*. Available at: <https://sustainabledevelopment.un.org/content/documents/1496png.pdf>. Accessed: 22 May 2016.

⁸⁷¹ Government of Papua New Guinea (2010). Climate-compatible development for Papua New Guinea. *Government of Papua New Guinea*. Available at: http://www.unredd.net/index.php?option=com_docman&Itemid=134&view=download&alias=7730-publications-ccds-2nd-draft-7730&category_slug=studies-and-publications-on-redd-1910. Accessed: 20 May 2016.

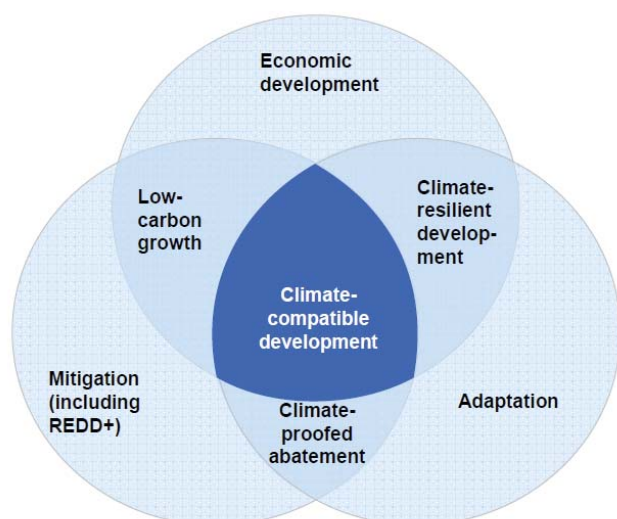


Figure 4.11 The components of climate-compatible development⁸⁷¹.

In 2012 PNG launched its DRM plan the Strategic Program for Climate Resilience⁸⁷² (SPCR). The overall outcome of the SPCR is “the enhancement of PNG’s resilience to climate change through improved access to resources, knowledge, and tools and climate resilient infrastructure at the national, sectoral, district, and community levels.”

The program aims to "develop capacity for climate change vulnerability mapping and *develop early warning systems and community emergency preparedness training*". Its main components are 1) Building Climate resilient Communities, 2) Addressing Climate Change Risks to Food Security and 3) Climate resilient Infrastructure.

Resilience is hoped to be enhanced through:

1. “Establishment of a pool of trained and qualified specialists to support climate change risk management mainstreaming activities at national and sectoral levels and within vulnerable communities.
2. Legal establishment and effective operation of PNG’s Climate Change Trust Fund, and the establishment of a small grants program to support priority adaptation projects for farmers, fisherfolk, and vulnerable communities, in particular women.
3. Coastal fisheries that are more resilient to impacts of climate change.
4. Critical infrastructure less vulnerable to impacts of climate change and disasters.
5. Vulnerable communities in remote islands and atolls made more resilient to climate change risks.”

The PNG SPCR was endorsed in 2012 with funding of \$25 million in grants, of which \$750,000 was allocated to prepare a grant project. The project, Building Resilience to Climate Change (BRCC) in Papua New Guinea, aims to support implementation of PNG’s SPCR. The impact is expected to be increased capacities of communities, government agencies and civil society to plan and respond to the impacts of climate change. To achieve this, it is expected to implement: a) climate responsive investment approaches identified and implemented by vulnerable communities, b) sustainable fishery eco-systems and food security investments piloted in nine vulnerable island and atoll communities and

⁸⁷² SPCR (2012). Papua New Guinea’s Strategic Program for Climate Resilience. *Strategic Program for Climate Resilience*. Available at: https://www-cif.climateinvestmentfunds.org/sites/default/files/meeting-documents/strategic_program_for_climate_resilience_for_papua_new_guinea_0.pdf. Accessed: 20 May 2016.

International Survey

c) enabling framework for climate resilient infrastructure established and the communication network extended. These concern implementation in several domains of resilience as discussed later.

In 2014 the National Climate Compatible Development Management Policy⁸⁶⁸ (NCCDMP) was developed. The NCCDMP aims “to build a climate resilient and carbon neutral pathway for climate compatible development” in PNG. A main focus is on adaptation responses i.e. resilience to climate change impacts in the natural and built environment should significantly be enhanced. Resilience of people and sectors should be built against the impacts of climate change through the implementation of appropriate adaptation measures, incorporating use of a risk management approach. Specific national, sectoral and provincial policies related to resilience include e.g. natural asset protection, sustainable land use planning, diversification of local economies, physical and sector vulnerabilities, threats to water supply, transportation Infrastructure.

4.9.2. Institutional Framework for Delivering Resilience

Roles and responsibilities mentioned in the NCCDMP⁴ are defined at 3 different levels:

1. National level

The main responsibility is coordination of a) Research and Development; b) Standards, Incentives and Regulation; c) Policy Development and Implementation; d) Provide National and International Leadership.

2. Sub-National level

The role of Sub-National actors is to address capacity and knowledge gaps via education, advocacy, awareness and consultation programs. This includes:

a) Provincial Government roles in the implementation of the policies through the Provincial Climate Change Committees and provincial priorities in terms of planning

b) Local Level Government roles where most climate impacts occur. When storms and floods occur, citizens look to their local leaders for answers and solutions, as well as for protection.

3. Public Private Partnerships level, i.e. active private sector participation is aimed to be driven through the Public Private Partnership arrangement.

Concerning responsibility a collaboration between the Provincial Local Level Government Affairs (DPLPGA) and the Office of Climate Change and Development (OCCD) is envisioned “to ensure that these sectors are climate resilient, as well as climate sustainable in terms of service delivery in the communities, and the province as a whole.”

The main key service delivery sectors in the provincial government sphere, operating under the legal mechanism of the Organic Law on Provincial and Local Level Government (OLPLLG), are: 1) Education, 2) Health, 3) HIV and AIDS, 4) Agriculture, 5) Fisheries, 6) Forestry, 7) Disaster Management, 8) Environment, 9) Community Development, 10) Village Courts, 11) Land Mediation, 12) Commerce and Industry, 13) Lands and Physical Planning, 14) Non-renewable resources, 15) Infrastructure.

4.9.3. Critical Infrastructure and Technical Resilience

The aforementioned Building Resilience to Climate Change (BRCC) has several outcomes which contain various elements of implementation of technological resilience. Some examples are highlighted below:

- Climate responsive investment approaches identified and implemented by vulnerable communities through (among others)

- localized climate projections to identify potential climate threats;
- Sustainable fisheries ecosystems and food security investments demonstrated and piloted in nine vulnerable island and atoll communities which includes (among others) to
 - demonstrate the techniques used in the rehabilitation of protective coral reefs surrounding vulnerable islands and degraded mangrove forests in nearby coastal areas;
 - pilot localized processing of marine products to extend their shelf life;
- Enabling framework for climate resilient infrastructure established and communication network by (among others)
 - upgrading engineering design standards;
 - extending the radio communications network to facilitate early warning for natural disasters and extreme climate events through a very high frequency network.

However, specific details for all these have not yet been developed or not available. Some interesting results to be expected are e.g. Design Manual for Measures to Improve Climate Resilience in Rural roads and Construction Manual for Resilience Enhancement Measures.⁸⁷³

An interesting example as a result of the policies discussed earlier is the Pacific-Australia Climate Change Science and Adaptation Planning Program (PACCSAP) Coastal Inundation Project⁸⁷⁴. The project aimed to enhance the capacity of Tonga, Papua New Guinea, Vanuatu and Samoa to undertake assessments of inundation risk to key settlements and infrastructure from sea level rise through the provision of critical baseline data, improved GIS capacity, and implementation of simple coastal inundation modelling.

4.9.4. Organisational Resilience

BRCC aims to assist the 21 island communities to develop emergency response strategies in the event of an extreme climate event and provide training in actions and procedures to be followed.

An example of actions addressing the enhancement of organisational resilience is the Disaster Response Exercise and Exchange (DREE) organised by the Government of Papua New Guinea (PNG) and the U.S. Army Pacific Command (USARPAC) in 2015.⁸⁷⁵ The DREE emphasizes operational capabilities and joint efforts for projects that enhance collaboration and communication throughout the South Pacific region. Additionally, it provides a framework for civil and military authorities to present best practices, engage in collaborative dialog, exercise plans and procedures, and enhance readiness to respond.

4.9.5. Social Resilience

BRCC addresses some aspects of implementation of social resilience. As an example strengthening of the resilience of local communities through sustainable fisheries ecosystems and food security investments in nine vulnerable island and atoll communities could be mentioned.

⁸⁷³ The World Bank (2011). PNG: Building a More Disaster and Climate Resilient Transport Sector. *The World Bank*. Available at: <http://www.worldbank.org/projects/P129322/png-building-more-disaster-climate-resilient-transport-sector?lang=en&tab=overview>. Accessed: 20 May 2016.

⁸⁷⁴ CRCSI (Udd.). Pacific Island Coastal Inundation Capacity Building. Government of Australia. Available at: <http://www.crcsi.com.au/research/commissioned-research/pacific-island-coastal-inundation-capacity-building/>. Accessed: 20 May 2016.

⁸⁷⁵ Embassy of the United States: Papua New Guinea (2015). Pacific Resilience: PNG and U.S. Army Partner for Disaster Response Exercise in Lae. *Embassy of The United States*. Available at: <http://portmoresby.usembassy.gov/mr05062015.html>. Accessed: 20 May 2016.

International Survey

According to the Pacific Adaptation to Climate Change (PACC)⁸⁶⁷ a drought plan is part of the policy/regulatory framework of the National Food Security Policy⁸⁷⁶. This framework aims to increase and diversify food production in order to achieve greater self-sufficiency in food and attain food security at the national and household levels.

4.9.6. Economic Resilience

BRCC's effort to identify and implement climate responsive investment by vulnerable communities could be mentioned as an example. To put this in context it should be mentioned that PNG's economy is in transition to a semi-commercial/commercial farming system. However, the majority of the population of PNG practice subsistence farming. To accommodate change, understanding the capacity of farming communities to adapt and be resilient is essential.⁸⁷⁷

4.9.7. Resilience Related Official Documents

Official documents on resilience:

- Vision 2050
- Climate-compatible Development Strategy (CCDS)
- Strategic Program for Climate Resilience (SPCR) for Papua New Guinea, 2012, <https://www-cif.climateinvestmentfunds.org/>
- Development Strategy Plan (DSP)
- Medium Term Development Plan (MTDP)
- Public Investment Plan (PIP)
- National Strategic Plan 2010-2030.

4.10. Samoa

Samoa is exposed to a number of natural and technological hazards. Some of these hazards are seasonal, such as tropical cyclones, floods and droughts. Others are an ever present threat, such as earthquakes, volcanic eruption, tsunamis, epidemics, industrial hazards, and exotic plant or animal diseases. A basic risk assessment carried out in Samoa's National Disaster Management Plan rated the Hazards according to Table 4.3:

⁸⁷⁶ Department of Agriculture and Livestock (2000). Papua New Guinea Food Security Policy 2000–2010. *Department of Agriculture and Livestock*.

⁸⁷⁷ Palaniappan G., Chambers B. et al. (2011). Building social resilience through understanding capacities of smallholder farming in Papua New Guinea. P. 1–4

Table 4.3 List of hazards in Samoa.

Hazard	Level of Risk
Cyclone	Extreme
Volcanic	Eruption Extreme
Tsunami	Extreme
Urban Fire (Apia)	Extreme
Public health crisis	Extreme
Environmental crisis – invasive species	Extreme
Flood	High
Earthquake	High
Landslide	High
Forest Fires	High
Aircraft emergency (airport)	High
Hazchem incident – marine	High
Lifeline Utility Failure – water	Moderate
Agricultural crisis – animal or plant disease	Moderate
Civil emergency – external	Moderate
Lifeline Utility Failure – telecommunications	Low
Lifeline Utility Failure – electricity	Low
Single asset infrastructure failure – building collapse	Low
Single asset infrastructure failure – dam	Low
Drought	Low
Aircraft emergency (other location)	Low
Maritime vessel emergency	Low
Hazchem incident – land	Low
Terrorism	Low
Civil emergency – internal	Low

In September 2009, Samoa was struck by a tsunami which killed 143 and injured 310 people. Over 12,000 people were affected by waves that wiped out large stretches of the south and south-east coasts of the main island of Upolu.

In late 2012, Samoa was severely affected by Tropical Cyclone Evan which killed 12 people and displaced thousands. OCHA ROP issued an Emergency Cash Grant of US\$50,000 and provided weather updates, assessment tools, and a global standby taskforce to support mapping. Several Pacific Humanitarian Team partners from Samoa and Fiji also supported ad-hoc requests from the government.⁸⁷⁸

4.10.1. Concept of Resilience

While there is a good understanding of vulnerability in Samoa there is a relatively poor understanding of resilience. The latter is evident in two ways. Firstly through the current Samoan language definition of resilience which has the same meaning as adaptation. Secondly through responses from a range of people in Samoa when presented with a more in-depth understanding of resilience based on the IPCC (2007) definition. A more comprehensive and meaningful definition of resilience is required for use in Samoa.

The current IPCC (2007) definition of resilience is recommended for use in Samoa. This will require revisiting of current English language definitions in use by MNRE and translation into Samoan language. A Samoan language definition of resilience needs to be developed with engagement of local people to ensure there is a clear understanding of what it means in practice.

⁸⁷⁸ <http://www.unocha.org/rop/about-us/about-ocha-regional/samoa>

International Survey

The IPCC (2007) defines resilience as “The ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self organisation, and the capacity to adapt to stress and change.”

A number of programmes and projects during the last five years also show that the concept of resilience has started to emerge in relation to climate change:

Pilot Programme for Climate Resilience, 2010

The Pilot Programme for Climate Resilience (PPCR) is one of the programmes under the Strategic Climate Fund of the Climate Investment Funds. The PPCR is designed to pilot and demonstrate ways to integrate climate risk and resilience into core development policies, planning and budgeting processes at national and regional level through increased capacity and scaled-up investments.

The PPCR is structured in two phases. Phase 1 will strengthen the enabling environment for climate change adaptation and disaster risk reduction, as needed, and develop the PPCR Strategic Programme for Climate Resilience (SPCR). In Samoa this is referred to as the Climate Resilience Investment Programme (CRIP). All Phase 1 initiatives underpin implementation of Phase 2. The latter will implement the CRIP, mainly through investments in the public and private sectors.

Strategic Programme for Climate Resilience , 2011

The SPCR identifies the following key challenges related to vulnerability to climate change/variability:

Damaging effects of climate change include floods, damage resulting from strong winds and high seas, coral bleaching and droughts, which is translating into major consequences for lives and livelihoods, and hence progress in achieving the Millennium Development Goals.

The programme identifies two investment projects to increase resilience in Samoa:

1: Enhancing the climate resilience of the West Coast Road (Apia to Airport)

Key results: Increased resilience of the West Coast Road infrastructure to extreme weather effects, improved transit conditions for all road users, and reduced routine and periodic maintenance costs.

2: Enhancing the climate resilience of coastal resources and communities

Key results: Reduce vulnerability to and enhance the capacity of natural systems and coastal communities to recover from impacts (chronic and acute) associated with climate change and extreme weather events.

Integration of Climate Change Risks and Resilience into Forestry Management in Samoa (ICCRIFS)

This UNDP-supported project is working to increase the resilience and adaptive capacity of Samoa's forest areas, and the communities that depend on them for livelihoods. The project aims at fostering a shift from current unsustainable forestry and agro-forestry practices towards a more sustainable and climate resilient system with forestry techniques adjusted to current and anticipated changes in climatic conditions. To this end, the project aims at implementing alternative forestry management

approaches and techniques, in demonstration sites, supported through creating an enabling environment to build institutional and technical capacities.^{879,880}

Enhancing the climate-resilience of tourism-reliant communities in Samoa

The objective of this project is to increase the resilience of the tourism sector of Samoa through mainstreaming climate risks into tourism-related policy processes and adaptation actions in coastal communities and tourism operators. As detailed in the project framework, tourism is a vital economic force in Samoa representing around 30% of GDP, and providing livelihood to many local businesses in the accommodation, catering and transportation sub-sectors, providing broader income opportunities through its knock off effects in the tourism value chain, such as handicrafts, agricultural production, communication services, etc. The benefits from tourism nationally and for local communities go well beyond direct economic impacts.⁸⁸¹

4.10.2. Institutional Framework for Delivering Resilience

Except from the National Disaster Management Plan, where resilience is mentioned briefly, there are no official documents where the concept resilience is used.

4.10.3. Critical Infrastructure and Technical Resilience

Except from the National Disaster Management Plan, where resilience is mentioned briefly, there are no official documents where the concept resilience is used.

4.10.4. Organisational Resilience

Except from the National Disaster Management Plan, where resilience is mentioned briefly, there are no official documents where the concept resilience is used.

4.10.5. Social Resilience

Except from the National Disaster Management Plan, where resilience is mentioned briefly, there are no official documents where the concept resilience is used.

4.10.6. Economic Resilience

Except from the National Disaster Management Plan, where resilience is mentioned briefly, there are no official documents where the concept resilience is used.

4.10.7. Resilience Related Official Documents

Except from the National Disaster Management Plan, where resilience is mentioned briefly, there are no official documents where the concept resilience is used.

⁸⁷⁹ Climate Change Adaption (Udd.). GEF-LDCF Project. *United Nations Development Programme*. Available at: <http://www.undp-alm.org/projects/lDCF-samoa-iccrifs>. Accessed: 20 May 2016.

⁸⁸⁰ GEF (Udd.). LDCF - Samoa - Integration of Climate Change Risk and Resilience into Forestry Management (ICCRIFS). *Global Environment Facility*. Available at: <https://www.thegef.org/gef/node/3341>. Accessed: 20 May 2016.

⁸⁸¹ Climate Change Adaption (Udd.). LDCF Project. *United Nations Development Programme*. Available at: <http://www.undp-alm.org/projects/lDCF-tourism-samoa>. Accessed: 20 May 2016.

4.11. Solomon Islands

According to the National Disaster Risk Management Plan⁸⁸², the following threats are considered significant for the Solomon Islands:

- Tropical Cyclones and Wind Storms;
- Floods;
- Earthquakes;
- Landslides;
- Volcanic Eruptions;
- Tsunamis and wave surges;
- Droughts;
- Pandemics;
- Agriculture Pests and Diseases;
- Aviation and Maritime Disasters;
- Fires;
- Industrial Accidents;
- Marine Pollution;
- Other man-made threats including the civil impacts of conflict.

In 2007, the Solomon Islands earthquake struck, with an 8.1 magnitude that also triggered a tsunami five minutes later⁸⁸³. 52 people were killed and almost 37,000 people were affected, with over 200 schools being destroyed, and the two main hospitals also sustained heavy damage. While an early-warning system was and remains in place, the earthquake struck too close to the shore for the warning to reach residents in time⁸⁸⁴.

4.11.1. Concept of Resilience

Resilience is a rather new concept used in the Solomon Islands, and as such the government does not appear to have an official definition of the concept. The word “resilience” is starting to appear in official literature. The National Disaster Risk Management Plan states “risk reduction management is [...] an investment for community resilience and sustainability.”

The World Bank, along with Solomon Islands’ Ministry of Environment, Climate Change, Disaster Management and Meteorology have undertaken the project CRISP, Community Resilience to Climate Disaster Risk in Solomon Islands Project in order to increase community resilience to climate change and natural hazard risk⁸⁸⁵.

In 2014, work started on the development of a risk Resilient Development Toolkit, a joint project between the Ministry of Development Planning and Aid Coordination (MDPAC), the Ministry of Environment, Climate Change, Disaster Management and Meteorology (MECDM), the Pacific Risk

⁸⁸² Solomon Islands Government (2009). National Disaster Risk Management Plan For Disaster Management Arrangements and Disaster Risk Reduction including for Climate Change. *Solomon Islands Government*. Available at: http://www.preventionweb.net/files/22085_14656ndrmpsolomonsfinaliseddraftff2.pdf. Accessed: 16 December 2015.

⁸⁸³ Hoerder D. (2007). Months after an earthquake and tsunami, Solomon Islands struggle to recover. *The United Nations Children's Fund*. Available at: http://www.unicef.org/emergencies/solomonislands_40050.html. Accessed: 16 December 2015.

⁸⁸⁴ Joyce C. (2007). Tsunami Moved Too Quickly for Warning System. *NPR*. Available at: <http://www.npr.org/templates/story/story.php?storyId=9293448>. Accessed: 16 December 2015.

⁸⁸⁵ The World Bank (2014). Community Resilience to Climate and Disaster Risk in Solomon Islands Project (CRISP). *The World Bank*. Available: http://www-wds.worldbank.org/external/default/WDSPContentServer/WDSP/IB/2015/12/02/090224b0838f5ea1/2_0/Rendered/PDF/Community0Resi0ands0Project00CRISP0.pdf. Accessed: 16 December 2015.

Resilience Programme (PRRP), Community Resilience to Climate and Disaster Risk in Solomon Islands Project (CRISP), and other partners⁸⁸⁶.

The Ministry of Development Planning and Aid Coordination (MDPAC) has a Risk Resilient Development Officer, and in 2015, “risk-resilient recovery planning” became an official function of MDPAC⁸⁸⁷.

4.11.2. Institutional Framework for Delivering Resilience

The disaster Recovery Coordination Committee (RCC), which includes representatives from all relevant ministries and NGOS, was established to coordinate disaster recovery, which now also includes risk-resilient planning, is partially responsible for resilience⁸⁸⁷. The National Disaster Management Office (NDMO) is also responsible⁸⁸⁷.

There is also a national Risk Resilient Development working group⁸⁸⁸.

4.11.3. Critical Infrastructure and Technical Resilience

There are no official documents where the concept resilience is used.

4.11.4. Organisational Resilience

There are no official documents where the concept resilience is used.

4.11.5. Social Resilience

There are no official documents where the concept resilience is used.

4.11.6. Economic Resilience

There are no official documents where the concept resilience is used.

4.11.7. Resilience Related Official Documents

There are no official documents where the concept resilience is used as the main word. Still there is a document that relates to resilience:

- “National Disaster Risk Management Plan For Disaster Management Arrangements and Disaster Risk Reduction including for Climate Change.” October 2009. Available at: http://www.preventionweb.net/files/22085_14656ndrmpsolomonsfinaliseddraftff2.pdf.

4.12. Vanuatu

Vanuatu experiences a wide range of natural disasters and regularly suffers from cyclones, volcanic eruptions, earthquakes, floods and droughts etc. The frequency and severity of these extreme events is expected to increase and as sea-level rise is anticipated due to human-induced climate changes. Figure 4.12 shows some natural hazards threatening the islands of Vanuatu.

⁸⁸⁶ ReliefWeb (2014). Risk Toolkit for Solomon Islands. *ReliefWeb*. Available at: <http://reliefweb.int/report/solomon-islands/risk-toolkit-solomon-islands>. Accessed: 16 December 2015.

⁸⁸⁷ ReliefWeb (2015). Disaster recovery that builds resilience recognized by government. *ReliefWeb*. Available at: <http://reliefweb.int/report/solomon-islands/disaster-recovery-builds-resilience-recognised-government>. Accessed: 16 December 2015.

⁸⁸⁸ ReliefWeb (2015). Risk is everyone’s business. *ReliefWeb*. Available at: <http://reliefweb.int/report/solomon-islands/risk-everyone-s-business>. Accessed: 16 December 2015.

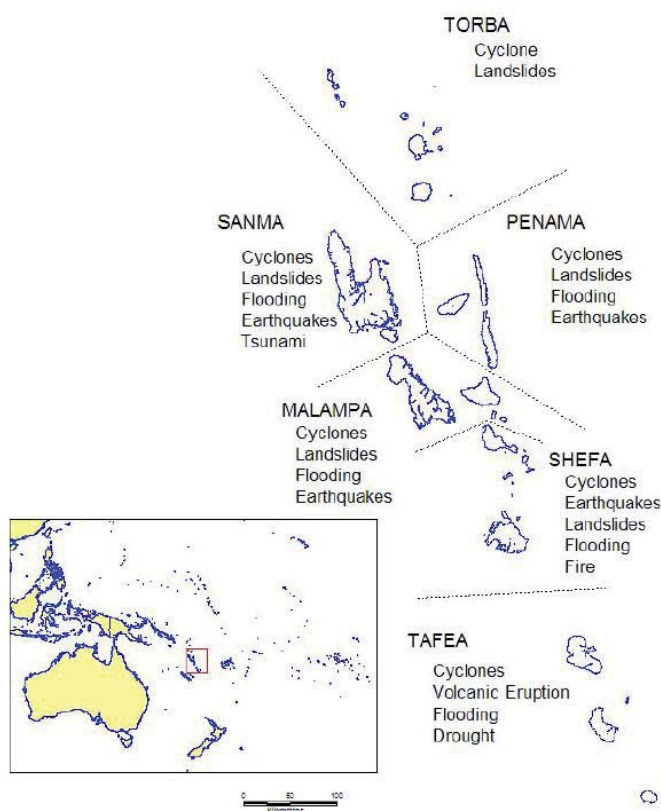


Figure 4.12 Natural hazards threatening the islands of Vanuatu.

Just to name a few recent natural disasters: Cyclone Uma in 1987 caused damage about US\$50 million in total; the 2002 Port Vila earthquake loss was estimated to be over US\$2.5 million; Cyclone Ivy in 2004 caused losses around US\$6 million and affected about 50,000 people⁸⁸⁹. The most recent tropical cyclone, Pam in 2015 resulted in damage and losses of at least US\$449.4 million equivalent to 64.1% of Vanuatu's Gross Domestic Product.⁸⁹⁰

Apart from Vanuatu's geographical vulnerability, the complex social and gender dynamics affect the country's resilience to natural disasters.⁸⁹¹ 80% of the population lives subsistence lifestyles, and many in remote and underserved locations. According to the Commonwealth Vulnerability Index Vanuatu ranks as the world's most vulnerable country out of 111 developing countries assessed.⁸⁹²

Due this high vulnerability, recent urban development in Vanuatu takes into consideration the risk of hazards such as flooding, earthquake and tsunami in order to reduce the impact of future disasters and increase community resilience.

⁸⁸⁹ NAB (2012). Disaster risk reduction and disaster management national action plan (2006 - 2016). *National Advisory Board on Climate Change and Disaster Risk Reduction*. Available at: <http://www.nab.vu/disaster-risk-reduction-and-disaster-management-national-action-plan-2006-2016>. Accessed: 20 May 2016.

⁸⁹⁰ Pacific Community (2015). Resilient urban development planning for Vanuatu. *Pacific Community*. Available at: <http://gsd.spc.int/component/content/article/630-resilient-urban-development-planning-for-vanuatu>. Accessed: 20 May 2016.

⁸⁹¹ Oxfam (2015). Creating a resilience framework to help Vanuatu prepare for climate change and an uncertain future. *Oxfam*. Available at: https://www.oxfam.org.au/wp-content/uploads/2015/07/2015-12-cc-case-study_vanuatu_fa.pdf. Accessed: 20 May 2016.

⁸⁹² Republic Of Vanuatu (2011). National Climate Change Adaptation Strategy for Land-Based Resources (2012 – 2022). *Republic Of Vanuatu*. Available at: http://www.adaptation-undp.org/sites/default/files/downloads/vanuatu_national_climate_change_adaptation_strategy_-_2012-2022.pdf. Accessed: 20 May 2016.

4.12.1. Concept of Resilience

Resilience as a concept is relatively new in Vanuatu. However, several official documents related to Disaster Risk Reduction and Disaster Management (DRR&DM) mention the term. Resilience is used as a desired characteristic to deal with the impacts of natural disasters.

Historically, Vanuatu has demonstrated resilience to natural hazards and an ability to rebuild its subsistence economy and societies, using traditional knowledge and external disaster relief and other development assistance.⁸⁸⁹ However, recent urbanization requires a coordinated approach to provide resilience for the communities at different levels.

Therefore the government made commitments under the Pacific Plan⁸⁹³ to mainstream DRR&DM into all development decision-making in an effort to reduce risk and strengthen the resilience of communities. The Pacific Plan in its “Kalibobo Roadmap” refers to sustainable development as a key pillar, where the key objective to enhance capacity and resilience of Pacific people and societies.

In response to the Hyogo Framework for Action and the Regional Frameworks of Action for Disaster Risk Reduction and Disaster Management, Vanuatu developed a plan for a systematic implementation the Disaster Risk Reduction and Disaster Management National Action Plan (NAP).

In the foreword of the NAP, Ham Lini Vanuaroora, the Prime Minister of Vanuatu, recognizes that “there is a need for a political will to bring about a change in the way we deal with disaster risks and to strengthen our community’s resilience through a more holistic approach to disaster risk reduction and disaster management.” The main purpose of the NAP is to “to build a safe, secure and resilient Vanuatu”. However, the resilience is not defined in the document.

Vanuatu’s national planning and budgetary process is linked to its Priorities and Action Agenda (PAA), first produced in 2003. In 2005, the government asked the SOPAC/PIFS/ UNDP/World Bank partnership to help develop a supplementary PAA on DRR&DM, to complement the current PAA. This supplementary PAA focuses on an additional strategic priority of ‘Safety, Security and Resilience’ of Vanuatu. The document reflects the people’s needs for more employment and economic opportunities; better health care and education; the provision of basic infrastructure; social stability and community safety and resilience. Unfortunately the supplementary PAA does not define the term resilience either. However, it refers to “improved resilience of communities and economies to disasters” as a performance indicator for monitoring performance against the overall goal of the supplementary PAA.

Concerning Critical Infrastructure the PAA recognizes that infrastructure is essential for maintaining services in times of crisis, therefore it must be *protected* from damage associated with disasters. A shift from protection to resilience of critical infrastructure is not mentioned.

Due to the country’s aforementioned high vulnerability to natural disasters, Vanuatu is subject of several research projects and reports. Some examples are given below:

The Environmental Vulnerability Index (EVI) was developed by the South Pacific Applied Geoscience Commission.⁸⁹⁴ The EVI was designed to provide a relatively quick and inexpensive mechanism for characterizing states in terms of the vulnerability of their natural environments to

⁸⁹³ Pacific Islands Forum Secretariat (2007). The Pacific Plan: for strengthening regional Cooperation and integration. *Pacific Islands Forum Secretariat*. Available at: <http://www.adb.org/sites/default/files/linked-documents/robp-pacific-2013-2015-pacific-plan.pdf>. Accessed: 20 May 2016.

⁸⁹⁴ Kaly, U., Pratt, C. (2000). Environmental Vulnerability Index: Development and provisional indices and profiles for Fiji, Samoa, Tuvalu and Vanuatu. *SOPAC*. Available at: <http://ict.sopac.org/VirLib/TR0306.pdf>. Accessed: 20 May 2016.

International Survey

natural and anthropogenic hazards. Three aspects of environmental vulnerability have been identified and are incorporated into an EVI: (1) the level of risk to hazards which act on the environment within a state; (2) intrinsic resilience of the environment to risks and (3) extrinsic resilience.

Intrinsic resilience refers to “the characteristics of a country which would tend to make it less/more able to cope with natural and anthropogenic hazards”, whereas extrinsic resilience results “from external forces acting on the environment and describes the ecological integrity or level of degradation of ecosystems”. The provisional results obtained for Fiji, Samoa, Tuvalu and Vanuatu demonstrated the great potential of the EVI as an international and national management tool.

4.12.2. Institutional Framework for Delivering Resilience

On a national level the National Advisory Board on Climate Change⁸⁹⁵ and Disaster Risk Reduction is responsible for disaster resilience. The NAB is a relatively new structure, merging the previous National Advisory Committee on Climate Change (NACCC) and Disaster Risk Reduction and Disaster Management National Action Plan Task Force (NTF).

Most of the population of Vanuatu lives in rural villages, where cultural historical and religious traditions play a more important role than official documents. In these small communities, chiefs are given political voice and have the authority to speak on the village’s behalf in council and parliamentary issues⁸⁹⁶ (Richmond & Sovacool 2012). Chiefs also have instruments to enforce land and maritime protection rules, thus to “implement resilience”.

4.12.3. Critical Infrastructure and Technical Resilience

No information was found.

4.12.4. Organisational Resilience

No information was found.

4.12.5. Social Resilience

Vanuatu culture retains a strong diversity through local regional variations and through foreign influence. There exist 113 language groups on the 70 inhabited islands. Culturally Vanuatu is very diverse with local communities have their own set of ‘*kastoms*’. *Kastoms* might be interpreted as norms and controls, including religion, economics, art and even magic. How values and culture contribute to resilience of communities (and individuals) in Vanuatu is studied by Dick and Meltherorong⁸⁹⁷.

Diversity is a key factor in creating social and cultural resources that form the basis of local community resilience. In Vanuatu ‘subsistence economy’ still outweighs the cash economy in terms of providing livelihoods for the population. As land provides source for food, shelter, currency and stability, it is arguably more robust than Western economies.

⁸⁹⁵ <http://www.nab.vu/>

⁸⁹⁶ Richmond, N., Sovacool, B. K. (2012). Bolstering resilience in the coconut kingdom: Improving adaptive capacity to climate change in Vanuatu. *Energy Policy*. Available at: <http://doi.org/10.1016/j.enpol.2012.08.018>. P. 843–848. Accessed: 20 May 2016.

⁸⁹⁷ Dick, T., Meltherorong, M. (2013). Dovetailing discourses of emergent resilience in Vanuatu. *Cambridge Scholars*. Available at: <http://www.cambridgescholars.com/songs-of-resilience-15>. Accessed: 20 May 2016.

4.12.6. Economic Resilience

There are no official documents provided about the economic resilience in Vanuatu.

The economic vulnerability of the country is studied in a UN study⁸⁹⁸, where a reference is made to economic resilience. The report sees enhanced economic specialization, which is actively encouraged and supported by national policy makers, as “an overall a factor of economic resilience”. Economic resilience here refers to less dependence from global economy.

Briguglio et al (2010) present a profile of Vanuatu’s economic vulnerability and economic resilience. Economic resilience is defined as the policy-induced ability of an economy to withstand and rebound from the negative effects of such shocks.⁸⁹⁹

4.12.7. Resilience Related Official Documents

Vanuatu’s regulatory framework for concerning disaster resilience is primarily based on the National Disaster Act 2000 (NDA), the Disaster Risk Reduction and Disaster Management National Action Plan 2006-2016 (NAP) and the Priorities Action Agenda 2006-2015 (PAA). The most important documents are:

National level:

- National disaster management act (Act no. 31 of August 2000). Available at: <http://www.pacificdisaster.net/pdnadmin/data/original/national%20disaster%20management%20act%20no.31.pdf>;
- The Disaster Risk Reduction and Disaster Management *National Action Plan* outlines a long-term DRR and DM plan in Vanuatu. Available at: <http://www.nab.vu/disaster-risk-reduction-and-disaster-management-national-action-plan-2006-2016>;
- The *Supplementary Priorities Action Agenda* provides an overview of the standard operating procedures, channels of communication, and operational structure of disaster management. Available at: <http://nab.vu/supplementary-priorities-and-action-agenda-disaster-risk-reduction-and-disaster-management-safe>;
- Strengthening NI - Vanuatu Resilience: National Recovery and Economic Strengthening Program Plan Strengthening Housing & Settlement Community Resilience - Expected Housing-Specific Project Outputs (September 2015) <http://reliefweb.int/map/vanuatu/strengthening-ni-vanuatu-resilience-national-recovery-and-economic-strengthening-program>;
- National Health Disaster Management Plan (2011). <http://www.pacificdisaster.net/pdnadmin/data/original/national%20health%20dm%20plan.pdf>.

5. Conclusions

The report collected rich information that could be used for the purposes of the current project. Case studies on Australia and New Zealand are particularly relevant for the project IMPROVER. Australia focuses on organisational resilience in order to achieve critical infrastructure resilience. The country has a tool called Organisational Resilience Health Check, which allows for the development of a shared understanding of the organisation’s progress towards resilience and identifies possible

⁸⁹⁸ UNCTAD (2012). Vulnerability profile of Vanuatu. *United Nations Conference On Trade And Development*. Available at: http://www.un.org/en/development/desa/policy/cdp/ldc/profile/vulnerability_profile_vanuatu_2012.pdf. Accessed: 20 May 2016.

⁸⁹⁹ Briguglio, L., Cordina, G. et al. (2010). Profiling Vulnerability and Resilience: A Manual for Small States. *Commonwealth Secretariat*. Available at: <https://books.google.com/books?id=vJAC3W1bJhcC&pgis=1>. Accessed: 20 May 2016.

International Survey

treatment actions and inhibitions. The tool was found to be publicly available online. New Zealand uses similar methodology to assess organisational resilience. In 2014 the country developed a Benchmark Resilience Tool with a list of indicators for measuring organisational resilience. The tool is a survey intended to measure the resilience of an organisation, allowing them to benchmark against other organisations in the same or related industries. Publicly available questionnaires used for the purpose were found online. The aforementioned tools could serve as a basis for developing similar methodologies in Europe.



IMPROVED RISK EVALUATION AND IMPLEMENTATION OF RESILIENCE CONCEPTS
TO CRITICAL INFRASTRUCTURE

Appendix 8 - Resilience Concepts in South America

Editor:

L. MELKUNAITE (DBI)

Authors (in alphabetic order)

G. CADETE (INOV)

C. GASPAR (INOV)

A. UTKIN (INOV)

Deliverable Number: D1.1

Date of delivery: May 31, 2016

Month of delivery: M12



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 653390

Coordinator:	David Lange at SP Sveriges Tekniska Forskningsinstitut (SP Technical Research Institute of Sweden)

Table of Contents

1	Executive Summary	291
2	Nomenclature	291
3	Resilience Concepts in South America	291
3.1.	Regional Overview	291
3.1.1	Concept of Resilience	293
3.1.2	Institutional Framework for Delivering Resilience	294
3.1.3	Critical Infrastructure and Technical Resilience	296
3.1.4	Organisational Resilience	296
3.1.5	Social Resilience	296
3.1.6	Economic Resilience	297
4	Case Studies	297
4.1.	Brazil	297
4.1.1	Concept of Resilience	300
4.1.2	Institutional Framework for Delivering Resilience	300
4.1.3	Critical Infrastructure and Technical Resilience	300
4.1.4	Organisational Resilience	300
4.1.5	Social Resilience	301
4.1.6	Economic Resilience	301
4.1.7	Resilience Related Official Documents	302
4.2.	Chile	302
4.2.1.	Concept of Resilience	306
4.2.2.	Institutional Framework for Delivering Resilience	306
4.2.3.	Critical Infrastructure and Technical Resilience	306
4.2.4.	Organisational Resilience	307
4.2.5.	Social Resilience	307
4.2.6.	Economic Resilience	307
4.2.7.	Resilience Related Official Documents	308
4.3.	Argentina	308
4.3.1.	Concept of Resilience	311
4.3.2.	Institutional Framework for Delivering Resilience	311
4.3.3.	Critical Infrastructure and Technical Resilience	312
4.3.4.	Organisational Resilience	313
4.3.5.	Social Resilience	313
4.3.6.	Economic Resilience	314
4.3.7.	Resilience Related Official Documents	314
4.4.	Other Countries	315
4.4.1.	Resilience Related Official Documents	315
4.4.2.	Institutional Framework for Delivering Resilience	315
5.	Conclusions	316

1 Executive Summary

This document presents an overview of the critical-infrastructure resilience concept and correspondent measures that have been put into practice in South America. For the analysis, we primarily used public data, pertinent scientific publications, and information available in the Internet. It should be noted that the concept of critical infrastructure resilience is its initial state of development in South America, and no clearly formulated policy in this area is conducted. For this reason, the global assessment of the Region is carried out in rather brief and reduced form, paying more attention to the country-level processes. The research is primarily focused on (but not restricted to) three countries: Brazil, Chile, and Argentina. Together they cover almost 68% of the continent area. All three chosen countries participate in the programme *100 Resilient Cities* via Santa Fe (Argentina), Porto Alegre & Rio de Janeiro (Brazil), and Santiago (Chile).

2 Nomenclature

CONAREC	National Advisory Board for the Recuperation of Regions Affected by Natural Disasters
DANE	National Administrative Department of Statistics
DIPECHO	Disaster Preparedness ECHO
ECHO	European Commission in order to authorize its Humanitarian Aid and Civil Protection department
EIRD	The International Strategy for Disaster Reduction, the Americas
EU	The European Union
GNV	Bolivarian National Guard of Venezuela
HFA	Hyogo Framework for Action
IFRC	the International Federation of Red Cross
ITDG	The Intermediate Technology Development Group
IW:LEARN	International Waters Learning Exchange & Resource Network
LAC	Latin America and Caribbean
NIT	National Intervention Team
ONEMI	National Office of Emergency of the Interior Ministry of Chile
ONEMI	The National Emergency Office of the Ministry of Interior
PCM	Presidency of the Council of Ministers
SARA	South America Risk Assessment
SARAS	South American Institute for Resilience and Sustainability Studies
SEN	National Emergency Secretariat
SINAGERD	The National System for Disaster Risk Management
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNISDR	United Nations Office for Disaster Risk Reduction
WCDRR	UN World Conference on Disaster Risk Reduction

3 Resilience Concepts in South America

3.1. Regional Overview

Numerous hazards in South America — such as global warming, changes in rainfall patterns, fast tropical glacier retreat, impacts on mountain wetlands, deforestation, and replacement of tropical

International Survey

forest by savannah — are directly related to the climate change⁹⁰⁰. South America is also prone to other weather-related disasters, like landslides, floods, extreme temperatures and wildfires. Latin America is the second region in the world, after Asia, in terms of frequency of disasters⁹⁰¹. According to Charvériat (2000), floods represent nearly 50% of the natural hazards occurred in South America; the next most significant threat is related to landslides. Brazil is the country, which faces the most natural hazards in the continent⁹⁰².

Floods are very frequent in South American countries, not only due to the El Niño phenomenon, but also to commonly generated climatic anomalies. In 2007, more than one million people were affected by floods, mainly in Brazil, Bolivia and Peru. The situation was even worse in 2008; Peru, Brazil, Argentina, Colombia suffered floods, as well as Bolivia and Ecuador where the situation was acute: more than 600,000 and 350,000 people respectively were affected and in need of humanitarian assistance. Geophysical hazards — volcanic eruption, earthquakes and earthquake-related landslides — are significant in Colombia, Ecuador and Peru and in some measure in Argentina, Bolivia, Chile and Venezuela. The most significant earthquakes registered in the last decade are: Chile – 2010 which was the 5th most powerful recorded on the Richter scale (8.8) and Peru – Ica 2007 and Arequipa 2001⁹⁰³.

This document presents an overview of the critical-infrastructure resilience concept and correspondent measures that have been put into practice in South America. For the analysis, we primarily used public data, pertinent scientific publications, and information available in the Internet.

First of all, it should be noted that the concept of critical infrastructure resilience is its initial state of development in South America, and no clearly formulated policy in this area is conducted. For this reason, the global assessment of the Region is carried out in rather brief and reduced form, paying more attention to the country-level processes. The research is primarily focused on (but not restricted to) three countries: Brazil, Chile, and Argentina. Together they cover almost 68% of the continent area (Figure 3.1).

⁹⁰⁰ Kronik, J., Verner, D., (2010). Indigenous peoples and climate change in Latin America and the Caribbean. *The World Bank*. Available at: <http://www.openknowledge.worldbank.org/bitstream/handle/10986/2472/555400PUB0Indi1EPI1958810601PUBLIC1.pdf>. Accessed: 2 May 2016

⁹⁰¹ Freeman, P. K., Martin, L. A., et al. (2003). National Systems for the Comprehensive Management of Disaster Risk and Financial Strategies for Natural Disaster Reconstruction, *Inter-American Development Bank*. Available at: <http://publications.iadb.org/bitstream/handle/11319/5913/National%20Systems%20for%20Comprehensive%20Disaster%20Management%3a%20Financing%20Reconstruction.pdf?sequence=2>. Accessed: 2 May 2016

⁹⁰² Charvériat, C. (2000). Natural disasters in Latin America and the Caribbean: An overview of risk. *Inter-American Development Bank*. Available at: http://www.mona.uwi.edu/cardin/virtual_library/docs/1036/1036.pdf. Accessed: 2 May 2016.

⁹⁰³ European Commission (2011). Humanitarian Implementation Plan (HIP), *European Commission*. Available at: http://ec.europa.eu/echo/files/funding/decisions/2011/HIPs/South_America.pdf. Accessed: 2 May 2016.



Figure 3.1. Geographical location of the chosen case study-countries (Brazil, Chile, and Argentina).

Chosen countries represent well the whole geographical area in question: they are located in diverse geographic areas and prone to different kinds of disasters, the most characteristic are:

- droughts for Brazil⁹⁰⁴
- earthquakes for Chile⁹⁰⁵
- floods for Argentina⁹⁰⁶

All three chosen countries participate in the programme *100 Resilient Cities* via Santa Fe (Argentina), Porto Alegre & Rio de Janeiro (Brazil), and Santiago (Chile)⁹⁰⁷.

3.1.1 Concept of Resilience

Several entities and authors, which are located in South America or have been carrying out research there, defined the term resilience. A typical example of the official definition from a government entity is that given by the Uruguayan National Emergencies System: resilience is the capacity of a system, community or society, potentially exposed to hazards, to adapt to them by resisting or changing — in order to achieve and maintain an acceptable level of its functioning and structure under adverse external conditions⁹⁰⁸. Resilience is also determined by the degree to which the social system is capable of organizing itself to increase its capacity to learn from past disasters in order to achieve better future protection and improve the measures for disaster risk reduction⁹⁰⁹⁹¹⁰.

⁹⁰⁴ Campos, J. N. B. (2015). Paradigms and public policies on drought in Northeast Brazil: A historical perspective. *Environmental Management*. P. 1052-1063

⁹⁰⁵ Shoichet, C. E., Romo, R. (2015). Chile earthquake: 8.3-magnitude quake strikes off coast, *CNN*. Available at: <http://edition.cnn.com/2015/09/16/americas/chile-earthquake/>. Accessed: 2 May 2016.

⁹⁰⁶ FloodList (2016). Breaking News: Argentina, *FloodList*, <http://floodlist.com/tag/argentina> Accessed: 18 January 2016.

⁹⁰⁷ Rockefeller Foundation (2013), 100RC: 100 Resilient Cities Program. *The Rockefeller Foundation*. Available at: <http://www.100resilientcities.org/>. Accessed: 2 May 2016.

⁹⁰⁸ Klein, R., Nicholls, R. et al. (2003). Resilience to natural hazards: How useful is this concept? *Environmental Hazards*. Available at: <http://www.sciencedirect.com/science/article/pii/S1464286704000105>. Accessed: 2 May 2016. P. 35-45.

⁹⁰⁹ Ibid.

The Red Cross defines resilience as “the ability to respond and adapt to changing circumstances” and resilient communities as the “ones that can react to and rebuild from disasters and emergencies quickly”⁹¹¹. Carmona et al. (2012) refer to resilience as the ability and capability to resist through changes, discontinuities and ability to adapt to the environmental risks, by means of effective management strategies, operations and governance structure⁹¹². Lira (2005) defined resilience as the reconstitution of the damages caused by exogenous elements⁹¹³.

As was already mentioned, the techniques for integrating resilience thinking into planning and development practice in South America are still in the early stages of their development⁹¹⁴. However, resilience is becoming an increasingly debated concept among the key actors and stakeholders assisting communities impacted by natural and man-made disasters. Thus, there is a “general acknowledgement of the need to strengthen individual, community and institutional mechanisms”, but little agreement is achieved “as to what resilience actually means, especially in the context of communities affected by conflict. Some consider resilience to be an end goal, while others consider it to be a process of adaptation”⁹¹⁵.

Events and processes that bear witness to the local evolution of the concept will be discussed in the following sections, devoted to particular countries and areas.

3.1.2 Institutional Framework for Delivering Resilience

Despite the noticeable lack of resources and the already discussed immature state of the critical infrastructure resilience concept in South America, recent years witnessed activity of various institutions and creation of several international entities and consortia for its further development and delivering.

Recently, the Ministry of Disaster Risk Management (*La Secretaría de Gestión del Riesgo de Desastres*) was founded in Peru, as a special agency of the Presidency of the Council of Ministers (PCM), through which the PCM exercises its functions as the governing body of the National System for Disaster Risk Management (SINAGERD), facilitating processes coordination and articulation of the entities of the system⁹¹⁶ (SINAGERD, 2015). The establishment of the institution is an important state level step forward towards the development of resilience practice in the region.

In 2005, the idea of *South American Institute for Resilience and Sustainability Studies* (SARAS) was conceived between several leading scientists acting in the region. The Institute was founded in late

⁹¹⁰ CARRI (2013). Definitions of Community Resilience: An Analysis, Community & Regional Resilience Institute. Available at: <http://www.resilientus.org/wp-content/uploads/2013/08/definitions-of-community-resilience.pdf>. Accessed: 2 May

⁹¹¹ RC (2014). Building Resilience. Red Cross Available at: <http://www.redcross.org/what-we-do/international-services/where-we-help/latin-america-caribbean/caribbean>. Accessed: 2 May 2016.

⁹¹² Carmona, V. C., Guimarães, Y. B. T. et al. (2012). Resiliência organizacional: uma meta-análise da produção científica nacional. Available at: http://www.transformare.adm.br/wp-content/uploads/2012/07/04_VIVIANE-CELINA-CARMONA.pdf. Accessed: 2 May 2016.

⁹¹³ Lira, I. S. (2005). Local economic development and territorial competitiveness in Latin America, *CEPAL Review* 85. Available at: http://repositorio.cepal.org/bitstream/handle/11362/11060/85079098I_en.pdf. Accessed: 2 May 2016. P. 79-98

⁹¹⁴ Mitchell, C. (2013). Planning for resilient cities in Latin America and Asia. Panel discussion at the 4th Global Forum on Urban Resilience & Adaptation, Bonn, Germany 31 May - 2 June 2013. *Local Governments for Sustainability*. Available at: http://resilient-cities.iclei.org/fileadmin/sites/resilient-cities/files/Resilient_Cities_2013/D3_SessionDescription.pdf. Accessed: 2 May 2016.

⁹¹⁵ ATHA (2016). Supporting Community Resilience in Conflict, *Harvard Humanitarian Initiative: Cambridge MA*. Available at: <http://atha.se/webcast/supporting-community-resilience-conflict>. Accessed: 2 May 2016.

⁹¹⁶ SINAGERD (2015). La Secretaría de Gestión del Riesgo de Desastres: Quiénes Somos, <http://sgrd.pcm.gob.pe/2015/02/quienes-somos/>

2000s in Uruguay⁹¹⁷. It was assigned with a task of running a five-year programme of annual conferences on relevant topics in Latin America. The cycle of conferences started in 2010, focusing on sustainable future of water resources in Latin America, a topic whose relation to disaster resilience will be discussed in the following sections. In 2009 SARAS was granted a substantial support from various universities and governmental entities. In 2011 additional support from the Municipality of Maldonado was approved, making SARAS one of the important centres for research on hazard risks and resilience.

In January 2013, *GEM Foundation* launched an international project SARA (South America Risk Assessment)⁹¹⁸. The three-year project aims to calculate hazard and risk, as well as to estimate the complex social and economic factors that aggravate the physical damage and decrease the post-event capacity of populations to respond to and recover from damaging earthquakes in South America, by involving local experts from the region. The project has been now extended to 7 countries: Peru, Ecuador, Venezuela, Colombia, Bolivia, Chile and Argentina. In addition to the seismic risk assessment at a national scale, a number of detailed city scenarios are also being developed, with the purposes of producing important results for communication of risk and disaster risk reduction. Lima and Quito have been selected for the city scenarios⁹¹⁹.

A Programme 100 Resilient Cities (100RC), pioneered by the *Rockefeller Foundation* (2013) is dedicated to helping cities around the world become more resilient to the physical, social and economic challenges that are a growing part of the 21st century. The Programme encircles several South America cities, including Santa Fe (Argentina); Porto Alegre, Rio de Janeiro (Brazil); Santiago (Chile); and Cali & Medellin (Colombia).

The European Union (EU) is also an important external actor providing resilience in the Region. In particular, the EU contributes to such type of activities through *Financing decisions*, which are legal acts adopted by the European Commission in order to authorize its Humanitarian Aid and Civil Protection department (ECHO) to spend from the EU budget and grant funding for humanitarian actions outside the region.. Several efficient methodologies and practices have been developed through the ECHO DRR programmes (DIPECHO and Drought Resilience Initiative) in the Latin America and Caribbean (LAC) region that enhance livelihood protection⁹²⁰. As livelihood protection is a relatively new component in these programmes, there is a need to share experiences and evidence on these successful practices and tools. A regional training and exchange sessions with implementing partners involved in this issue allow this information to be compiled and disseminated, enhancing knowledge and information, and providing new tools and opportunities⁹²¹.

The *United Nations Office for Disaster Risk Reduction* provide general support at the international level — orientating, supporting policy making and carrying out dedicated programmes⁹²².

The Intermediate Technology Development Group – Practical Action (ITDG), a non-governmental organization, aims to demonstrate and advocate for the sustainable use of technology to reduce

⁹¹⁷ SARAS (2016). South American Institute for Resilience and Sustainability Studies, About Us, SARAS, Available at: <http://www.saras-institute.org/en/conozcanos/conozcanos-el-instituto.html>. Accessed: 2 May 2016.

⁹¹⁸ GEM Foundation (2016). About GEM: Mission. *GEM*. Available at: <http://www.globalquakemodel.org/gem/mission/>. Accessed: 2 May 2016.

⁹¹⁹ GEM Foundation (2013). Integrated and collaborative seismic risk assessment. *GEM*. Available at: <http://www.globalquakemodel.org/what/regions/south-america/>. Accessed: 2 May 2016.

⁹²⁰ ITDG (2016). Practical Solutions. *Intermediate Technology Development Group*. Available at: <http://practicalaction.org/>. Accessed: 2 May 2016.

⁹²¹ European Commission (2013). Humanitarian Implementation Plan (HIP), *DIPECHO South America*. Available at: http://ec.europa.eu/echo/files/funding/decisions/2013/HIPs/DIPECHO_southAm.pdf. Accessed: 2 May 2016.

⁹²² UNISDR (2016). The United Nations Office for Disaster Risk Reduction: Mission and Objectives, United Nations Office for Disaster Risk Reduction. Available at: <http://eird.org/americas/we/mission-and-objectives.html>. Accessed: 2 May 2016.

poverty in developing countries⁹²⁰. In South America it runs (jointly with other actors) several projects, the most significant being DIPECHO⁹²³.

3.1.3 Critical Infrastructure and Technical Resilience

From the technical viewpoint, resilience is the ability of a *system* to provide and maintain an acceptable level of service in the face of faults and challenges to normal operation. Depending on the *system* dimension, the technological resilience possesses various scales. For example, the resilience of cities is related to capacity to sustain their basic services and production of technological knowledge in the face of adverse events⁹²⁴. Efforts for providing the required abilities are materialized through technological and hardware/software applications (involving, e.g., probes and sensors), concepts, and guidelines for decision making and support.

3.1.4 Organisational Resilience

Organisational resilience appears as a concept to develop in all organizations facing the challenge of rapid changes the global 21st century brings about. Nowadays high agility and resilience are seen as “a new perspective and framework to enable organizations to understand the pace and disruptiveness of change, and to develop the capabilities needed to master it”⁹²⁵. The organizational resilience is essentially “the capacity for resisting, absorbing, and responding, even reinventing if required, in response to fast and/or disruptive change that cannot be avoided”⁹²⁶.

3.1.5 Social Resilience

Much literature has recently written which is concerned with the question of what form a promising concept of societal resilience might take. Keck & Sakdapolrak (2013) argue that social resilience “has the potential to be crafted into a coherent analytic framework that can build on scientific knowledge from the established concept of social vulnerability, and offer a fresh perspective on today's challenges of global change”⁹²⁷. Three dimensions of the social resilience are identified by the authors:

- *Coping* capacities, the ability of social actors to cope with and overcome all kinds of adversities;
- *Adaptive* capacities, their ability to learn from past experiences and adjust themselves to future challenges in their everyday lives;
- *Transformative* capacities, their ability to craft sets of institutions that foster individual welfare and sustainable societal robustness towards future crises.

Viewed in this way, the search for ways to build societal resilience — especially in the livelihoods of the poor and marginalized — is revealed to be not only a technical, but also a political issue.

⁹²³ ITDG (2015). Programa DIPECHO América del Sur 2015-2016. *Intermediate Technology Development Group*. Available at: <http://www.solucionespracticas.org.pe/Programa-DIPECHO-Am%C3%A9rica-del-Sur-2015-2016>. Accessed: 2 May 2016.

⁹²⁴ Balland, P. A., Rigby, D. et al. (2015). The technological resilience of US cities. *Cambridge Journal of Regions, Economy and Society*. Available at: <http://cjres.oxfordjournals.org/content/8/2/167>. Accessed: 2 May 2016. P. 167-184

⁹²⁵ Olivos, A. M. (2014). From Individual to Organizational Resilience, A Case Study Review. MSc. Thesis. *University of Pennsylvania*. Available at: http://repository.upenn.edu/cgi/viewcontent.cgi?article=1073&context=od_theses_msod. Accessed: 2 May 2016.

⁹²⁶ McCann, J., Selsky, J. (2012). Mastering Turbulence: The Essential Capabilities of Agile and Resilient Individuals, Teams and Organizations. *John Wiley & Sons*. Available at: <http://eu.wiley.com/WileyCDA/WileyTitle/productCd-1118164830.html>. Accessed: 2 May 2016.

⁹²⁷ Keck, M., Sakdapolrak, P. (2013). What is social resilience? Lessons learned and ways forward. *Erdkunde*. Available at: <http://www.erdkunde.uni-bonn.de/archive/2013-1/what-is-social-resilience-lessons-learned-and-ways-forward>. Accessed: 2 May 2016. P. 5-19.

3.1.6 Economic Resilience

The welfare impact of a disaster does not only depend on the physical characteristics of the event or its direct impacts in terms of lost lives and assets⁹²⁸. It also depends on the ability of the economy to cope, recover, and reconstruct — and therefore to minimize — aggregate consumption losses. This ability can be referred to as the (macro-) economic resilience to natural disasters. It has two components:

- instantaneous resilience, which is the ability to limit the magnitude of immediate production losses for a given amount of asset losses, and
- dynamic resilience, which is the ability to reconstruct and recover.

Welfare impacts also depend on micro-economic resilience, which depends on the distribution of losses; on households' vulnerability, such as their pre-disaster income and ability to smooth shocks over time with savings, borrowing, and insurance, as well as on the social protection system or the mechanisms for sharing risks across the population.

The economic disaster risk in a country can be reduced by

- reducing the exposure or vulnerability of people and assets,
- increasing macroeconomic resilience (reducing aggregate consumption losses for a given level of asset losses), or
- increasing microeconomic resilience (reducing welfare losses for a given level of aggregate consumption losses).

4 Case Studies

4.1. Brazil

According to the *National Plan for Risk Management and Response to Natural Disasters*, the main natural hazards in Brazil, particularly in the South and Southeast, are floods and landslides caused by heavy rain and strong wind⁹²⁹. In the North and Northeast, the main risks are related to droughts⁹³⁰.

All of the above discussed natural hazards are mostly related to the El Niño phenomenon, which has a really strong impact upon the whole continent — however, with different outcomes depending on the geography of where the hazards happen.

In early January 2011, a series of flash floods and mudslides struck the Brazilian Serrana mountain region near Rio de Janeiro as well as the states of Minas Gerais and São Paulo, destroying buildings, roads, houses, and other facilities. Rescue teams from the Brazilian National Civil Defence and the army made their way to remote locations with aid and transportation.

These series of disasters have encouraged efforts for

- better equipped rescue teams, and
- more community awareness and mobilization regarding

⁹²⁸ Hallegatte, S. (2014). Economic Resilience: Definition and Measurement. *The World Bank*. Available at: http://www-wds.worldbank.org/external/default/WDSPContentServer/WDSP/IB/2014/05/02/000158349_20140502133741/Rendered/PDF/WPS6852.pdf. Accessed: 2 May 2016.

⁹²⁹ PAC (2012). Plano Nacional de Gestão de Riscos e Resposta a Desastres Naturais. *Programa de Aceleração do Crescimento*. Available at: <http://www.pac.gov.br/pub/up/relatorio/d0d2a5b6f24df2fea75e7f5401c70e0d.pdf>. Accessed: 2 May 2016.

⁹³⁰ UCS (2014). Causes of Drought: What's the Climate Connection? *Union of Concerned Scientists MIT*. Available at: http://www.ucsusa.org/global_warming/science_and_impacts/impacts/causes-of-drought-climate-change-connection.html#.VpjJ_Pki9J. Accessed: 2 May 2016.

International Survey

- disaster prevention,
- risk management,
- resilience systems and
- nationwide preparedness.

A special Cabinet has been created to help the victims in Rio de Janeiro, taking responsibility for mobilizing different institutions in order to help the municipalities in the states affected by the disasters and for supporting the local rehabilitation. Its main activity is the identification of the demands coming directly from the affected population, local governments and municipalities. The Government was supported by the experience and funds of the World Bank, with a \$485M loan for the reconstruction of houses and buildings destroyed and for the relocation of families in risk areas⁹³¹.

The most recent registered disaster in Brazil was a mudslide provoked by two mining dams crumpled in Brazil's mineral-rich state, Minas Gerais. This disaster killed 16 people and left thousands homeless⁹³². About 60 million cubic meters of iron waste flowed into the Doce River. Toxic brown mudflows reached the Atlantic Ocean 17 days later. The overall impact and environmental consequences to river and the beaches near its mouth, as well as to the wildlife are still unclear. This incident has been described as the worst environmental disaster in Brazil's history.

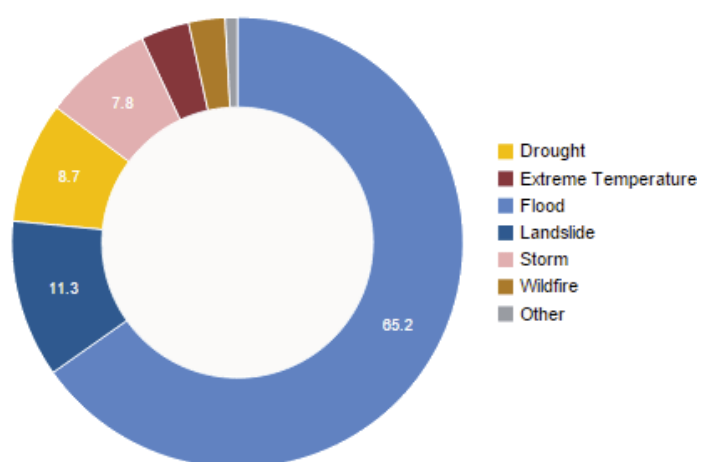
Comparative characterization of natural disasters in Brazil in terms of frequency, mortality, and economic impact (internationally reported losses in 1990-2014)⁹³³ is given in Figure 4.1.

⁹³¹ Buani, C. (2011). Brazil Floods and Mudslides — A Brazilian Perspective. ALNAP. Available at: <http://news.trust.org/item/20110203152100-3v25xhttp://news.trust.org/item/20110203152100-3v25x>. Accessed: 2 May 2016.

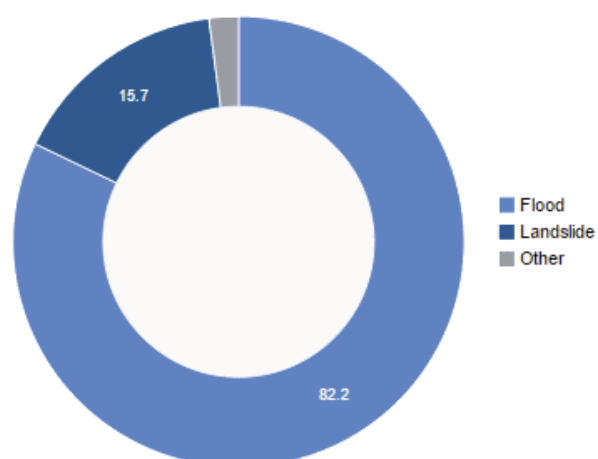
⁹³² The Guardian (2015). Brazil dam disaster: judge freezes assets of miners BHP and Vale. *The Gurdian*. Available at: <http://www.theguardian.com/world/2015/dec/20/brazil-dam-disaster-judge-freezes-assets-of-miners-bhp-and-vale>. Accessed: 2 May 2016.

⁹³³ PreventionWeb (2014). Brazil Disaster & Risk Profile: Basic Country Statistics and Indicators (2014). *PreventionWeb — project of the UN Office for Disaster Risk Reduction (UNISDR)*. Available at: <http://www.preventionweb.net/countries/bra/data/>. Accessed: 2 May 2016.

Frequency



Mortality



Economic issues

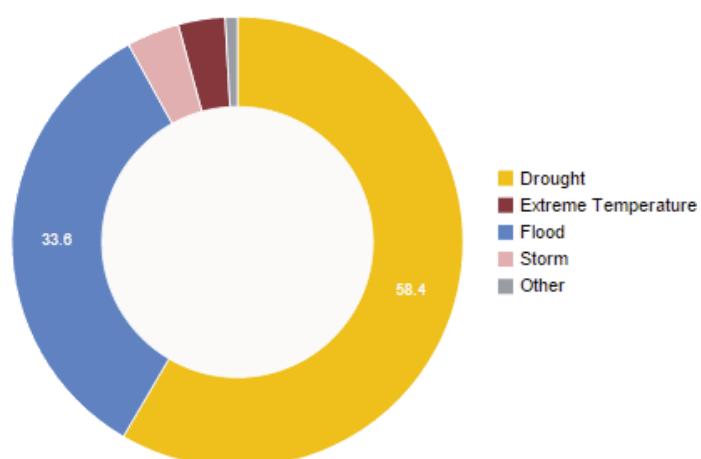


Figure 4.1. The International Disaster Database: Brazil, internationally reported losses 1990 - 2014⁹³³.

International Survey

4.1.1 Concept of Resilience

In the Brazilian context, resilience is often defined as the ability of a person, community, institution, company, or system to adapt and survive, regardless of what kind of stress or adverse condition they might experience — see, e.g., programme *Rio Resiliente*⁹³⁴.

To be resilient, the region, country or community has to provide access to the basic services and protect its economic, social and business environments from extensive damage, in order to be able to recover them fast afterwards. That is why for our resilience research the problems of social challenges are not less important than those of adaptation to the climate changes.

4.1.2 Institutional Framework for Delivering Resilience

The identified governmental and other actors developing and delivering the resilience concept in Brazil are the following:

Proteção e Defesa Civil [Brazilian Civil Defence System, BCDS]⁹³⁵ is the main actor in Brazil responsible for delivering resilience. It contributes to planning, coordinating and executing programs, projects and civil defence actions through a network of Civil Defence institutions that are organized at the national, state and regional levels. During critical events, special teams also carry out coordination and direct work at the disaster site. BCDS usually follow guidelines provided by international institutions like the United Nations Office for Disaster Risk Reduction (UNISDR) in order to comply with international standards and good practices.

The UNISDR provides general support at the higher, international level — orientating, supporting policy making and carrying out dedicated programmes.⁹³⁶ The typical operational relationship between BCDS and UNISDR can be observed in the execution of the joint campaign *Rio de Janeiro: Searching for Resilience to Heavy Rains*. This campaign promoted a set of measures aiming at making Rio de Janeiro resilient to floods and landslides provoked by heavy rain.

4.1.3 Critical Infrastructure and Technical Resilience

No official state level definition of critical infrastructure resilience was found while performing the research. It also should be mentioned that generally the concept of technological resilience is rather scarce and is ever present only in other types of resilience.

The best examples are related to societal resilience, where technology is becoming a major ingredient for risk assessment and making better decisions — for example, through mapping geological risk areas and implementing public alert systems.

Another case is creation of a 24/7 Operational/Command Centre equipped with high end facilities for information management, allowing the authorities to visualize, monitor, analyse and take actions in real time.

4.1.4 Organisational Resilience

At the present state of the concept, Organisational resilience in Brazil is restricted to some business continuity management and disaster recovery programs offered by private companies.

⁹³⁴ Junqueira, P. (2015). *Rio Resiliente: Diagnóstico e Áreas de Foco. Municipality of Rio de Janeiro*. Available at: <http://centrodeoperacoes.rio/assets/PEF-0112-14-LVR-210x280-Resiliencia-43.pdf>. Accessed: 2 May 2016.

⁹³⁵ See: <http://www.mi.gov.br/defesacivil>.

⁹³⁶ See: <http://eird.org/americas/index-eng.html>

4.1.5 Social Resilience

During the *Rio de Janeiro: Searching for Resilience to Heavy Rains* campaign, several actions were implemented in order to achieve resilience of the locals to heavy rains, in line with five 5 key priorities defined by the Hyogo Protocol⁹³⁷:

- i. Make disaster risk reduction a priority
- ii. Assess risk and make decisions
- iii. Build self-awareness and self-consciousness
- iv. Reduce risk
- v. Be ready to act.

In the first stage, this campaign dealt with the acquisition of a weather radar, strengthening of civil defence and other related institutions, the creation of a 24/7 Operational/Command Centre, and the creation of a prevention plan against floods.

To assess risk and make better decisions, this program supports the mapping of geological risk areas, and the creation of a public alert system.

In order to better inform the population, the initiative aims to support and train civil defence community clusters and bring these actions to the schools.

Along with the fourth priority, the Brazilian civil defence commits to legally demarcate the areas that are more prone to natural disasters and preserve them. Additionally, the re-allocation of people living in risk areas is also a top priority, which is followed by the construction of infrastructures to stabilize the hillsides.

Lastly, the program purposes the creation of an emergency plan, with proper responsibility attribution, and practicing drills.

4.1.6 Economic Resilience

Rio Resiliente defines economic and financial resilience as a capacity to resist or resume the normal functioning after economic recessions or severe downturns of the stock market. This kind of situations might have more or less severe consequences, depending on the ability to adapt to new economic circumstances.

The Brazilian economy showed a strong resilience during the global financial crisis. This was mainly due to the nature of its growth. According to the program *Rio Resiliente*, presented by the city Mayor Eduardo Paes, Rio de Janeiro receives nearly 2 million tourists a year and relies heavily on tourism, which is believed to be one of the main aspects of the economic resilience. It is highly service-based, capable of growing and absorbing labour resources. Remarkably, devaluating the national currency, the internal crisis makes the city more attractive for international tourists due to lower staying cost.

The economic resilience of the city was one of the main reasons that keeps Moody's rate of Rio de Janeiro within the BBB investing grade. The economy is referred to as "dynamic" — service-based (about 86%) with a focus on the infrastructure investments. The remaining part belongs to the industry, with high stakes of the multinational corporations Petrobras and Vale⁹³⁴. In 2012, Rio de Janeiro was the first municipality that received investment grades from all the three main rating agencies: Moody's, Fitch and Standard & Poor's.

⁹³⁷ UNISDR (2015). Rio de Janeiro em Busca da Resiliência Frente Chuvas Fortes. Campanha da UNISDR. *United Nations Office for Disaster Risk Reduction*. Available at: http://www.rio.rj.gov.br/dlstatic/10112/4402327/4109121/RIODEJANEIRORESILIENTE_2013.pdf. Accessed: 2 May 2016.

International Survey

The whole Brazilian economy possesses similar structure. Composition of the Brazil GDP in 2014 is shown in Figure 4.2. The economy is mainly based in services (71%), while the remaining part is mostly represented by the oil and mining industry — as in the case of Rio de Janeiro, the multinational corporations Petrobras and Vale have the greatest share. Agriculture represents only 5.6% of the national GDP.

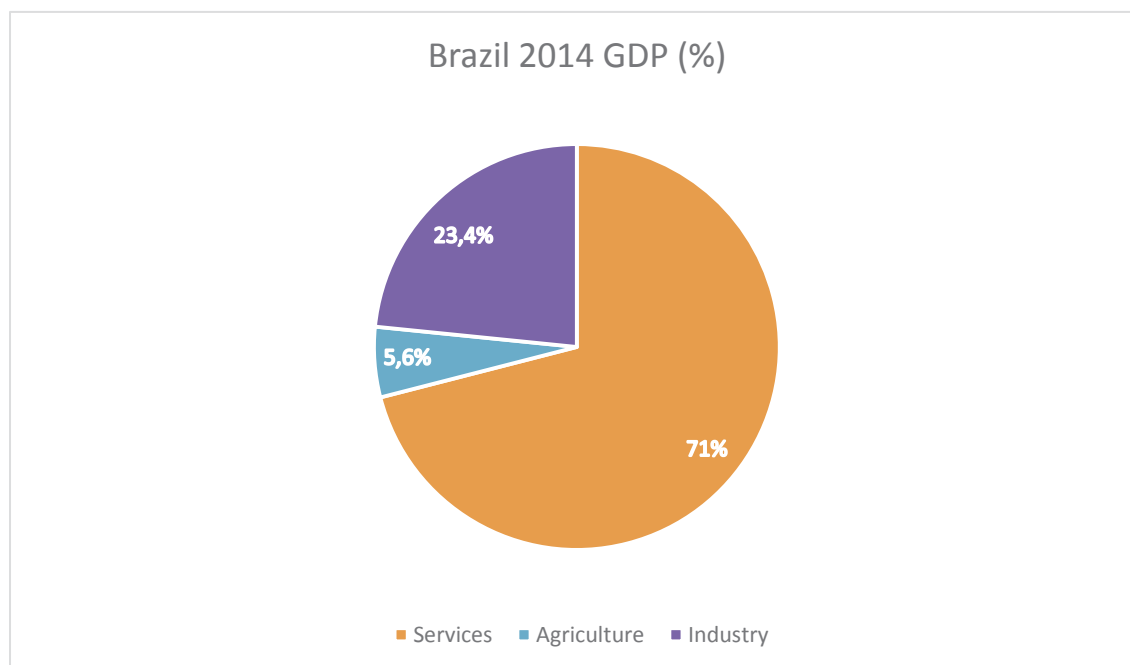


Figure 4.2. Structure of Brazil GDP in 2014⁹³⁸.

4.1.7 Resilience Related Official Documents

For the reasons discussed in the general overview on the subject, there are only a few documents that specifically address resilience of critical infrastructures. The most accessible documents are the following:

- *Rio de Janeiro: Searching for Resilience to Heavy Rains*, a report prepared within the framework of the joint campaign involving the United Nations Office for Disaster Risk Reduction (UNISDR) and the national Civil Defence⁹³⁷.
- *Resilient Rio: Diagnosis and Focus Areas (Rio Resiliente: Diagnóstico e Áreas de Foco)*, an extensive overview and data source compiled under the general coordination of Dr. P. Junqueira, as a deliverable of the already mentioned *Rio Resiliente* initiative. Several authors have identified the main risks related to the climate changes in Rio de Janeiro, such as heavy wind and rain, heat waves, sea-level rise, dengue and other situations that might affect the normal living conditions of the city⁹³⁴.

4.2. Chile

Chile has experienced some of the world's most severe earthquakes and has responded by creating an effective building code and seismic activity monitoring system. However, floods and landslides disproportionately affect low-income communities while resource segregation further limits available

⁹³⁸ The World Bank (2014). Databank on Latin America & Caribbean (developing only), *The World Bank*. Available at: <http://data.worldbank.org/country/brazil>. Accessed: 2 May 2016.

interventions. City officials recognize the need for a sustainable urban development plan, which addresses both community planning and fight against the environmental degradation.

Only a small segment of population has access to high-quality infrastructure, social services, business locations, and educational institutions, while the vast majority of the residents stay in underserved and unstable communities.

The most common hazards in Chile are

- earthquakes,
- floods (coastal and due to rainfalls),
- resource scarcity,
- social inequity and
- wildfires.

More comprehensive characterization of natural disasters (frequency, mortality, and economic impact — internationally reported losses in 1990-2014) is given in Figure 4.3⁹³⁹.

Despite the frequency of heavy raining events, Earthquakes are responsible for the majority of fatalities and economic losses⁹⁴⁰.

Chile is one of the most earthquake-prone countries in the world. Just off the coast, the Nazca tectonic plate plunges beneath the South American plate, pushing the towering Andes cordillera to ever-higher altitudes. The strongest earthquake recorded happened in Chile in 1960 when a magnitude 9.5 tremor killed more than 5,000 people.

In 2010, a magnitude 8.8 quake and ensuing tsunami in central Chile killed more than 500 people, destroyed 220,000 homes and washed away docks, riverfronts and seaside resorts. This earthquake was many times more powerful than the one that devastated Haiti earlier this year but caused only a small fraction of the casualties, thanks to geological luck and the country's preparation for such a disaster: for several years before the catastrophe Chilean Government had been promoting construction of building that "sway with seismic waves rather than resist them"⁹⁴¹.

In March 2015 unusually heavy thunderstorms brought torrential rainfall to northern Chile's Atacama Desert, flooding one of the driest regions in the world. Flash floods swept down valleys, cutting off villages, destroying structures, and carrying vehicles for miles. According to Reuters, Chile's President Michelle Bachelet said it will cost at least \$1.5 billion to repair the damages caused by the flooding and mudslides that left a toll of over two dozen people dead and nearly another 140 missing⁹⁴². The small coastal city of Chanaral was hit hardest by the floods and many residents are still trying to cope with the loss of their homes and belongings. The city of Copiapo, home to 160,000 people is also partly cut off, with airports in both Copiapo and Antofagasta further to the north closed to commercial air traffic. The unusual weather phenomenon was caused by a cold front hitting the Andes. Spurred by

⁹³⁹ PreventionWeb (2014). Chile Disaster & Risk Profile: Basic Country Statistics and Indicators (2014). *PreventionWeb — project of the UN Office for Disaster Risk Reduction (UNISDR)*. Available at: <http://www.preventionweb.net/countries/chl/data/>. Accessed: 2 May 2016.

⁹⁴⁰ UNESCO (2010). Análisis de Riesgos de Desastres en Chile. *DIPECHO*. Available at: <http://www.desaprender.org/fileSendAction/fcType/5/fcOid/351732408828786494/fodoid/351732408828786493/Documento%20Pais%20Chile%202010.pdf>. Accessed: 2 May 2016.

⁹⁴¹ The Guardian (2010). Chile's earthquake was horrible - but it could have been so much worse. *The Guardian*. Available at: <http://www.theguardian.com/world/2010/mar/01/chile-earthquake-resistant-design>. Accessed: 2 May 2016.

⁹⁴² The Atlantic Photo (2015). Devastating Floods Hit Northern Chile. *The Atlantic Photo*. Available at: <http://www.theatlantic.com/photo/2015/04/devastating-floods-hit-northern-chile/390024/>. Accessed: 2 May 2016.

International Survey

high temperatures, it produced strong rains at the high altitudes instead of snow, which swept down to valleys and towns in the foothills⁹⁴³.

On March 25, near the 17:00 (UTC 3) hours, facing serious events due to flooding, the President declared Constitutional State of Exception Catastrophe throughout the Region of Atacama. The Armed Forces of Chile took control of the area to protect and maintain public order in the affected regions. The officer in charge is Chief Lieutenant Colonel Marcel Urrutia Caro, belonging to the Army Chile. Hours later a state of emergency was extended to the town of Antofagasta. The President arrived to the areas affected by floods on March 25. On March 26, curfew was decreed across the Atacama region since 23:00 to 6:00 hours (UTC -3) and Marines were deployed in the city of Chañaral to contain looting registered in some shops during the day.

⁹⁴³ International Business Times (2015). Floods in Chile and landslides in Peru after heaviest rain in 80 years. *International Business Times*. Available at: <http://www.ibtimes.co.uk/floods-chile-landslides-peru-after-heaviest-rain-80-years-1493792>. Accessed: 2 May 2016.

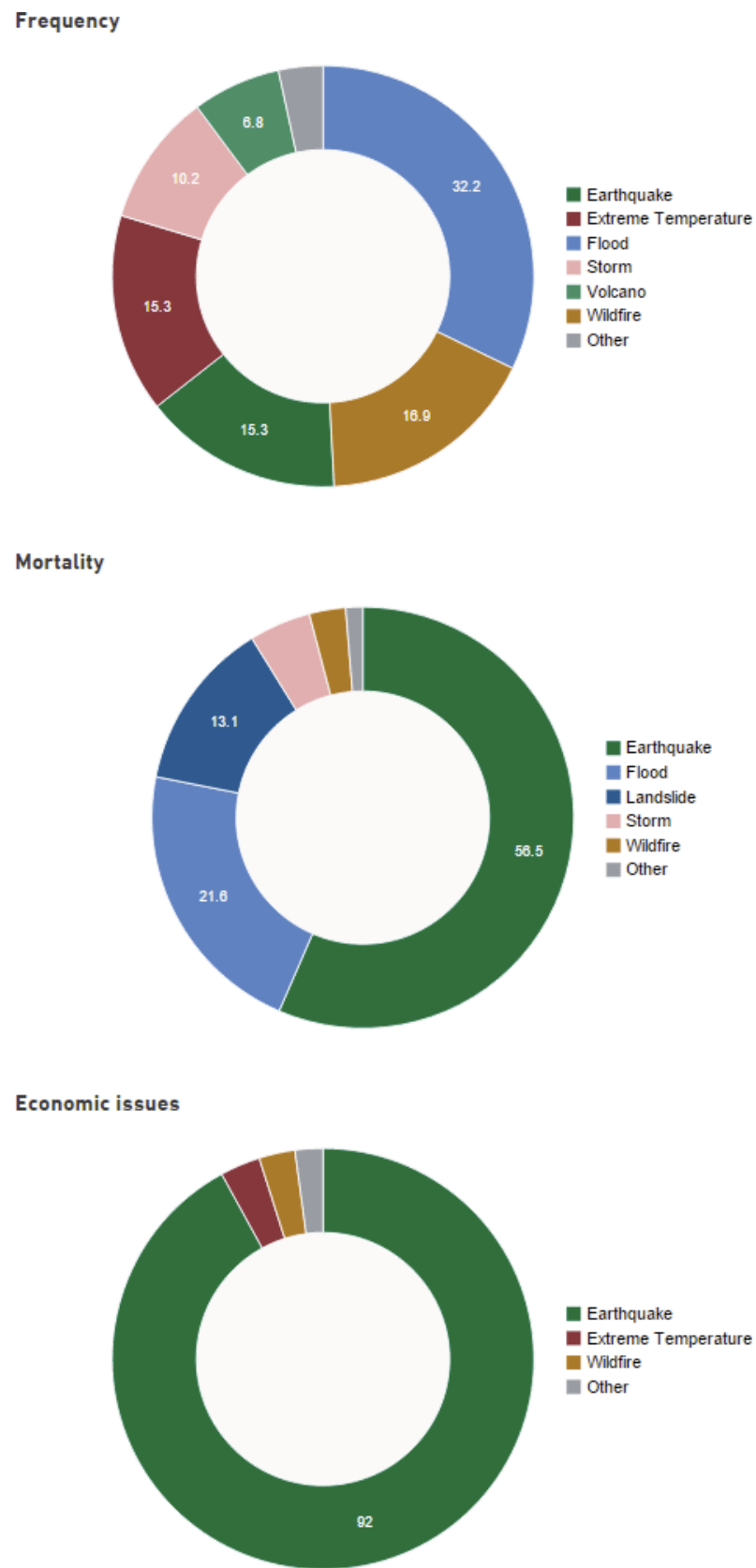


Figure 4.3. The International Disaster Database: Chile, internationally reported losses 1990 - 2014⁹³⁸.

4.2.1. Concept of Resilience

According the National Office of Emergency of the Interior Ministry of Chile (ONEMI), resilience is the capacity of a system, community or society, while exposed to a hazardous event, to resist, absorb, adapt and recover from its effects in a timely and effective manner, which includes the preservation and restoration of their structures and basic functions⁹⁴⁴.

In Chile, the concept of resilience exists, however is poorly developed, with the most noticeable advances in the area of urban planning and design (earthquake resistant construction techniques and urban planning).

4.2.2. Institutional Framework for Delivering Resilience

Defensa Civil [Chilean Civil Defence System]⁹⁴⁵ participates in volunteer tasks of education and social responsibility for the benefit of citizens, promoting prevention and natural/man-made disaster risk reduction. It includes immediate response and reconstruction units as an integral part of the national system of civil protection.

The National Emergency Office of the Ministry of Interior (ONEMI)⁹⁴⁶ is the technical agency of the Chilean State responsible for coordinating the National System of Civil Protection. Its mission is to plan, promote, coordinate and implement prevention, response and rehabilitation actions in situations of collective risk, emergencies, disasters and natural or human caused catastrophes.

4.2.3. Critical Infrastructure and Technical Resilience

No official state level definition of critical infrastructure resilience was found in Chile. However, the attempts to implement technological resilience in Chile have a long history, at least in the construction industry. Chile began thinking about earthquakes and architecture as far back as the 1930s, but it came out with its first anti-seismic building regulations in the 1970s⁹⁴⁷. For the last decade, the majority of activities and achievements are link with the name of General Ricardo Toro, the ONEMI Director, appointed by the previous Chilean government and ratified by the current President Michelle Bachelet⁹⁴⁸. Nowadays Chile's building codes require that all new buildings must withstand a 9.0-magnitude earthquake — eventually suffering cracking and tilting, but being able not to collapse.

The 2010 8.8-magnitude earthquake was a serious resilience test: among nearly 6,000 buildings in the affected area, as little as six were seriously damaged, and only four of them had to be demolished. Christophe Schmachtel, a UN humanitarian affairs officer based in Geneva, stated that "Chile today has completely learned UN protocols and adapted them to local needs and has become a showcase. In our global meetings [on earthquake preparation], Chile is now the example"⁹⁴⁹.

⁹⁴⁴ ONEMI (2014). Política Nacional para la Gestión de Riesgo de Desastres, Ministerio del Interior y Seguridad Pública. ONEMI. Available at: http://siac.onemi.gov.cl/documentos/POLITICA_NACIONAL_PARA_LA_RRD.pdf. Accessed: 2 May 2016.

⁹⁴⁵ See <http://www.defensacivil.cl/>.

⁹⁴⁶ See <http://www.onemi.cl/>.

⁹⁴⁷ WYSS, J. (2015). Americas: Engineers vs. God: Chile's building codes take edge off massive earthquake. *Miami Herald*. Available at: <http://www.miamiherald.com/news/nation-world/world/americas/article35576640.html>. Accessed: 2 May 2016.

⁹⁴⁸ Terra (2014). La tragedia que no alcanzó a doblegar al director Onemi. *Terra*. Available at: <http://noticias.terra.cl/chile/la-tragedia-que-no-alcanzo-a-doblegar-al-director-onemi.e3ce272fff325410VgnVCM10000098cceb0aRCRD.html>. Accessed: 2 May 2016.

⁹⁴⁹ The Guardian (2015). How did Chile manage to survive its recent earthquake virtually unscathed? *The Guardian*. Available at: <http://www.theguardian.com/cities/2015/sep/25/how-chile-survive-earthquake-virtually-unscathed>. Accessed: 2 May 2016.

Another kind of technological/societal resilience is referred by Quesada (2014) where he states the importance of new communication technologies, like "Google", "Facebook", "Twitter" and "WhatsApp" for their practical way of spreading the information when natural disasters occur as long as the power supply system remain unaffected⁹⁵⁰.

4.2.4. Organisational Resilience

Chile is a classic example of a “pyramidal” national system that was gradually developed by expansion of the powers of a single entity, ONEMI. Contrary to many other Latin America systems that were created under the aegis of ministries of defence, ONEMI, since 1970, belongs to the Ministry of the Interior. After leading the recovering process after the earthquake of 1965, the organization grew to incorporate other elements of disaster management. Currently it emphasizes strategies of foreseeing and mitigation as well as pays special attention to the vulnerability as an essential factor of the risk management⁹⁰¹. Despite it appears centralized and hierarchical, the Chilean system follows the basic principles of organizational resilience. In particular, it is composed of *committees* at the community, provincial and regional levels. They are responsible for evaluating proposed actions, designing and prioritizing prevention, mitigation and preparedness projects — appropriate to each administrative level. In the case of an emergency, all of the available resources in the affected community are used first. If the magnitude of the event exceeds the local capacity, additional resources are mobilized successively from the provincial, regional and national levels.

4.2.5. Social Resilience

The current administration of ONEMI is focused on reinforcing both the Early Warning and Civil Protection Systems in order to face emergencies such as evacuation of the coastline for tsunami warnings, snowfall in the south, etc.

The Early Warning System permanently and systematically monitors the threat-related parameters, conditions of vulnerability and occurrences of destructive events — to collect, evaluate and disseminate, as soon as possible, the available information on risk or emergency situations. It also coordinates control operations of such events and other damage mitigation measures appropriately evaluated.

The ongoing program *Chile Preparado* provides the population in all Chilean regions with the information on how to be prepared against natural hazards such as earthquakes, tsunamis and volcanic eruptions. *Chile Preparado* also includes a set of emergency drills of total evacuation in risk situations.

Another example of societal resilience came from the Chilean Red Cross initiative after the 2010 Chile earthquake. They built local disaster response capacity by delivering food and basic household goods, emergency health services, shelter supplies and water sanitation devices⁹⁵¹.

4.2.6. Economic Resilience

According to Rodrigo Vergara, the Governor of Chile's Central Bank, institutional investors in Chile hold significant amounts of foreign assets (1.7 times the value of foreign reserves held by the Central Bank) providing an extra possible source of liquidity in a situation of capital inflows shutdown. Chile

⁹⁵⁰ Quesada, P. G. (2014). Las Consecuencias del Determinismo Tecnológico en las Comunicaciones en caso de desastres Naturales. *El caso chileno*. Available at:

<http://www.estudioscotidianos.com/index.php/estudioscotidianos1/article/view/43>. Accessed: 2 May 2016. P. 2-23.

⁹⁵¹ Red Cross (2010). Chile Earthquake: One Year Progress Report. *Red Cross*. Available at:

http://www.redcross.org/images/MEDIA_CustomProductCatalog/m3140112_ChileEarthQuakeOneYearReport.pdf

International Survey

has a flexible exchange rate which means that in the case of an important setback in capital flows the national currency *peso* will depreciate. The monetary policy is “based on a flexible inflation-targeting scheme in a context of low inflation, and the strong position of the financial system provide ample room for such depreciation, as evidenced in 2008-09 during the global financial crisis”⁹⁵². Chilean government has ample capacity to borrow abroad if necessary that, in conjunction with the facts mentioned above, this makes Chile little vulnerable to financial crises⁹⁵².

4.2.7. Resilience Related Official Documents

To the best of our knowledge, there exist only a few state level official documents at least partly related to the resilience concept.

Política Nacional para la Gestión de Riesgo de Desastres [National Policy for Disaster Risk Management] is a document describing the international commitments undertaken by Chile as a signatory of the Hyogo Framework for Action (HFA)^{944 953}. This policy serves as a framework to guide various state institutions to significantly reduce the side effects caused by disasters, providing a set of guidelines for developing a sustained disaster risk reduction process and adequately respond to emergency situations in the country.

The National Civil Protection Plan [*Plan Nacional, Instrumento Indicativo para la Gestión Integral Decreto N° 156, 12 de marzo de 2002*] seeks to enhance the preventive capacities, along with the continuous improvement of preparedness and emergency activities towards disasters⁹⁵⁴. The activities aim at establishing an indicative instrument for decentralized management, according to the specific risks and available resources of each geographical area of the country.

4.3. Argentina

Argentina is primarily exposed to the following hazards:

- aging infrastructure,
- floods (coastal and rainfall),
- infrastructure failure and
- social inequity.

Extremely severe floods in 2003 and 2007 in Santa Fe demonstrated the vulnerability of the city destroying physical infrastructures and having broad negative impact on poor communities. In order to improve the maintenance of its water management system, the Santa Fe authority joined forces with provincial and national government agencies. The city has been working to improve communication, education, risk prevention and community awareness on possible natural disasters.

Significant floods also occurred as recently as in January 2016⁹⁵⁵. The Uruguay, Paraguay and Paraná Rivers began to overflow in late December 2015 after a period of unusually heavy rain, blamed on El Niño. Since then, over 120,000 people have been forced to leave their homes. Civil defence and relief agencies are finding it difficult to carry out full damage assessments. In a report on their Floods

⁹⁵² Financial Times (2014). Chile is a leading global example of resilience. *Financial Times*. Available at: <http://on.ft.com/1hb8kV0>. Accessed: 2 May 2016.

⁹⁵³ UNISDR (2005). Hyogo Framework for Action (HFA), *United Nations Office for Disaster Risk*. Available at: <http://www.unisdr.org/we/coordinate/hfa>. Accessed: 2 May 2016.

⁹⁵⁴ ONEMI (2002). Plan Nacional, Instrumento Indicativo para la Gestión Integral Decreto N° 156, 12 de marzo de 2002. *Ministerio del Interior y Seguridad Pública*. Available at: http://www.preventionweb.net/files/21234_163632002plannacionaldeproteccinciv.pdf. Accessed: 2 May 2016.

⁹⁵⁵ See: <http://floodlist.com/tag/argentina>

Emergency Plan of Action for Argentina⁹⁵⁶, the International Federation of Red Cross (IFRC) say that at the moment, there is "no quantifiable information regarding damage to structures or loss of dwellings"⁹⁵⁵ in affected areas of Argentina, as water levels differ between neighbourhoods, ranging from 50 cm to 2.20 m deep, and are causing damage to buildings in the area. The provinces of Entre Ríos, Corrientes and Chaco were the worst affected and the floods have been blamed for at least 6 deaths. IFRC said that in Concordia the Uruguay River reached its highest level in 50 years. At the peak of the floods, more than 13,500 people were displaced in the province of Entre Ríos, mostly in Concordia. Since then levels of the Uruguay and Paraná had fallen. As of 06 January 2015, around 11,000 people remained displaced in Concordia, Entre Ríos province, and around 8,000 in Corrientes Province.

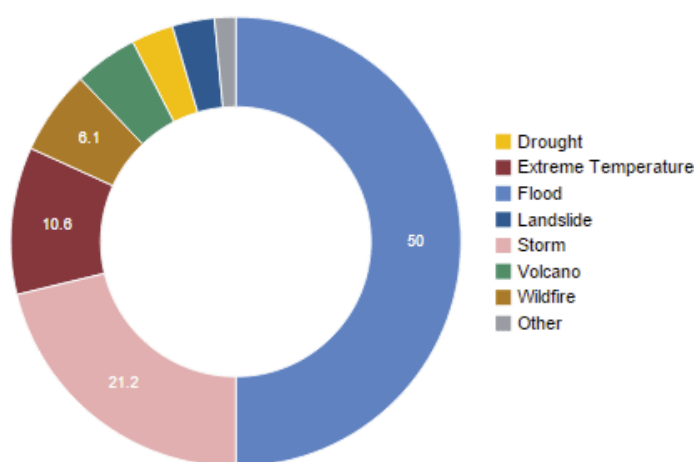
Detailed characterization of *natural* disasters in terms of frequency, mortality, and economic impact carried out by PreventionWeb is given in Figure 4.4⁹⁵⁷. As seen from the charts, floods provide extremely grave impact on Argentinean society, being responsible for 95.2% of all economy losses and 47.1% of total mortalities. Floods are also the most frequent catastrophic events, occurring as frequent as all other natural disasters taken together.

⁹⁵⁶ Bolado, C. D. (2016). Emergency Plan of Action (EPoA), *Argentine Red Cross: Buenos Aires*. Available at: <http://adore.ifrc.org/Download.aspx?FileId=120034>. Accessed: 2 May 2016.

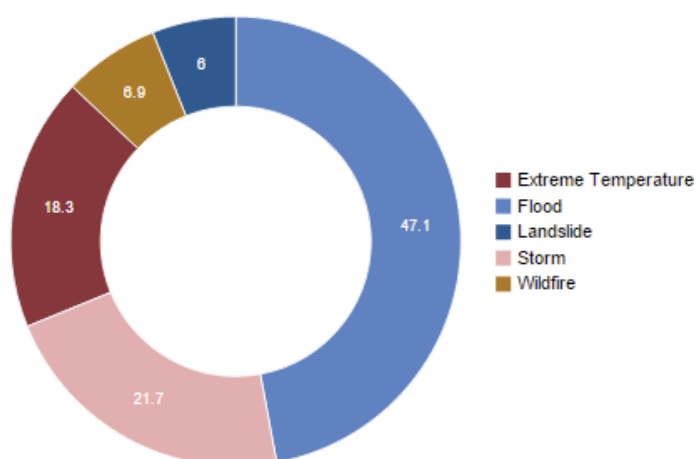
⁹⁵⁷ PreventionWeb (2014) Argentina Disaster & Risk Profile: Basic Country Statistics and Indicators (2014). *PreventionWeb* — project of the UN Office for Disaster Risk Reduction (UNISDR). Available at: <http://www.preventionweb.net/countries/arg/data/>. Accessed: 2 May 2016.

International Survey

Frequency



Mortality



Economic issues

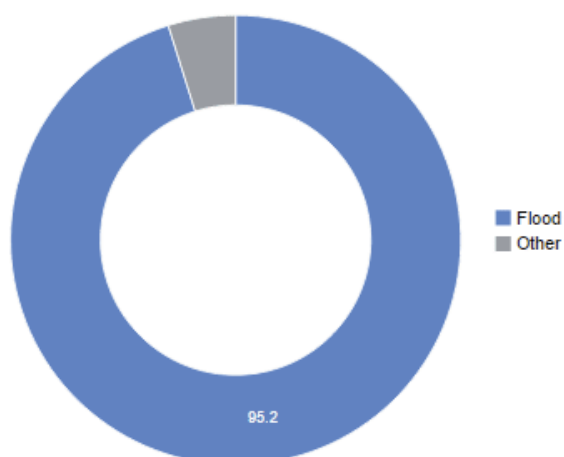


Figure 4.4. The International Disaster Database: Argentina, internationally reported losses 1990 - 2014⁹⁵⁷.

Societal challenges

In 1998, Argentina entered what turned out to be a four-year depression, during which its economy shrank 28 percent. Argentina's experience has been cited as an example of the failure of free markets and fixed exchange rates, among other things. The evidence does not support those views. Rather, bad economic policies converted an ordinary recession into a depression. Three big tax increases in 2000-2001 discouraged growth, and meddling with the monetary system in mid-2001 created fear of currency devaluation. As a result, confidence in Argentina's government finances evaporated. In a series of blunders that made matters even worse, from December 2001 to early 2002, succeeding governments undermined property rights by freezing bank deposits; defaulting on the government's foreign debt in a thoughtless manner; ending the Argentine peso's longstanding link to the dollar; forcibly converting dollar deposits and loans into Argentine pesos at unfavourable rates; and voiding contracts⁹⁵⁸.

4.3.1. Concept of Resilience

No official state level definition of resilience was found in Argentina. As we saw from the previous case studies, the general perception of resilience does not change dramatically from region to region. However, different facets of this concept have received different attention in particular countries and regions. While in Chile the resilience concept has mostly been developed in the direction of technological resilience in the construction industry due to frequent earthquakes, the famous 2001 Argentinean economic collapse - whose excellent *in situ* description is given by Fernando Aguirre, known in the WWW community as Ferfal - stimulated prioritized development of the socio-economic resilience⁹⁵⁹.

4.3.2. Institutional Framework for Delivering Resilience

The key role in development of the Argentine National Contingency Plan is played by the Argentine Coast Guard [*Prefectura Naval Argentina*, PNA]⁹⁶⁰.

Argentina is unique in that it created *ex ante* an entity at the national level that will be in charge for allocating funds to reconstruction projects. In 1998, Argentina passed National Resolution 496/8 creating the National Advisory Board for the Recuperation of Regions Affected by Natural Disasters (*Consejo Nacional para la Recuperación de Zonas en Emergencia Climática*, CONAREC) to oversee the post-disaster rehabilitation and rebuilding of the affected communities. One of CONAREC principal objectives is to coordinate and distribute funding to provincial and municipal authorities to aid in the rebuilding of infrastructure such as homes, businesses and roads in the aftermath of a disaster. Formed by representatives from several provincial governments, CONAREC serves as a medium between national and provincial efforts. As for funding, there is a limited penetration of insurance firms for disaster risk insurance. Argentina depends heavily on national reserves of credit and international lending organizations to provide needed liquidity in the face of natural disasters⁹⁶¹.

Possessing significant material resources and manpower, the *Argentine Red Cross* (a branch of the International Federation of Red Cross and Red Crescent Societies)⁹⁶¹ is also one of the most important actors in the area of resilience delivery. It comprises several specialised teams like National

⁹⁵⁸ Saxon, J. (2003). Argentina's Economic Crisis: Causes and Cures. *Joint Economic Committee*. Available at: http://www.jec.senate.gov/public/_cache/files/5bf2f91-6cdf-4e70-8ff2-620ba901fc4c/argentina-s-economic-crisis---06-13-03.pdf. Accessed: 2 May 2016.

⁹⁵⁹ Aguirre F. (2009). *The Modern Survival Manual: Surviving the Economic Collapse*. Wiley. Available at: <http://www.rapidtrends.com/surving-argentinas-economic-collapse-part-1-3/>. Accessed: 2 May 2016.

⁹⁶⁰ See <http://www.prefecturanaval.gov.ar/>.

⁹⁶¹ See: <http://www.ifrc.org/en/what-we-do/where-we-work/americas/argentine-red-cross/>.

International Survey

Intervention Team (NIT), Headquarters Health Team, Headquarters First Aid Team, Headquarters Risk Management Team and the information technology (IT) and Telecom Team (Bolado 2016).

The White Helmets Commission [*Comisión Cascos Blancos*]⁹⁶² is a body of the Argentine Ministry of Foreign Affairs, International Trade and Worship in charge of designing and implementing international humanitarian assistance. It has a network of bilateral and multilateral cooperation links through which it coordinates immediate response to social and natural disasters; it works on rehabilitation, reconstruction and development tasks; and it promotes risk prevention and management, in Argentina and abroad.

USAID, the lead U.S. Government agency⁹⁶³ provides support for resilience in Argentina by many ways, in particular, acting (jointly with Spain) through the *Adaptation Partnership*, formed in May 2010 in response to a recognized need for development practitioners to share information and lessons on adaptation efforts⁹⁶⁴. Chaired by Costa Rica, Spain and the United States, the goal of the partnership is to encourage effective adaptation by serving as an interim platform to catalyse action and foster communication among the various institutions and actors engaged in the effort to scale up adaptation and resilience around the world, including Argentina. The Partnership synthesizes lessons learned and good practices, highlighting needs and priorities, and identifying opportunities for cooperation and alignment of support to build resilience to the adverse effects of climate change. It is also enhancing communities of practice engaged in the adaptation effort.

The *United Nations* support is carried out via two programmes, UNDP (United Nations Development Programme) and UNEP (United Nations Environment Programme).

4.3.3. Critical Infrastructure and Technical Resilience

No state level official definition of critical infrastructure resilience was found in Argentina. Technological resilience efforts are mostly canalized in

- providing technical means for
 - relocation programmes,
 - assessing the water balance in vulnerable areas, and
 - climate resistant agriculture
- improving drainage and urban planning to facilitate green space development and air movements,
- adjusting building designs to a warmer climate.

Some already implemented, ongoing, and future measures in this field are overviewed by the Adaptation Partnership⁹⁶⁵. In particular:

The project *Sustainable Management of the Water Resources of the la Plata Basin with Respect to the Effects of Climate Variability and Change*⁹⁶⁶ of IW:LEARN (International Waters Learning Exchange & Resource Network) was carried out from 2009 to 2014 having strengthened the efforts of the governments of Argentina, Bolivia, Brasil, Paraguay and Uruguay to implement their shared vision for the environmentally and socially sustainable economic development of the la Plata Basin, specifically

⁹⁶² See: <http://www.cascosblancos.gov.ar/>.

⁹⁶³ See: <http://www.usaid.gov/>.

⁹⁶⁴ Adaptation Partnership (2016). About the Adaptation Partnership: Our Vision and Activities. *Adaptation Partnership*. <http://sites.google.com/a/ccrdproject.com/adaptation-partnership2/about-us>. Accessed: 2 May 2016.

⁹⁶⁵ Keller, M., Medeiros, D., et al. (2011). Review of Current and Planned Adaptation. *Adaptation Partnership*. Available at: http://www.iisd.org/pdf/2011/South_America_Adaptation_Action.pdf. Accessed: 2 May 2016.

⁹⁶⁶ See: <http://iwlearn.net/iw-projects/2095>

in the areas of the protection and integrated management of its water resources and adaptation to climatic change and variability.

The project SGP-HD 004 *Coming down the mountain: understanding the vulnerability of Andean communities to hydroclimatologic variability and global environmental change*⁹⁶⁷ (lasted from 2007 to 2011, included Argentina, Bolivia, and Chile) identified and characterized vulnerabilities of specific stakeholders to climate variability and climate-induced water problems.

Ongoing project CRN 3035 *Towards usable climate science: Informing decisions and provision of climate services to the agriculture and water sectors of southeastern South America*⁹⁶⁸ has several specific objectives, in particular, (i) conduct research and outreach to inform resilient decision-making in climate-sensitive sectors such as agricultural production and water resources management in southeastern South America, one of the major food-producing regions in the world, and (ii) facilitate sustainable societal adaptation to a shifting and changing climate.

4.3.4. Organisational Resilience

No official state level concept of organisational resilience was found in Argentina.

Concrete organizational resilience processes can be illustrated by the fight of Santa Fe city communities against flooding. Due to the high risk of flooding, the authorities built embankments and dykes. This risk reduction measures turned out to be not sufficient to prevent the 2003 floods, which caused an urgent displacement of 139,886 persons and affected 27,928 households. This hazardous event forced the civil society to join into groups that supported the regional process of awareness, risk reduction training, development of an emergency plan, and the creation of risk maps for the community⁹⁶⁹. After the floods of 2003 and 2007, Santa Fe had an even bigger problem, the housing needs. There were some funds available from the Red Cross that helped developing three new neighbourhoods. After pressure, the Government developed projects appropriate for emergency housing instead of long-term permanent housing. The houses were distributed without adequate infrastructures and social services. This action led to complex situations, in which families could not be relocated in less than four years.

This series of events led to changes in organizational structure and policies. In Santa Fe, the city administrative authorities created a disaster risk reduction entity, responsible for the development of better emergency plans, risk maps and city infrastructures. At the national scope, the government, through the Ministry of Water, Public Services and Environment, created two programs, the urban flood protection program and the drainage and water retention program. These programs aimed at providing the urban areas with infrastructure support and with the promotion and creation of river basin committees⁹⁶⁹.

4.3.5. Social Resilience

Although the adaptation of communities to climate change does not appear to be a priority issue for the Argentinian government, the issue has gained greater attention in recent years. A national-level commission on climate change with a mandate to elaborate adaptation strategies and link them to government policies was established in 2006, and a National Climate Change Strategy, with adaptation as one of the key pillars, is currently in development. Through its National

⁹⁶⁷ See: <http://www.iai.int/?p=2154>

⁹⁶⁸ See: <http://www.iai.int/?p=2660>

⁹⁶⁹ Hardoy, J., Pandiella, G., et al. (2011). Local disaster risk reduction in Latin American urban areas. *Environment and Urbanization*. Available at: <http://eau.sagepub.com/content/23/2/401.abstract>. Accessed: 2 May 2016. P. 401-413.

International Survey

Communications, Argentina has also identified relatively specific lines of action for adaptation in a range of sectors, including urban systems, human health, and infrastructure.

Officials also recognize that resilience plans must address all the pertinent processes and phenomena, including the disparity of the effects of flood among different social strata and admitting that social inequality can exacerbate violence and marginalization, often resulting in infrastructure vandalism.

After 2003 floods in Santa Fe, civil society began to join into groups that supported the regional process of awareness, risk reduction training, development of an emergency plan, and the creation of risk maps for the community.⁹⁶⁹

4.3.6. Economic Resilience

In Argentina, socio-economic is primarily connected with the possibility to create a network of local, often barter, markets. During the 2001 economic collapse, these markets self-organized to create a flow of trade of necessary goods and services, when access to standard currency was radically reduced and even ultimately removed from society. Another resilience force is associated with community cooperatives, which must be formed to provide the means for a higher level of local function and, thus, greater regional stability. During an economic crisis, markets and cooperatives must function together to create a culture of mutual cooperation, to decrease tensions and conflict and to safeguard the basic needs of every individual within the community.⁹⁷⁰

4.3.7. Resilience Related Official Documents

Among few official documents related to resilience, the most detailed and fundamental is the *Argentine National Contingency Plan*⁹⁷¹.

An overview of some resilience measures can be found in the *Official Statement* made by Mr Gabriel Ive, President of White Helmets Commission, at the Third UN World Conference on Disaster Risk Reduction (WCDRR) in Sendai, Japan, March 2015⁹⁷².

A detailed description of emergency actions can be found in the *Emergency Plan of Action* developed by the Argentine Branch of the IFRC⁹⁵⁶.

Argentina does not have a National Development Plan *per se*, but its development is guided by a set of strategic national policies. In the area of environment, these policies mention the climate change in general, not adaptation to it in particular. The National Climate Change Strategy is currently being elaborated through a participatory process that will address both climate change adaptation and mitigation⁹⁰¹.

⁹⁷⁰ Bodi, K. (2010). Argentina's collapse and the grassroots of resilience. *Resilience.org*. Available at: <http://www.resilience.org/stories/2010-11-03/argentinas-collapse-and-grassroots-resilience>. Accessed: 2 May 2016.

⁹⁷¹ PLANACON (1998). Argentine National Contingency Plan. *Prefectura Naval Argentina: Buenos Aires*. Available at: <http://www.wittobriens.com/external/content/document/2000/1671711/1/National%20Contingency%20Plan.pdf>. Accessed: 2 May 2016.

⁹⁷² Ive, G. (2015). Exposición de la República Argentina, III Conferencia de las Naciones Unidas sobre Reducción de Riesgos de Desastres. *Preventionweb*. Available at: <http://www.preventionweb.net/files/globalplatform/argentina%5B1%5D.pdf>. Accessed: 2 May 2016.

4.4. Other Countries

4.4.1. Resilience Related Official Documents

At the **high level**, the strategies and financial instruments for disaster risk management in a larger region, Latin America and the Caribbean, are defined by the Inter-American Development Bank in⁹⁷³.

The *International Strategy for Disaster Reduction, the Americas* (EIRD, 2016), developed and backed up by the United Nations, includes, among many others, measures for introducing the resilience in **all countries** of the region⁹⁷⁴.

Caracterización Amenazas y Desastres Naturales [Characterization of Threats and Natural Disasters] elaborated by *Departamento Administrativo Nacional de Estadística* [DANE, National Administrative Department of Statistics] of **Colombia** is one of the principle official documents defining the measures to prevent and fight disasters in Colombia⁹⁷⁵.

In **Paraguay**, the national policy in the area of risk management and resilience is formulated in a document *Política Nacional para la Gestión de Riesgo de Desastres* [National Policy for Disaster Risk Management]⁹⁷⁶ - quite similar, even in title, to the akin document issued by the Chilean Government⁹⁴⁴. Having weaker development of the resilience concept, in conducting its national policy Paraguay relies much stronger on the international actors, especially on UNDP (United Nations Development Programme).

4.4.2. Institutional Framework for Delivering Resilience

Among other regional actors outside **Brazil, Chile, and Argentina**, significant roles in civil defence, disaster management and delivering resilience in the region are played by:

- National System for Disaster Risk Management [*Sistema Nacional de Gestión del Riesgo de Desastres, SINAGERD*], **Peru**, which provides the guidelines, instruments and definitions for the national policy on disaster risk management⁹⁷⁷.
- *Universidad de la Republica, Uruguay*, which actively participates in numerous projects and programs on infrastructure resilience⁹⁷⁸.
- Ministry of Water and Environment [*Ministerio de Medio Ambiente y Agua*], Government of **Bolivia**, which carries out an important international project Bolivia Climate Resilience - Integrated Basin Management (2014-2020) supported by The World Bank⁹⁷⁹.
- Risk Mitigation and Disaster Preparedness System (*Sistema Nacional para la Prevención y Atención de Desastres, SNPAD*), **Colombia**, led by the Presidency of the Republic⁹⁸⁰.

⁹⁷³ Miller, S., Keipi, K. (2005). Strategies and Financial Instruments for Disaster Risk Management in Latin America and the Caribbean, *Inter-American Development Bank*. Available at: http://www.preventionweb.net/files/2528_ENV145StratFinanciaInstrumentsE.pdf. Accessed: 2 May 2016.

⁹⁷⁴ EIRD (2016). Estrategia Internacional para la Reducción de Desastres. *United Nations*. Available at: <http://www.eird.org/perfiles-paises/perfiles/index.php/Portada>. Accessed: 2 May 2016.

⁹⁷⁵ DANE (2011). Caracterización Amenazas y Desastres Naturales. *Departamento Administrativo Nacional de Estadística de Colombia*. Available at: <http://www.dane.gov.co/files/sen/planificacion/caracterizaciones/CADN.pdf>. Accessed: 2 May 2016.

⁹⁷⁶ Presidencia de la República del Paraguay (2013). Política Nacional para la Gestión de Riesgo de Desastres, *Gobierno Nacional*. Available at: http://www.ifrc.org/docs/IDRL/paraguayPNGRR%20-%20SEN_drht72rp.pdf. Accessed: 2 May 2016.

⁹⁷⁷ SINAGERD (2014). Sistema Nacional de Gestión del Riesgo de Desastres. *SINAGRED*. Available at: <http://sgdr.pcm.gob.pe/category/sinagerd/>. Accessed: 2 May 2016.

⁹⁷⁸ UdeLaR (2016). New Policies for Adaptation of Agriculture to Climate Change. *Universidad de la Republica*. Available at: <http://www.universidad.edu.uy/prensa/renderItem/itemId/32586>. Accessed: 2 May 2016.

⁹⁷⁹ World Bank (2014). Projects & Operations: Bolivia Climate Resilience - Integrated Basin Management. *The World Bank*. Available at: <http://www.worldbank.org/projects/P129640/bolivia-climate-resilience-integrated-basin-management?lang=en&tab=details>. Accessed: 2 May 2016.

- The *United Nations* — acting, in line with the International Strategy for Disaster Reduction, the Americas⁹⁷⁴ in several South America countries, with the leading role in **Ecuador**⁹⁸¹, **Guyana**⁹⁸², and **Suriname**⁹⁸³.
- National Emergency Secretariat (*Secretaría de Emergencia Nacional*, SEN), **Paraguay**, reporting directly to the President of the Republic, whose role and mission are focused management and disaster risk reduction⁹⁸⁴.
- Bolivarian National Guard of **Venezuela** (*Guardia Nacional de Venezuela*, GNV), also called the Armed Forces of Cooperation (*Fuerzas Armadas de Cooperación*), one of the four components of the National Armed Forces, which performs civil defence role⁹⁸⁵ (GNV, 2016).

5. Conclusions

The analysis carried out above testifies (already mentioned) little development of the resilience concept in the South America, which in general is less mature than in Europe. There are few official documents directly related to the resilience concept. However, one should always bear in mind that the resilience — as a separate subject of development and study — did not arise out of nowhere: most of its techniques and methods had been developing for decades within the framework of disaster assessment, prevention and management. As such, sufficient volume of information about this early stage of the resilience concept in South America was extracted from documents devoted to cooperative and national contingency plans and regulations.

On the other hand, the regional development of the resilience concept is highly inhomogeneous, and in particular subject areas and geographical regions it may correspond to the best practices and standards worldwide. For example, many specialists and policy makers have pointed to Chile's stringent building codes as a key reason why the death toll from its recent earthquakes (in the hundreds) has been so much lower than in Haiti (in the hundreds of thousands).

To sum up, despite of the early stage of development, numerous documents and research listed above testify that the resilience concept is turning out to be fruitful in all South America countries. The society needs more empirical studies based on historical data or generated scenarios, which can be applied in contexts such as policy making, regional planning, economics, etc. Because the structural properties that confer resilience (and sustainability) are not yet scientifically defined in a clear way, further research is needed to understand these features and their complementarities, synergies and trade-offs.

⁹⁸⁰ SNPAD (2016). Sistema Nacional para la Prevención y Atención de Desastres, *SNPAD*. Available at: <http://www.gestiondelriesgo.gov.co/snigrd/index.aspx>. Accessed: 2 May 2016.

⁹⁸¹ EIRD-Ecuador (2016). Estrategia Internacional para la Reducción de Desastres: Ecuador. *United Nations*. Available at: <http://www.eird.org/perfiles-paises/perfiles/index.php/Ecuador>. Accessed: 2 May 2016.

⁹⁸² EIRD-Guyana (2016). Estrategia Internacional para la Reducción de Desastres: Guyana. *United Nations*. Available at: <http://www.eird.org/perfiles-paises/perfiles/index.php/Guyana>. Accessed: 2 May 2016.

⁹⁸³ EIRD-Suriname (2016). Estrategia Internacional para la Reducción de Desastres: Suriname. *United Nations*. Available at: <http://www.eird.org/perfiles-paises/perfiles/index.php/Suriname>. Accessed: 2 May 2016.

⁹⁸⁴ SEN (2016). Secretaría de Emergencia Nacional. *Secretaría de Emergencia Nacional*. Available at: <http://www.sen.gov.py/pagina/51-mision-y-vision.html>. Accessed: 2 May 2016.

⁹⁸⁵ GNV (2016). Guardia Nacional de Venezuela. Available at: <http://www.guardia.mil.ve/>. Accessed: 2 May 2016.



IMPROVED RISK EVALUATION AND IMPLEMENTATION OF RESILIENCE CONCEPTS
TO CRITICAL INFRASTRUCTURE

Appendix 9 - Resilience Concepts in USA

Editor:

L. MELKUNAITE (DBI)

Authors (in alphabetic order)

P.J. REILLY (UNIVERSITY OF SHEFFIELD)

R. STEVENSON (UNIVERSITY OF SHEFFIELD)

Deliverable Number: D1.1

Date of delivery: May 31, 2016

Month of delivery: M12



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 653390

Coordinator:	David Lange at SP Sveriges Tekniska Forskningsinstitut (SP Technical Research Institute of Sweden)

Table of Contents

1	Executive Summary	320
2	Nomenclature	320
3	Resilience Concepts in the United States of America	321
3.1.	Concept of Resilience	322
3.2.	Institutional Framework for Delivering Resilience	323
3.3.	Technical Resilience and Critical Infrastructure Resilience	323
3.4.	Organisational Resilience	328
3.5.	Social Resilience	330
3.6.	Economic Resilience	331
3.7.	Resilience Related Official Documents	331
4	Case Studies	332
4.1.	Massachusetts	332
4.1.1.	Concept of Resilience	332
4.1.2.	Institutional Framework for Delivering Resilience	332
4.1.3.	Technical Resilience and Critical Infrastructure Resilience	333
4.1.4.	Organisational Resilience	333
4.1.5.	Social Resilience	333
4.1.6.	Economic Resilience	334
4.1.7.	Resilience Related Official Documents	334
4.2.	Oregon	334
4.2.1.	Concept of Resilience	334
4.2.2.	Institutional Framework for Delivering Resilience	334
4.2.3.	Technical Resilience and Critical Infrastructure Resilience	335
4.2.4.	Organisational Resilience	335
4.2.5.	Social Resilience	335
4.2.6.	Economic Resilience	335
4.2.7.	Resilience Related Official Documents	335
4.3.	Texas	336
4.3.1.	Concept of Resilience	336
4.3.2.	Institutional Framework for Delivering Resilience	336
4.3.3.	Technical Resilience and Critical Infrastructure Resilience	336
4.3.4.	Organisational Resilience	337
4.3.5.	Social Resilience	337
4.3.6.	Economic Resilience	337
4.3.7.	Resilience Related Official Documents	337
4.4.	Idaho	338
4.4.1.	Concept of Resilience	338
4.4.2.	Institutional Framework for Delivering Resilience	338
4.4.3.	Technical Resilience and Critical Infrastructure Resilience	338
4.4.4.	Organisational Resilience	339
4.4.5.	Social Resilience	339
4.4.6.	Economic Resilience	339
4.4.7.	Resilience Related Official Documents	340
4.5.	Illinois	340
4.5.1.	Concept of Resilience	340

4.5.2.	Institutional Framework for Delivering Resilience	340
4.5.3.	Technical Resilience and Critical Infrastructure Resilience	341
4.5.4.	Organisational Resilience	341
4.5.5.	Social Resilience	341
4.5.6.	Economic Resilience	341
4.5.7.	Resilience Related Official Documents	341
5	Conclusions	342
Appendix 1		343

1 Executive Summary

Concept of resilience has a long history in the US. The resilience discourse in the context of critical infrastructure was first introduced in unofficial policy analyses and, in some cases, scientific analyses produced in the late 1990s. Resilience Measurement Index (RMI) was found to be used in the country as a paramount tool to measure critical infrastructure resilience. The report discusses resilience definitions and implementation at the national level, as well as state level. Five case studies are provided, namely Massachusetts, Oregon, Texas, Idaho and Illinois.

2 Nomenclature

BEOC	The Business Emergency Operations Center
CEDS	Comprehensive Economic Development Strategy
CIR	Critical infrastructure resilience
CMI	Consequences Measurement Index
COOP	Continuity of Operations
DHS	The Department of Homeland Security
ECC	Emergency Coordination Centre
ECIP	Enhanced Critical Infrastructure
EOC	Emergency Operations Centres
EOPSS	Executive Office of Public Safety and Security
EU	European Union
FEMA	Federal Emergency Management Agency
HSIN	the Homeland Security Information Network
IEMA	Illinois Emergency Management Agency
IEMP	Interactive Ecoregional Management Plan
INHMP	Illinois Natural Hazard Mitigation Plan
IST	Infrastructure Survey Tool
MAUT	Multi-attribute utility theory
MEMP	Massachusetts Emergency Management Program: Multiyear Strategic Plan
NIAC	National Infrastructure Advisory Council
NIST	National Institute of Standards and Technology
NPM	National Preparedness Month
NRP	National Preparedness Plan
OEM	Oregon Emergency Management
OEMP	Oregon Emergency Management Plan
OER	Office of Economic Resilience
ORP	Oregon Resilience Plan
PDCA	Plan-Do-Check-Act
PKEMRA	The Post-Katrina Emergency Management Reform Act
PMI	Protective Measures Index
PPD-8	Presidential Policy Directive 8: National Preparedness
PSA	Protective Security Advisory
PSCD	Protective Security Coordination Division
PSPrep	Private Sector Preparedness Program
QHSR	Quadrennial Homeland Security Review
RI	Resilience Index

RMI	Resilience Measurement Index
SIDRP	State of Illinois Disaster Recovery Plan
SIHMP	The State of Idaho Hazard Mitigation Plan
SORP	The State of Oregon Recovery Plan
SRIA	The Sandy Recovery Improvement Act
THSSP	Texas Homeland Security Strategic Plan
TOHS	Texas Office of Homeland Security
US	United States of America

3 Resilience Concepts in the United States of America

While reading official documents related to the concept of resilience in the US, three themes emerge:

1. The US is disaster-prone;
2. The frequency of disasters related to extreme weather events (e.g. droughts, floods, wildfires) will likely increase due to climate change;
3. Spending on disaster relief and recovery will have to increase due to these threats (Weiss & Weidman 2013).

The Department of Homeland Security (DHS) Federal Emergency Management Agency (FEMA) maintains a list of disaster declarations, which has been regularly updated since 1953⁹⁸⁶. There appears to have been an increase over time in the number of disaster declarations. For example, in the previous five years (2010-2014), 641 disaster declarations were filed.⁹⁸⁷ This, for example, compared to 737 disaster declarations for the ten-year period from 1990 until 1999.⁹⁸⁷

The key recent hazards, which influenced US disaster response and recovery legislation, appear to be 9/11, Hurricane Katrina in 2005, and Hurricane Sandy in 2012. Alongside natural disasters, terrorist attacks are widely perceived to be the most serious hazards that the US faces.⁹⁸⁸ Nevertheless, it has been argued that post-9/11 legislation has adversely affected FEMA's ability to respond to major disasters, and perhaps even contributed to the sub-optimal response to Hurricane Katrina (Mener 2007). This criticism dates back to the establishment of the DHS in 2002, which brought together several federal agencies including FEMA. This reorganisation was said to have prioritized protecting the country from domestic and international terrorism at the expense of all-hazard disaster management (Mener 2007). Hence, law enforcement personnel were given a more influential role in preparedness and response than fire and rescue services personnel, despite concerns that this might not always be the most appropriate course of action for managing disasters (Mener 2007, 37). The bureaucratic structures created by the DHS were also blamed for the slow response to Hurricane Katrina, particularly in relation to its declaration as an Incident of National Significance (Mener 2007).

In August 2005 Hurricane Katrina became the most costly disaster in US history. There were an estimated 1,833 fatalities, 600,000 people displaced from their homes due to the flooding that affected 80 percent of the city, and damage to the local economy and infrastructure that totaled \$135 billion (Plyer 2015). Katrina led to greater evaluation of disasters preparedness and response efforts at both

⁹⁸⁶ See <http://www.fema.gov/disasters>.

⁹⁸⁷ FEMA Disaster Declarations. Disaster Declarations by Year. Available at: <http://www.fema.gov/disasters/grid/year>. Accessed: 24 October 2015.

⁹⁸⁸ Homeland Security Committee. 2015. Ready & Resilient? Examining Federal Emergency Preparedness & Response Capabilities. Available at: <https://www.youtube.com/watch?v=zZkqmygcRNs&feature=youtu.be>. Accessed: 25 October 2015.

federal and national levels, as well as a number of legislative reforms. The Post-Katrina Emergency Management Reform Act of 2006 (PKEMRA) stated that “promoting and planning for the protection, security, resiliency, and post-disaster restoration of critical infrastructure and key resources, including cyber and communications assets” was one of FEMA’s core missions.⁹⁸⁹ PKEMRA also called for an additional emergency support function annex within the National Preparedness Plan (NRP) “which focused on the identification, protection, resiliency, and restoration of critical infrastructure and key resources to be considered”⁹⁸⁹.

3.1. Concept of Resilience

DHS defines resilience as: “The ability to adapt to changing conditions and withstand and rapidly recover from disruption due to emergencies. Whether it is resilience towards acts of terrorism, cyber-attacks, pandemics, and catastrophic natural disasters, our national preparedness is the shared responsibility of all levels of government, the private and non-profit sectors, and individual citizens”⁹⁹⁰.

In general, the US first officially recognised resilience in national doctrine in the 2010 National Security Strategy. Although the Post-Katrina Emergency Management Reform Act of 2006 (PKEMRA) states that one of FEMA’s key roles is “promoting and planning for the protection, security, resiliency, and post-disaster restoration of critical infrastructure”, it does not provide any clear definition of resilience.⁹⁹¹ The 2010 National Security Strategy states that the US must enhance its resilience or its ability, as a nation, to adapt to changing conditions and prepare for, withstand and rapidly recover from disruption. A year later, FEMA announced the release of the country’s first-ever National Preparedness Goal, which sets the vision for nationwide preparedness and identifies the core capabilities and targets necessary to achieve preparedness across the five mission areas of prevention, protection, mitigation, response and recovery. And while resilience had for years been applied to different aspects of disaster relief such as the impact of earthquakes, the concept of resilience also officially entered the world of homeland security in response to the 9/11 events (Kahan 2015). More recently, the DHS recognised resilience in the 2014 Quadrennial Homeland Security Review (QHSR), which established a series of goals and objectives in the areas of critical infrastructure, global movement/supply chain systems and cyberspace. One of the five QHSR missions – “Mission 5 - Strengthening National Preparedness and Resilience” is solely devoted to resilience.

The Presidential Policy Directive/PPD-8 sets out the goal to strengthen “the security and resilience of the United States through systematic preparation for the threats that pose the greatest risk to the security of the nation,”⁹⁹² including acts of terrorism and catastrophic natural disasters. It defines the term resilience as “the ability to adapt to changing conditions and withstand and rapidly recover from disruption due to emergencies”⁹⁹².

The 2011 inaugural edition of the National Preparedness Goal defined successful preparedness as “a secure and resilient Nation with the capabilities required across the whole community to prevent, protect against, mitigate, respond to, and recover from the threats and hazards that pose the greatest

⁹⁸⁹ US Congress. 2006. S.3721 - Post-Katrina Emergency Management Reform Act of 2006. Available at: <https://www.congress.gov/bill/109th-congress/senate-bill/3721>. Accessed: 25 October 2015.

⁹⁹⁰ DHS.2015. Resilience. Available at: <http://www.dhs.gov/topic/resilience>. Accessed: 26 October 2015.

⁹⁹¹ US Congress. 2006. S.3721 - Post-Katrina Emergency Management Reform Act of 2006. Available at: <https://www.congress.gov/bill/109th-congress/senate-bill/3721>. Accessed: 25 October 2015.

⁹⁹² DHS. 2011. Presidential Policy Directive / PPD-8: National Preparedness. Available at: <http://www.dhs.gov/presidential-policy-directive-8-national-preparedness>. Accessed: 25 October 2015.

risk”⁹⁹³. The document also talks about “community resilience” and “risk and disaster resilience”⁹⁹⁴. Here the concept of resilience is defined as “the ability to adapt to changing conditions and withstand and rapidly recover from disruption due to emergencies”⁹⁹⁵.

The Sandy Recovery Improvement Act of 2013 (SRIA) required FEMA to make recommendations for the development of a national strategy to reduce the costs of future disasters that included recommendations on how to improve resilience of state, local, and tribal communities and to lower future response and recovery costs⁹⁹⁶. A definition of the concept of resilience was not explicitly provided in this document.

The DHS Climate Action Plan also refers to adaptability as one of the key principles underpinning resilience. It defines resilience as the “ability to adapt to changing conditions and withstand and rapidly recover from disruption due to emergencies”⁹⁹⁷. The document stresses the importance of supporting climate resilient investment and boosting the resilience of both buildings and critical infrastructures. The missions of DHS include mitigating hazards, enhancing preparedness, ensuring effective emergency response and rapid recovery from disaster⁹⁹⁸. DHS is designated as the driving force in preparing the US to mitigate the consequences of a changing climate, which will be achieved via actions in four specific areas: departmental actions, critical infrastructure resilience, resilience to disasters, and environmentally responsible maritime activity in the Arctic.

The second, 2015 edition of the National Preparedness Goal defined the concept of whole community preparedness as: “a secure and resilient nation with the capabilities required across the whole community to prevent, protect against, mitigate, respond to, and recover from the threats and hazards that pose the greatest risk”⁹⁹⁹. These risks include natural disasters, disease pandemics, man-made hazards, terrorist attacks and cyber-attacks.⁹⁹⁹

3.2. Institutional Framework for Delivering Resilience

FEMA in coordination with partners across the whole community is the central organisation responsible for delivering resilience in the US. FEMA has developed the National Preparedness System - a collective effort based on the understanding that everyone from the individual to the first responder has a role to play in preparing the country for disasters. This approach is reinforced in Presidential Policy Directive (PPD)-8: National Preparedness. PPD-8 called for greater integration and a shared understanding for addressing threats and hazards across prevention, protection, mitigation, response and recovery in order to make the most effective use of the country’s resources and to achieve unity of effort.

3.3. Technical Resilience and Critical Infrastructure Resilience

The concept of critical infrastructure in particular can be traced back to the US in the mid-1990s, when some infrastructures began to be seen as critical for the functioning of the society, and, at the same

⁹⁹³ FEMA. 2011. National Preparedness Goal 1st Edition. Available at: <https://www.fema.gov/pdf/prepared/npg.pdf>. Accessed: 25 October 2015.

⁹⁹⁴ Ibid. P. 2.

⁹⁹⁵ Ibid. P. A-2.

⁹⁹⁶ FEMA. 2013. Sandy Recovery Improvement Act of 2013. Available at: <http://www.fema.gov/sandy-recovery-improvement-act-2013>. Accessed: 26 October 2015.

⁹⁹⁷ DHS. 2013. DHS Climate Action Plan. P. 1. Available at: <http://www.dhs.gov/sites/default/files/publications/DHS%20Climate%20Action%20Plan.pdf>. Accessed: 26 October 2015.

⁹⁹⁸ Ibid. P. 11.

⁹⁹⁹ FEMA. 2015. National Preparedness Goal 2nd Edition. Available at: <http://www.fema.gov/national-preparedness-goal>. Accessed 25 October 2015.

International Survey

time, vulnerable to security-related threats (rather than safety or natural hazards). Critical infrastructure protection has become a key concept in subsequent policy documents and public policy discourse in both the US and European Union (EU) member states. Whereas in Europe the emphasis tends to be on national regulation to build critical infrastructure resilience, the US approach has tended to revolve around private-public partnerships (Pursiainen & Gattinesi 2014).

The resilience discourse in the context of critical infrastructure was first introduced in unofficial policy analyses and, in some cases, scientific analyses produced in the late 1990s. By the late 2000s, the concept was frequently used in critical infrastructure-related policy documents, most notably in the US. Moteff (2012) suggests that the Critical Infrastructure Task Force of the Homeland Security Advisory Council initiated a public policy debate following Katrina, in which it argued that the government's critical infrastructure policies focused too much on protecting assets from terrorist attacks rather than improving the resilience of these assets against a variety of threats. This approach gained support in policy circles, and in 2008 the House Committee on Homeland Security held a series of hearings on the issue of resilience. This appeared to be linked to a renewed focus on resilience in policy documents, moving away from superficial references to the topic towards specific protective measures that could be implemented (Moteff 2012).

In 2009, the National Infrastructure Advisory Council (NIAC) adopted one of the most important documents related to critical infrastructure resilience in the US titled "Critical Infrastructure Resilience".¹⁰⁰⁰ The document defines infrastructure resilience as "the ability to reduce the magnitude and/or duration of disruptive events. The effectiveness of a resilient infrastructure or enterprise depends upon its ability to **anticipate, absorb, adapt to, and/or rapidly recover** from a potentially disruptive event"¹⁰⁰¹.

Absorptive capacity is defined as "ability of the system to endure a disruption without significant deviation from normal operating performance"¹⁰⁰². **Adaptive capacity** is "the ability of the system to adapt to a shock to normal operating conditions. Recoverability is the ability of the system to recover quickly – and at low cost – from potentially disruptive events"¹⁰⁰².

According to the NIAC report, critical infrastructure resilience is characterized by three key features:¹⁰⁰³

- **Robustness:** the ability to maintain critical operations and functions in the face of crisis;
- **Resourcefulness:** the ability to skillfully prepare for, respond to and manage a crisis or disruption as it unfolds;
- **Rapid recovery:** the ability to and/or reconstitute normal operations as quickly and efficiently as possible after a disruption.

The NIAC recognises that **protection** and **resilience** are not opposing concepts. On the contrary, according to the document they represent complementary and necessary elements for a comprehensive risk management strategy. The strong foundation developed for infrastructure protection continues to be an essential part of risk management in all critical infrastructure sectors. According to the document, infrastructure protection refers to the "ability to prevent or reduce the effect of an adverse event"¹⁰⁰².

A combination of the NIAC and the critical infrastructure operators' and owners' lobby played a key role in these developments. Because the majority of all US critical infrastructure is privately owned,

¹⁰⁰⁰ FEMA. 2015. National Preparedness Goal 2nd Edition. Available at: <http://www.fema.gov/national-preparedness-goal>. Accessed: 12 April 2016.

¹⁰⁰¹ Ibid. P. 8.

¹⁰⁰² Ibid. P. 12

¹⁰⁰³ Ibid. P. 13.

the 2008 report asserts that the **public-private partnership** is the most efficient way to enhance critical infrastructure security based on the idea that where “market forces are free to operate, they will be the most efficient and efficacious vehicle to enhance the security posture of critical infrastructures”¹⁰⁰⁴. The 2009 report develops this further and makes a number of recommendations including asking the US government to use a White House level authority to adopt a common definition for resilience and disseminate a top-down strategy for the development and funding of resilience efforts.¹⁰⁰⁵ It also calls for greater coordination between all levels of government and critical infrastructure owners and operators, clarification of the responsibilities of critical infrastructure partners, the strengthening of public-private partnerships, encouraging resilience through appropriate market incentives and the implementation of government-enabling activities in conjunction with critical infrastructure owners and operators.

Looking at the US government documents that have followed these unofficial policy reports, the lobbyists’ approach appears to be at least partially influenced by these principles. Hence, the 2009 update of the National Infrastructure Protection Plan was renamed Partnering to Enhance Protection and Resiliency, emphasising the role of public-private partnerships in building resilience. However, it should be acknowledged that the term ‘resilience’ is still used rather loosely with no clear definition provided. Since 2009, resilience has been a constant reference point in government documents that relate to critical infrastructure. Incidents such as the 2011 Fukushima disaster and Hurricane Sandy have led to new policy documents that emphasise resilience over protection.¹⁰⁰⁶ Moteff (2012) concludes that the US policy had, by 2012, evolved “to the point that resilience and protection of critical infrastructure assets are recognized as distinct options to be equally considered when seeking to reduce the risks associated with potential attacks on critical infrastructures.” Consequently, resilience has begun to be the subject of targeted funding, including in Research & Development (Moteff 2012) and via a dedicated “Regional Resilience Assessment Program” (Mortin 2014).

The Presidential Policy Directive - Critical Infrastructure Security and Resilience asserts: “proactive and coordinated efforts are necessary to strengthen and maintain secure, functioning, and resilient critical infrastructure”¹⁰⁰⁷. The Directives defines resilience as “the ability to prepare for and adapt to changing conditions and withstand and recover rapidly from disruptions...[it] includes the ability to withstand and recover from deliberate attacks, accidents, or naturally occurring threats or incidents.”¹⁰⁰⁸ Having accurate information and analysis about risk is essential to achieving resilience. Resilient infrastructure assets, systems, and networks must also be robust, agile, and adaptable. Mitigation, response, and recovery activities contribute to strengthening critical infrastructure resilience. The Presidential Policy Directive further states that resilience “is a shared responsibility among the Federal, state, local, tribal, and territorial entities, and public and private owners and operators of critical infrastructure”¹⁰⁰⁹.

¹⁰⁰⁴ NIAC. 2008. National Infrastructure Advisory Council, Critical Infrastructure Partnership Strategic Assessment Final Report and Recommendations. October 14, 2008. Available at: https://www.dhs.gov/xlibrary/assets/niac/niac_critical_infrastructure_protection_assessment_final_report.pdf. Accessed: 12 April 2016.

¹⁰⁰⁵ NIAC. 2009. National Infrastructure Advisory Council. Critical Infrastructure Resilience. Final Report and Recommendations, September 8, 2009. Available at: https://www.dhs.gov/xlibrary/assets/niac/niac_critical_infrastructure_resilience.pdf. Accessed: 12 April 2016.

¹⁰⁰⁶ Hurricane Sandy Rebuilding Task Force. 2013. Hurricane Sandy Rebuilding Strategy. Stronger Communities, A Resilient Region. Presented to the President of the United States August 2013. Available at: <http://portal.hud.gov/hudportal/documents/huddoc?id=hsrebuildingstrategy.pdf>. Accessed: 12 April 2016.

¹⁰⁰⁷ The White House. 2013. Presidential Policy Directive – Critical Infrastructure Security and Resilience. PPD-21. Available at: <https://www.whitehouse.gov/the-press-office/2013/02/12/presidential-policy-directive-critical-infrastructure-security-and-resil>. Accessed: 13 April 2016.

¹⁰⁰⁸ Ibid.

¹⁰⁰⁹ Ibid.

International Survey

The Presidential Policy Directive helped shape the updated National Infrastructure Protection Plan¹⁰¹⁰, which was subtitled Partnership for Critical Infrastructure Strategy and Resilience. This document contains a crisis management checklist, which covers all types of possible critical infrastructure disaster scenarios, from prevention to recovery phases. It focuses primarily on organisational and management issues, but it also stipulates that whenever an incident has taken place one should “repair or replace damaged infrastructure with cost-effective designs that are more secure and resilient”¹⁰¹⁰. In sum, the two aforementioned US policy documents have recognized critical infrastructure protection “as an enabler of CIR” (critical infrastructure resilience) (Gaynor 2014, 10).

Although the US approach appears to emphasise resilience over protection¹⁰¹⁰, it should be noted that it remains underpinned by **public-private partnerships**. This has created some suspicion about the operators and owners of critical infrastructure merely paying “lip-service” to resilience when it suits them - individual operators tend to invest as little as possible into these partnerships.¹⁰¹¹

Regarding the assessment and implementation of critical infrastructure resilience, the US is rather advanced in this field compared to, for example, the EU. In September 2007, Department of Homeland Security Leadership directed the Protective Security Coordination Division (PSCD's), Protective Security Advisory (PSA) Program to participate in the Enhanced Critical Infrastructure (ECIP) Initiative. This Initiative serves as a cornerstone of the voluntary outreach effort by the Government to help to increase resilience of critical infrastructures across the country. Based on the Initiative, PSAs conduct ECIP visits to critical infrastructure facilities. During an ECIP visit, PSAs focus on coordination, outreach, training, education, and building existing relationships with federal, state, local, tribal, territorial, and private sector partners.¹⁰¹² ECIP visits are often followed by security surveys using the **Infrastructure Survey Tool (IST)**. The IST was developed in 2008 to serve as a web-based tool to better facilitate data collection and analysis under the ECIP Initiative.¹⁰¹³

IST consists of three indexes, namely the **Protective Measures Index (PMI)**, the **Resilience Measurement Index (RMI)**, and the **Consequences Measurement Index (CMI)**. The combination of these three indexes allows critical infrastructure to be compared in terms of resilience, vulnerability, consequences, and ultimately risk (see Figure 3.1).

¹⁰¹⁰ NIPP.2013. National Infrastructure Protection Plan. Partnering for Critical Infrastructure Security and Resilience. Homeland Security. Available at: <https://www.dhs.gov/national-infrastructure-protection-plan>. Accessed: 12 April 2016.

¹⁰¹¹ Perera, D. 2013. Market pressures weigh against private sector critical infrastructure resilience. Available at: <http://www.fiercehomelandsecurity.com/story/market-pressures-weigh-against-private-sector-critical-infrastructure-resil/2013-04-04>. Accessed: 25 October 2015.

¹⁰¹² DHS. 2015. Critical Infrastructure Vulnerability Assessments. Available at: <https://www.dhs.gov/critical-infrastructure-vulnerability-assessments>. Accessed: 12 April 2016.

¹⁰¹³ DHS. 2009. Infrastructure Survey Tool. Available at: http://mcpf.us/downloads/Archives/ist_one_pager_april_2009.pdf. Accessed: 12 April 2016.

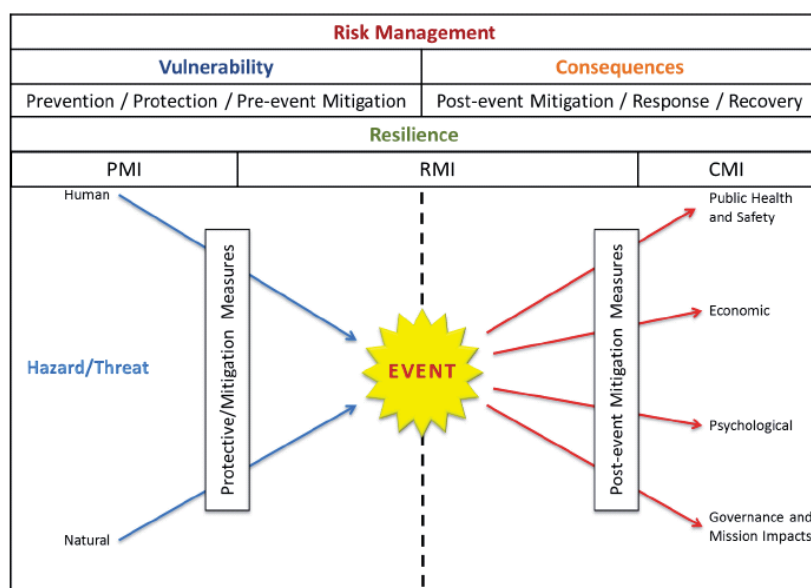


Figure 3.1 Risk Management Bowtie Diagram¹⁰¹⁴

The first index developed as part of the DHS ECIP program was the PMI, in 2008. This index is designed to capture the protective measures in place in a given facility. The fourth version of this index, which was launched in 2013, addresses elements characterising physical security, security management, security force, information sharing, and security activity background. The second index, the RMI, characterises the resilience of critical infrastructure. This index was guided by the standards used for the voluntary Private Sector Preparedness Program (PSPrep) and National Security Directive PPD-8. The Psprep program is based on three main standards, namely British Standards Institute 25999, NFPA 1600, and ANSI/ASIS SPC. 1-2009, which provide a comprehensive management systems approach to organisational resilience, preparedness, and business continuity.¹⁰¹⁵ A third index, the CMI, characterises the maximum consequences potentially generated by an adverse event at a facility.

The RMI is of particular relevance for the current research. The current RMI is a descendent of an earlier index called the Resilience Index (RI). The RMI combines questions that have been developed on the basis of business continuity and resilience standards and specifically draw from following¹⁰¹⁶:

- British Standards Institute 25999 Standard on Business Continuity;
- NFPA 1600 Standard on Disaster/Emergency Management and Business Continuity Programs;
- ANSI/ASIS SPC.1-2009 Standard on Organisational Resilience;
- ISO 22301 Societal Security – Business Continuity Management Systems – Requirements 06-15-2012.

RMI organises the collected information into four groups (RMI Level 1), namely: preparedness, mitigation measures, response capabilities, and recovery mechanisms. A detailed RMI structure is presented in Appendix 1. The Index is based on decision analysis and multi-attribute utility theory (MAUT). This indicator can be used:

- Alone for addressing the resilience of a specific facility;
- In combination with PMI and CMI to characterise overall risk;

¹⁰¹⁴ Argonne National Laboratory. 2013. Resilience Measurement Index: An Indicator of Critical Infrastructure Resilience. P. 4. Available at: <http://www.ipd.anl.gov/anlpubs/2013/07/76797.pdf>. Accessed: 13 April 2016.

¹⁰¹⁵ Ibid. P. 1.

¹⁰¹⁶ Ibid. P. 8.

International Survey

- For addressing regional resilience;
- For guiding decisions for special events and domestic incidents.¹⁰¹⁷

3.4. Organisational Resilience

The most important document related to organisational resilience in the US is the ASIS SPC.1-2009 Organisational Resilience Standard.¹⁰¹⁸ The Standard defines organisational resilience as “the adaptive capacity of an organisation in a complex and changing environment. Resilience is the ability of an organisation to resist being affected by an event or the ability to return to an acceptable level of performance in an acceptable period of time after being affected by an event. Resilience is the capability of a system to maintain its functions and structure in the face of internal and external change and to degrade gracefully when it must”¹⁰¹⁹. The Standard adopts the Plan-Do-Check-Act (PDCA) model, which is applied to structure the organisational resilience management system processes (see Table 3.1)¹⁰²⁰.

Table 3.1 Plan-Do-Check-Act model.

Plan (establish the management system)	Establish management system policy, objectives, processes, and procedures relevant to managing risk and improving security, incident preparedness, response, continuity, and recovery and to deliver results in accordance with an organisation’s overall policies and objectives.
Do (implement and operate the management system)	Implement and operate the management system policy, controls, processes, and procedures.
Check (monitor and review the management system)	Assess and measure process performance against management system policy, objectives, and practical experience and report the results to management for review.
Act (maintain and improve the management system)	Take corrective and preventive actions, based on the results of the internal management system audit and management review, to achieve continual improvement of the management system.

¹⁰¹⁷ Argonne National Laboratory. 2013. Resilience Measurement Index: An Indicator of Critical Infrastructure Resilience. P. 23. Available at: <http://www.ipd.anl.gov/anlpubs/2013/07/76797.pdf>. Accessed: 13 April 2016.

¹⁰¹⁸ ASIS International. 2009. Organisational Resilience: Security, Preparedness, and Continuity Management Systems-Requirements with Guidance for Use. ASIS SPC.1-2009 American National Standard. Available at: https://www.ndsu.edu/fileadmin/emgt/ASIS_SPC.1-2009_Item_No._1842.pdf. Accessed: 13 April 2016.

¹⁰¹⁹ Ibid. P. 48.

¹⁰²⁰ For the graphical depiction of the PDCA model see P. viii.

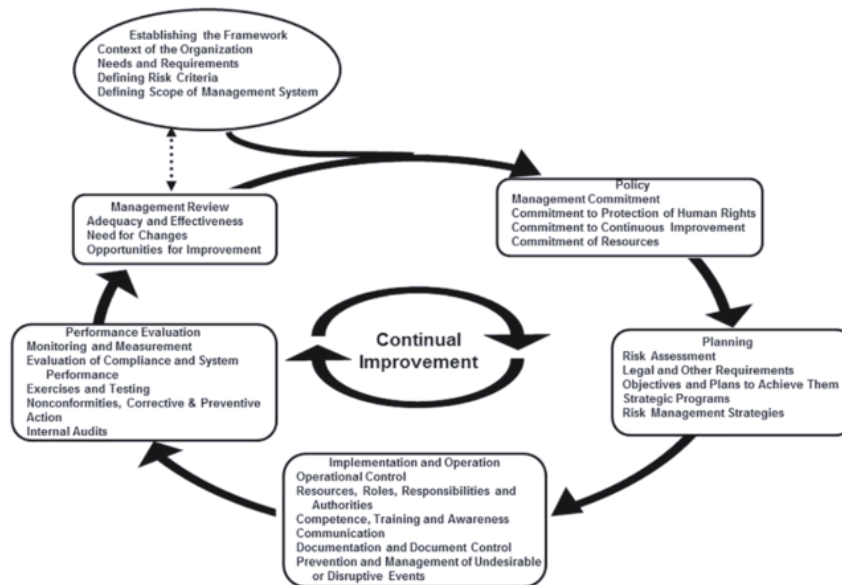


Figure 3.2 Organisational Resilience Management System Flow Diagram¹⁰²¹

The Standard provides recommendations for any type of organisation to identify and develop best practices to assist and foster action in 15 areas¹⁰²²:

- a. Providing top management driven vision and leadership for strategies to protect assets and assure the resilience of the organisation;
- b. Identifying and evaluating assets, services, and functions to determine the parts of the operations and business that are critical to its short-and long-term success;
- c. Identifying potential hazards and threats, and assessing risks and impacts;
- d. Mitigating the impact of a wide variety of hazards and threats, including natural disasters, technological and environmental accidents, and man-made disasters;
- e. Understanding the roles and responsibilities needed to protect assets and further resilience;
- f. Managing necessary incident/emergency preparedness and response resources;
- g. Developing strategic alliances and mutual aid agreements;
- h. Developing and maintaining incident/emergency preparedness and response plans, and associated operational procedures;
- i. Developing and conducting training and exercises to support and evaluate incident/emergency preparedness, response plans, and operational procedures;
- j. Developing and conducting training programs to implement preparedness, response plans, and operational procedures;
- k. Ensuring that relevant employees, customers, and other stakeholders are aware of the incident/emergency preparedness and response arrangements and (where appropriate) have confidence in their application;
- l. Developing internal and external communications procedures, including response to requests for information from the media or the public;
- m. Establishing metrics for measuring and demonstrating success;
- n. Documenting the key resources, infrastructure, tasks, and responsibilities required to support critical operational functions;

¹⁰²¹ ASIS International. 2009. Organisational Resilience: Security, Preparedness, and Continuity Management Systems-Requirements with Guidance for Use. ASIS SPC.1-2009 American National Standard. P. 4. Available at: https://www.ndsu.edu/fileadmin/emgt/ASIS_SPC.1-2009_Item_No._1842.pdf. Accessed: 13 April 2016.

¹⁰²² Ibid. P. 19.

- o. Establishing processes that ensure the information remains current and relevant to the changing risks and operational environments.

FEMA also helps enhance organisational resilience with its *Ready* campaign and its preparedness certification programme for business. Launched in February 2003, FEMA's *Ready* was a national public service advertising campaign designed to educate and empower Americans to prepare for and respond to human-made and natural disasters. The objective of the campaign was to collaborate with members of the public to increase the levels of basic preparedness. *Ready* also has a component which focused on Business Disaster Preparedness, providing tools to businesses that would help them create a plan that addresses the impact(s) of various hazards. Additionally, FEMA's Voluntary Private Sector Preparedness Certification Program encourages the adoption of continuity standards and practices by businesses everywhere as a way to build the country's resilience.¹⁰²³

3.5. Social Resilience

FEMA has sponsored disaster preparedness campaigns to provide the American public with disaster preparedness information. The need for such campaigns was underscored in Presidential Policy Directive 8: National Preparedness (PPD-8). PPD-8 authorizes the Federal Government, and specifically directs the Secretary of Homeland Security, to “coordinate a comprehensive campaign to build and sustain national preparedness, including public outreach and community-based and private-sector programs to enhance national resilience”¹⁰²⁴.

Since its inception in 2004, National Preparedness Month is observed each September in the US.¹⁰²⁵ The month culminates in the Preparathon Day.¹⁰²⁶ Sponsored by FEMA, National Preparedness Month encourages US citizens to take steps to prepare for emergencies. FEMA's *Ready* campaign disseminates information to help the general public prepare for and respond to emergencies, including natural disasters and potential terrorist attacks. The PrepareAthon! helps to build a more resilient nation by increasing the number of individuals who understand the type of disasters that could happen within their respective communities, sharing information on what measures should be taken in order to mitigate the damage from such incidents and encouraging citizens to participate in community resilience planning.¹⁰²⁷ September was chosen as National Preparedness Month, due to the anniversary of the 9/11 attacks falling within this calendar month. 9/11 was also symbolic of the dangers of not being prepared for such disasters. In addition, September coincides with the peak of the Atlantic hurricane season.

In April 2015, the National Institute of Standards and Technology (NIST) released a draft (which was open for comments until June 26, 2015) of a ‘Community resilience planning guide,’ which provided a practical and flexible approach to help communities to allocate resources for disaster preparedness and improve their resilience through increased awareness of hazard risks.¹⁰²⁸ The guide was intended to help communities “bounce back quickly and efficiently after a hazard passes” (May 2015). The guide

¹⁰²³ FEMA. 2015. The Voluntary Private Sector Preparedness Program -- PS-Prep™ & Small Business Preparedness. Available at: <http://www.fema.gov/voluntary-private-sector-preparedness-program-ps-preptm-small-business-preparedness>. Accessed: 26 October 2015.

¹⁰²⁴ DHS. 2011. Presidential Policy Directive / PPD-8: National Preparedness. Available at: <http://www.dhs.gov/presidential-policy-directive-8-national-preparedness>. Accessed: 25 October 2016.

¹⁰²⁵ Ready. 2015 National Preparedness Month (NPM). Available at: <http://www.ready.gov/september>. Accessed: 25 October 2015.

¹⁰²⁶ America's PreparAthon!. Available at: <http://www.community.fema.gov/>. Accessed: 24 October 2015.

¹⁰²⁷ DHS. 2015. Written testimony of FEMA Administrator Craig Fugate for a House Committee on Homeland Security, Subcommittee on Emergency Preparedness, Response, and Communications hearing. Available at: <http://www.dhs.gov/news/2015/10/22/written-testimony-fema-administrator-house-homeland-security-subcommittee-emergency>. Accessed: 24 October 2015.

¹⁰²⁸ NIST. 2015. Community Resilience Planning Guide. Available at: <http://www.nist.gov/el/resilience/guide.cfm>. Accessed: 25 October 2015.

focuses on the social functions that sustain a community, such as healthcare, public safety, education, business and employment as well as the role that the built environment (such as buildings and infrastructure) plays in supporting these functions.

Overall, the terms ‘social’, ‘societal’ and ‘community’ resilience are used interchangeably to refer to the capacity to reduce the negative societal consequences of loss of critical services. Some documents referred to ‘the British stiff upper lip throughout World War II’ and ‘the resolve British citizens showed after the July 2005 bombings, evidenced by resuming train service the following day’ as examples of ‘societal resilience’ and exemplar ‘resilient societies’.¹⁰²⁹

3.6. Economic Resilience

Economic resilience is defined as “an area’s ability to prevent, withstand, and quickly recover from major disruptions (i.e., ‘shocks’) to its economic base”¹⁰³⁰. Thus, the economic resilience concept does not solely focus on the aspect of recovery. The ability to recover quickly from a shock, the ability to withstand a shock and the ability to avoid the shock altogether should all, according to the US Economic Development Administration, be seen as primary attributes of economic resilience.

In the US, there is a dedicated Office of Economic Resilience (OER) which helps communities build ‘resilient economies’ by enhancing quality of place, advancing job creation strategies, reducing housing/transportation/energy consumption costs, promoting clean energy solutions and creating economic opportunities.¹⁰³¹ OER has produced an economic resilience planning evaluation tool to guide communities’ and regions’ economic development plans.¹⁰³²

3.7. Resilience Related Official Documents

- US Congress. 2006. S.3721 - Post-Katrina Emergency Management Reform Act of 2006. Available at: <https://www.congress.gov/bill/109th-congress/senate-bill/3721>;
- NIAC. 2008. National Infrastructure Advisory Council, Critical Infrastructure Partnership Strategic Assessment Final Report and Recommendations. October 14, 2008. Available at: https://www.dhs.gov/xlibrary/assets/niac/niac_critical_infrastructure_protection_assessment_final_report.pdf;
- NIAC. 2009. National Infrastructure Advisory Council. Critical Infrastructure Resilience. Final Report and Recommendations, September 8, 2009. Available at: https://www.dhs.gov/xlibrary/assets/niac/niac_critical_infrastructure_resilience.pdf;
- ASIS International. 2009. Organisational Resilience: Security, Preparedness, and Continuity Management Systems-Requirements with Guidance for Use. ASIS SPC.1-2009 American National Standard. Available at: https://www.ndsu.edu/fileadmin/emgt/ASIS_SPC.1-2009_Item_No._1842.pdf;
- DHS. 2011. Presidential Policy Directive / PPD-8: National Preparedness. Available at: <http://www.dhs.gov/presidential-policy-directive-8-national-preparedness>;
- FEMA. 2011. National Preparedness Goal 1st Edition. Available at: <https://www.fema.gov/pdf/prepared/npag.pdf>;

¹⁰²⁹ DHS. 2011. Community resilience task force recommendations. Available at: <https://www.dhs.gov/xlibrary/assets/hsac-community-resilience-task-force-recommendations-072011.pdf>. Accessed: 25 January 2015.

¹⁰³⁰ US Economic Development Administration. Comprehensive Economic Development Strategy (CEDS) Content Guidelines. Available at: <http://www.eda.gov/ceds/files/CEDS-Content-Guidelines-full.pdf>. Accessed: 24 January 2016.

¹⁰³¹ Housing and Urban Development. Economic Resilience. Available at: http://portal.hud.gov/hudportal/HUD?src=/program_offices/economic_resilience. Accessed: 25 January 2016.

¹⁰³² HUD Exchange. Economic resilience planning evaluation tool, Available at: <https://www.hudexchange.info/resources/documents/Economic-Resilience-Planning-Evaluation-Tool.pdf>. Accessed: 24 January 2016.

International Survey

- DHS. 2011. Presidential Policy Directive / PPD-8: National Preparedness. Available at: <http://www.dhs.gov/presidential-policy-directive-8-national-preparedness>;
- FEMA. 2013. Sandy Recovery Improvement Act of 2013. Available at: <http://www.fema.gov/sandy-recovery-improvement-act-2013>;
- DHS. 2013. DHS Climate Action Plan. Available at: <http://www.dhs.gov/sites/default/files/publications/DHS%20Climate%20Action%20Plan.pdf>;
- The White House. 2013. Presidential Policy Directive – Critical Infrastructure Security and Resilience. PPD-21. Available at: <https://www.whitehouse.gov/the-press-office/2013/02/12/presidential-policy-directive-critical-infrastructure-security-and-resil>;
- NIPP. 2013. National Infrastructure Protection Plan. Partnering for Critical Infrastructure Security and Resilience. Homeland Security. Available at: <https://www.dhs.gov/national-infrastructure-protection-plan>;
- FEMA. 2015. National Preparedness Goal 2nd Edition. Available at: <http://www.fema.gov/national-preparedness-goal>;
- NIST. 2015. Community Resilience Planning Guide. Available at: <http://www.nist.gov/el/resilience/guide.cfm>.

4. Case Studies

4.1. Massachusetts

4.1.1. Concept of Resilience

In the Massachusetts Emergency Management Program: Multiyear Strategic Plan 2013-2016 (MEMP) resilience is not mentioned as the aim of the plan, however the purpose of the plan is to ‘protect against, prevent, prepare for, mitigate, respond to, and recover from natural, man-made and technological emergencies.’¹⁰³³

Resilience is mentioned specifically regarding enhanced preparedness, the goal of which is to increase resiliency and the ability to respond to and rapidly recover from disasters. Resilience is also mentioned alongside the goal of enhanced mitigation capabilities ‘enhance resiliency [...] thereby reducing loss of life, property, economy, infrastructure and cultural resources from disasters.’¹⁰³⁴. These concepts of resilience mirror the DHS definition of withstanding and recovering from emergencies (See 1.1)

4.1.2. Institutional Framework for Delivering Resilience

An interagency state recovery plan/framework is proposed in the MEMP. The state is broken up into five areas (see Figure 1.), each of which have individual responsibility for emergency management in their area. Each area has an Emergency Operations Centres (EOC) to coordinate local emergency prevention, mitigation and response, in addition to the MEMP. Each area also has their own preparedness plan. For example, Boston has plans for citizens in emergencies due to for storm, earthquake, fire, terror or no power. Details include how to personally prepare for an emergency, and evacuation routes.

¹⁰³³ Massachusetts Emergency Management Agency. 2013. Massachusetts Emergency Management Program: Multiyear Strategic Plan 2013-2016 p. 1-1. Available at <http://www.mass.gov/eopss/docs/mema/mema-strategic-plan-final-may-2013.pdf>. Accessed: 24 April 2015

¹⁰³⁴ *ibid*, p.2-5



Figure 4.1 Massachusetts Homeland Security Planning Regions.

The MEMP stakeholders include state, federal and private sector partners. The MEMP includes a plan for allowing credentialed public and private sector to access critical infrastructure and services in impacted areas.

MEMP also presents other governmental bodies to work with including, EOPSS (Executive Office of Public Safety and Security) to produce a risk assessment on threat and hazard identification, and FEMA for consistent guidance.

4.1.3. Technical Resilience and Critical Infrastructure Resilience

The MEMP includes aspects of technical resilience. The plan acknowledges the need for a cyber disruption plan, and the need to plan for catastrophic communications failure.

The MEMP also acknowledges the use of technology to improve resilience, including the need to enhance GIS, upgrade webEOC (digital emergency operating centres), and rapid assessment technology.

4.1.4. Organisational Resilience

The MEMP does not directly mention organisational resilience; however some of the geographical areas have resources for business resilience, e.g. NERAC's Business Preparedness Resources. This links to resources by the DHS and FEMA on how to 'institute a management system that addresses business continuity, organizational resilience, and emergency management'¹⁰³⁵.

4.1.5. Social Resilience

There are two aspects of social resilience produced in the Massachusetts emergency preparedness plans; preparing the community to be resilient to emergency situations and mitigating the effects of an emergency on the community.

Much emphasis is put on preparing the community in emergency management. MEMA have information on how citizens can stay informed on possible incidents, build emergency kits, create

¹⁰³⁵ See <http://www.nerac.us/preparedness-resources/business-preparedness-resources/>

International Survey

plans on how to keep family, pets and those with disabilities safe, and information on community preparedness schemes, such as the Citizen Corps Program and the American Red Cross¹⁰³⁶.

The second aspect of social resilience is mitigating the effects of a disaster on the community. The MEMP notes the need for a state-wide disaster housing plan, a mass feeding coordination plan, protocols for public alerting, including social media, mobile alert and website, and annual training needs assessment for communities.

4.1.6. Economic Resilience

As mentioned in section 1.1.5, one aspect of a resilient economy is promoting clean energy solutions. Massachusetts has a Community Clean Energy Resiliency Initiative¹⁰³⁷. This involves a grant program to fund projects which use clean energy concepts to make local energy supply more resilient to severe climate events caused by climate change.

4.1.7. Resilience Related Official Documents

Massachusetts Emergency Management Agency. 2013. Massachusetts Emergency Management Program: Multiyear Strategic Plan 2013-2016. Available at <http://www.mass.gov/eopss/docs/mema/mema-strategic-plan-final-may-2013.pdf>

4.2. Oregon

4.2.1. Concept of Resilience

The Oregon Emergency Management Plan (OEMP) for the DHS states the vision is that ‘Oregon has safe and resilient communities’¹⁰³⁸. Resilience and resiliency is mentioned throughout the report, however the concept of resiliency is never properly defined. As with other state Emergency Management Plans, the mission is to ‘develop and enhance preparedness, response, recovery and mitigation capabilities to protect the lives, property and environment of the whole community’

4.2.2. Institutional Framework for Delivering Resilience

The OEMP is significant for requires local, tribal, state and federal agencies. Private partnerships are also sought in order to expand the knowledge base of the Oregon Emergency Management (OEM) resource network. In the OEMP, the OEM notes that

‘Successful mitigation projects require the appropriate mix of technical support and local ownership. OEM’s role in successful local hazard mitigation projects should be one of guidance and support, not one where OEM is acting as the local project manager.’¹⁰³⁹

The OEMP acknowledges the since emergency situations are scarce, maintaining resources that are focussed on specific emergencies can be difficult. The OEM has an Emergency Coordination Centre (ECC) which coordinates various emergency response agencies and organisations in an emergency situation across jurisdictional borders.

¹⁰³⁶ See <http://www.mass.gov/eopss/agencies/mema/be-prepared/>

¹⁰³⁷ See <http://www.mass.gov/eea/energy-utilities-clean-tech/renewable-energy/resiliency/resiliency-initiative.html>

¹⁰³⁸ Oregon Office of Emergency Management. 2014. Oregon Emergency Management Plan. p.2. Available at: http://www.oregon.gov/OMD/OEM/docs/plan_train/OEM%20Strategic%20Plan%202014-2020.pdf Accessed: 24 April 2016

¹⁰³⁹ Ibid, p.13.

4.2.3. Technical Resilience and Critical Infrastructure Resilience**4.2.4. Organisational Resilience****4.2.5. Social Resilience**

The OEMP notes the importance of social resilience and citizen emergency planning. It recommends state-wide exercises to assess citizen preparedness and community recovery plans.

As one of the greatest hazards to Oregon are earthquakes and tsunamis from the Cascadia subduction zone, community resilience to these natural disasters is of utmost importance. The OEMP notes that communities should be able to address healthcare, sheltering, housing and debris removal for the community.

Furthermore, the OEMP notes that local and tribal organisations are responsible for local hazard identification and risk reduction plans. The OEM has responsibility for aiding with this through plan development, project execution and access to federal funding.

The State of Oregon Recovery Plan (SORP) notes that the variety of agencies and organisations responsible for emergency management (including non-profit and faith-based organisations) should plan and promote mitigation, resilience and sustainability to reduce the impact of disasters on communities, and improve their ability to recover.

4.2.6. Economic Resilience

Funding is available from the SORP for economic resilience. Areas include relief from severe economic dislocation events to accelerate economic recovery, short-term plans to create and retain high wage/high skill jobs, alleviate unemployment and out-migration, supporting fisheries, and to enhance resilience of coastal communities whose economies are more at risk from natural hazards.

Economic resilience is mentioned in the Oregon Resilience Plan (ORP) which focuses on resilience to natural disasters from the Cascadia subduction zone, such as earthquakes and tsunamis. Improving the resilience of buildings, roads, bridges, energy, water and health will in turn improve the resilience of the local economy and local businesses.

4.2.7. Resilience Related Official Documents

Oregon Office of Emergency Management. 2014. State of Oregon Recovery Plan - State Of Oregon Emergency Management Plan: Volume IV. Available at http://www.oregon.gov/OMD/OEM/docs/OR%20RECOVERY%20PLAN_FULL%20PLAN_FINAL_DEC%202014.pdf

Oregon Seismic Safety Policy Advisory Commission. 2013. The Oregon Resilience Plan. Available at https://www.oregon.gov/OMD/OEM/ossac/docs/Oregon_Resilience_Plan_Final.pdf

Oregon Office of Emergency Management. 2014. Oregon Emergency Management Plan. Available at http://www.oregon.gov/OMD/OEM/docs/plan_train/OEM%20Strategic%20Plan%202014-2020.pdf

International Survey

4.3. Texas

4.3.1. Concept of Resilience

As with other DHS Emergency Management Plans, the main concepts of Texas Homeland Security Strategic Plan (THSSP) 2015-2020 are to prevent, protect, mitigate, respond and recover from threats, hazards and vulnerabilities. Implementing the plan should create a more ‘secure and resilient’¹⁰⁴⁰ state.

The main hazards identified in THSSP are crime and terror through the ‘unsecured border with Mexico’¹⁰⁴¹

4.3.2. Institutional Framework for Delivering Resilience

The THSSP identifies agencies, jurisdictions, and the private sector as major stakeholders in delivering resilience. This can be at state, county and municipal levels. The private sector is a major stakeholder in the THSSP; ‘The state encourages the voluntary cooperation of the private sector in advancing this plan’¹⁰⁴².

The THSSP is applicable to state agencies, regional organizations, local and tribal governments, private sector organizations, and the public. The THSSP also notes that local communities should prepare for threats and hazards most likely to affect their local area, whereas statewide agencies should prepare for more extreme hazards which would be beyond the local organisations.

There are two levels of operations delivering resilience in Texas. At a state level the Texas Office of Homeland Security (TOHS) are responsible for development and capability of security. At a local level there are Emergency Operations Centres (EOC). Both of these agencies are responsible for coordinating a variety of agencies, non-profit groups, and private sector organisations that aid in emergency management.

4.3.3. Technical Resilience and Critical Infrastructure Resilience

The THSSP acknowledges cyber threats as a major hazard to security as they could cause disruption to critical infrastructure such as energy, water, healthcare, public health, the economy, and law enforcement. To aid in preventing these attacks cyber security assessments, penetration tests, and vulnerability scans are performed on state information resources.

As part of *Goal 1: Prevent*, the THSSP notes that criminals and terrorists active in the cyber realm are becoming harder to identify and neutralise. Therefore Texas is committed to enhancing cyber security technology, including hardware, software and networks in order to store, analyse, and organise data collected on possible cyber threats. Furthermore, the Texas Department of Information Resources developed the Texas Cybersecurity Framework which has 40 critical controls for protecting information resources from cyber-attacks.

Technology is also used to improve community resilience. The Texas Department of Agriculture provides high speed broadband internet access in rural communities to improve alerting and information exchange during an emergency.

¹⁰⁴⁰ The State of Texas. 2015. Texas Homeland Security Strategic Plan 2015-2020. p.2. Available at: https://www.txdps.state.tx.us/director_staff/txHomelandSecStratPlan2015-2020.pdf. Accessed: 24 April 2016.

¹⁰⁴¹ Ibid, p.29

¹⁰⁴² Ibid, p.2

4.3.4. Organisational Resilience

Organisational resilience is noted in relation to resilience of critical infrastructure in the THSSP. The coordination of multi-agency and public-private partnerships are essential. In order for these multiple organisations to coordinate Sector Working Groups are created. These are responsible for develop plans and solutions to ensure the resilience of networks, systems, assets and facilities of critical infrastructure. Furthermore, the Homeland Security Information Network (HSIN) is responsible for making sure information on emergency situations, and possible threats are disseminated to all stakeholders.

4.3.5. Social Resilience

The THSSP defines social resilience as ‘the ability of communities to absorb, cope with, and adjust to external shocks’¹⁰⁴³ encouraging whole community preparedness initiatives, enhancing awareness of risks and potential mitigation measures, and ensuring that communities consider the needs of their most vulnerable groups. Texas has 83 programs to engage local communities which improve community resilience, e.g. Citizen Corps and Neighborhood Watch.

Communities can also aid with the *Goal 1: Prevent*, as the THSSP states it will ‘promote public awareness and by providing easily accessible technology for citizen reporting’¹⁰⁴⁴. Technology such as systems like iWatch allows citizens to report suspicious activity on crime, terror and human trafficking.

School children are taught Community Emergency Response Team and leadership skills in order to increase community resilience.

The state also develops further outreach materials such as guides, handouts, and training videos to assist local communities in preparing for effective post-incident recovery.

4.3.6. Economic Resilience

The TSHHP acknowledges the enormous effect disasters can have on the economy directly and indirectly. Disasters affecting energy, industrial incidents and organised crime can all impact on local economies. In order to mitigate this ‘an understanding of economic trends and vulnerabilities essential to effective homeland security risk management’¹⁰⁴⁵

The Business Emergency Operations Center (BEOC) aims to disseminate information, determine resource needs and critical requirements to support the private sector’s ability to recover and return to normal after an emergency.

The link between community resilience and economic resilience is noted in *Goal 5: Recover*. In order for communities to recover from disasters effectively the community’s economy must be helped to recover through resuming business and employment opportunities.

4.3.7. Resilience Related Official Documents

The State of Texas. 2015. Texas Homeland Security Strategic Plan 2015-2020. Available at: https://www.txdps.state.tx.us/director_staff/txHomelandSecStratPlan2015-2020.pdf

¹⁰⁴³ Ibid, p. 45

¹⁰⁴⁴ Ibid, p.29

¹⁰⁴⁵ Ibid, p.14

4.4. Idaho

4.4.1. Concept of Resilience

Resilience is not defined explicitly in any of the documents; however resiliency is mentioned in the context of hazard mitigation as mitigation actions are associated with preparedness for, response to and recovery from emergencies.

4.4.2. Institutional Framework for Delivering Resilience

The framework includes hazard mitigation on an individual level ensuring members of the public are prepared for emergencies, on a community level, and on a state, tribal or national level depending on the severity of the emergency.

The job of the state is to coordinate ‘protective, mitigation, emergency response activities, preparedness programs, and resource support’¹⁰⁴⁶ to local and private stakeholders, who have primary responsibility during local level emergencies. How these local and private organisations approach critical infrastructure resilience is also a responsibility of the state, in order to ensure consistent approaches throughout the state to identify key resources, perform risk identification and analysis, and produce mitigation plans.

The most serious threats identified for the state of Ohio are from flood and wildfire, and these receive the most funding.

4.4.3. Technical Resilience and Critical Infrastructure Resilience

The State of Idaho Hazard Mitigation Plan (SIHMP) states that threats to cyberspace can come from solar flares, power disruptions or cyber terrorism, and can in turn affect ‘industry, government, health, business, and private’¹⁰⁴⁷. Idaho’s focus on technical resilience to cyber terrorism is not just preventing attacks, but mitigating the effect of damage due to malware infection by isolating it in order to stop it from spreading. Solar flares can cause problems with systems that utilise GPS. The ISHMP includes a risk assessment of the areas likely to be affected during magnetic storms (see figure 4.2), and mitigation strategies such as coordinating with power companies to take transformers off-line could help mitigate the risk.

¹⁰⁴⁶ Idaho Bureau of Homeland Security. 2008. Continuity of Operations (COOP) Planning Manual. p.2-8. Available at: http://bhs.idaho.gov/Pages/Plans/COOP_COG.aspx. Accessed: 24 April 2016.

¹⁰⁴⁷ Idaho Bureau of Homeland Security. 2010. State of Idaho Hazard Mitigation Plan. p.3.16-1. Available at: <http://bhs.idaho.gov/Pages/Plans/Mitigation/Documents/SHMPFinalw-signatures.pdf>. Accessed: 24 April 2016

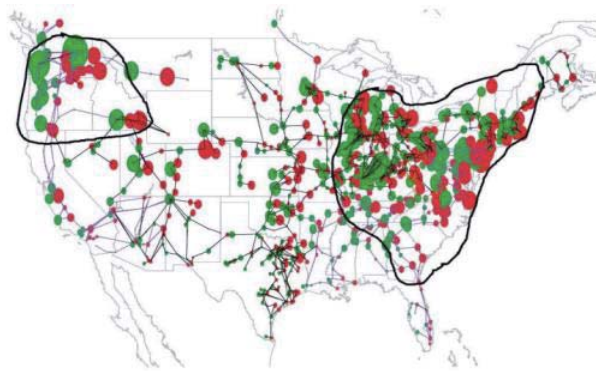


FIGURE 7.1 Scenario showing effects of a 4800 nT/min geomagnetic field disturbance at 50° geomagnetic latitude scenario. The regions outlined are susceptible to system collapse due to the effects of the GIC disturbance; the impacts would be of unprecedented scale and involve populations in excess of 130 million. SOURCE: J. Kappenman, Metatech Corp., "The Future: Solutions or Vulnerabilities?," presentation to the space weather workshop, May 23, 2008.

Figure 4.2. Effect of severe space weather events in Idaho

4.4.4. Organisational Resilience

Idaho State notes that disasters can interrupt the workings of the government and reduce its efficacy in delivering vital services such as public health and safety. Keeping these services going is vital for public trust in the state agencies so continuity of operations is vital, especially during a disaster. In order to achieve this, the Continuity of Operations (COOP) Planning Manual was created. COOP is defined as 'an effort to ensure the stability of critical government business functions during a wide range of potential emergencies and events.'¹⁰⁴⁸

The COOP plan not only looks at how to ensure delivery of services during an emergency, but includes preparedness measures such as ensuring operational and managerial requirements are met before an emergency occurs, and recovery measures such as protecting equipment and records, and planning for orderly recovery.

4.4.5. Social Resilience

One objective in the SIHMP is to motivate communities and citizens to take preparedness and mitigation actions. Resources for individuals and communities can be found on a separate website, www.readyidaho.org. This includes information on how individuals can prepare for emergencies by creating emergency kits of food, water, first aid, a torch, and battery powered radio. It recommends making a plan with family and friends on how to keep in contact and evacuation plans. Finally it recommends staying informed about the emergencies most likely to affect the local area and what plans are in place on a community level to if a disaster were to happen.

4.4.6. Economic Resilience

The SIHMP goals include reducing economic impacts from natural, technological, and human-caused hazard events.

Readyidaho.org has information on how businesses can protect themselves, and recover quickly after a disaster. Examples include backing up critical data and records, ensuring business premises can withstand natural disasters by meeting building standards to resist wind, fire or seismic activity, and coordinating with utility providers to determine alternatives and back-ups if utilities are affected.

¹⁰⁴⁸ Idaho Bureau of Homeland Security. 2008. Continuity of Operations (COOP) Planning Manual. p.6. Available at: http://bhs.idaho.gov/Pages/Plans/COOP_COG.aspx. Accessed: 24 April 2016.

International Survey

4.4.7. Resilience Related Official Documents

Idaho Bureau of Homeland Security. 2008. Continuity of Operations (COOP) Planning Manual. Available at: http://bhs.idaho.gov/Pages/Plans/COOP_COG.aspx

Idaho Department of Health and Welfare. (date unknown). Ready Business – What are the costs. Available at: <http://healthandwelfare.idaho.gov/Portals/0/Health/ReadyIdaho/WhatAreTheCosts.pdf>

Idaho Bureau of Homeland Security. 2010. State of Idaho Hazard Mitigation Plan. Available at: <http://bhs.idaho.gov/Pages/Plans/Mitigation/Documents/SHMPFinalw-signatures.pdf>

4.5. Illinois

4.5.1. Concept of Resilience

The purpose of the Illinois Natural Hazard Mitigation Plan (INHMP) is to provide a framework for the recovery and reconstruction process, and to identify current and proposed mitigation projects which will reduce the impact of future hazards events.

The term resilience is mainly used in this document to describe the resiliency of buildings, structures and infrastructure to withstand disasters. For example *Goal 3* of the hazard mitigation goals is to ensure infrastructure such as roads, utilities and water are ‘resilient to the impacts of natural and man-made hazards’¹⁰⁴⁹

For a geographical area to be resilient is described as the area possessing ‘greater resources for recovery’¹⁰⁵⁰, which differs from other documents concept of resilience which also include preparing, preventing, mitigating, and responding to emergency situations, not just recovering from them. The State of Illinois Disaster Recovery Plan (SIDRP) also refers to resilience as a concept applicable to recovery from disasters; it states that communities and businesses will be more resilient if they have the ‘financial resources to recover more quickly’.¹⁰⁵¹

4.5.2. Institutional Framework for Delivering Resilience

Although the Illinois Emergency Management Agency (IEMA) has ultimate responsibility for the hazard mitigation plan, other state agencies were involved. This includes the Bureau of Disaster Assistance and Preparedness and the Illinois Natural Hazard Mitigation Planning Committee composed of federal, state and local governments, the private sector and a non-profit organisations.

The Business Emergency Operation Center (BEOC) is a private sector emergency operation centre the encourages cooperation between state and governmental agencies with ‘agriculture and food; retail; energy; information technology; postal and shipping; bank and finance; communications, transportation systems; chemical; manufacturing; healthcare and public health, water; security; small business; and service industry.’

¹⁰⁴⁹ Illinois Emergency Management Agency. 2013. Illinois Natural Hazard Mitigation Plan. p.V-88. Available at: https://www.illinois.gov/iema/Mitigation/Documents/Plan_IllMitigationPlan.pdf. Accessed: 24 April 2016.

¹⁰⁵⁰ Ibid. Section: Illinois Statewide Flood Hazard Assessment, p.13

¹⁰⁵¹ State of Illinois. 2012. Disaster Recovery Plan. Section: Disaster Housing – p.7. Available at: <http://www.illinois.gov/iema/Preparedness/Documents/IDRP/IDRP.pdf> Accessed: 24 April 2016.

4.5.3. Technical Resilience and Critical Infrastructure Resilience

The only technical hazard in the IHMP is dam failure, even though dam failures are usually caused by natural events like flooding. Dam failure caused by natural causes can be mitigated as the effects can usually be predicted, however dam failure due to human causes or damage has more impact as these types of failure cannot usually be predicted and mitigation strategies such as warning downstream residents may not be possible.

4.5.4. Organisational Resilience

4.5.5. Social Resilience

Community-led resilience projects are promoted by the IEMP. For example, the Community Rating System is a volunteer program which encourages local communities to advance floodplain management to reduce flood insurance premiums.

Community resilience can be improved by educating and informing ‘families, businesses, organizations, community leaders, and senior officials’¹⁰⁵² on risks that will most likely affect their local area.

Furthermore, by encouraging community engagement, inclusion of the whole community in emergency preparedness can help that area to prevent, protect, respond to and recover from disasters in a way that sustains or improves the community’s resilience.

The SIDRP includes mass care for the community. This includes shelter, food, and first aid for the community.

4.5.6. Economic Resilience

Economic resilience in Illinois is mainly focussed on economic recovery. The DRP includes economic recovery in its long-term strategy after essential needs of the individual have been met. Strategies for economic recovery include access to funding and grants, and small business administration loans to help with the costs of economic injury and physical damage.

In the IHMP economic resilience is mentioned as a benefit for mitigating various events such as drought, flood and lightening, and economic recovery plans are highlighted.

4.5.7. Resilience Related Official Documents

State of Illinois. 2012. Disaster Recovery Plan. Available at:
<http://www.illinois.gov/iema/Preparedness/Documents/IDRP/IDRP.pdf>

State of Illinois. 2014. Illinois Emergency Operations Plan. Available at:
<http://www.illinois.gov/iema/Preparedness/Documents/IEOP/IEOP.pdf>

Illinois Emergency Management Agency. 2013. Illinois Natural Hazard Mitigation Plan. Available at:
https://www.illinois.gov/iema/Mitigation/Documents/Plan_IllMitigationPlan.pdf

¹⁰⁵² Illinois Emergency Management Agency. 2013. Illinois Natural Hazard Mitigation Plan. p.I-11. Available at:
https://www.illinois.gov/iema/Mitigation/Documents/Plan_IllMitigationPlan.pdf. Accessed: 24 April 2016.

5. Conclusions

The US is one of the most advanced countries regarding resilience. It has an official country level definition of critical infrastructure resilience, as well as a tool for measuring it, which is of particular relevance for the current research. It also has the ASIS SPC.1-2009 Organisational Resilience Standard. The country also implements various programmes aimed at increasing social resilience. For example, the PrepareAthon! helps to build a more resilient nation by increasing the number of individuals who understand the type of disasters that could happen within their respective communities, sharing information on what measures should be taken in order to mitigate the damage from such incidents and encouraging citizens to participate in community resilience planning.

It could also be concluded that most of the efforts to build resilience are being implemented at the national rather than state-level. Information collected while conducting five case studies indicate that the local efforts to increase resilience are of way smaller extent compared to the national ones.

Appendix 1

Resilience Measurement Index Structure

