博士論文

Comprehensive evaluation and practical improvement of a country's disaster resilience

(国を単位とした災害レジリエンスの総合的な評価とその向上策に関する研究)

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ABSTRACT

The images and debris of the devastating disasters are still in remembrance as their impacts, both emotional and physical, were unimaginable and almost impossible to quantify in tangible terms. Over the past decades, disasters have shed their impact all over the world. The intensity, frequency, and magnitude of disasters have increased. In order to capture such impact, scholars have shifted from risk-centric and vulnerability-focused approaches to resilience enhancement. This has been echoed by an increasing number of targets under intergovernmental frameworks for disaster risk reduction and resilience enhancement. However, resilience as a concept has been in a constant debate over its definition, underlying elements, and operationalization. Therefore, there has been a call from international arenas for a resilience measurement framework. Without it, those targets would lose credibility, and more importantly, the necessary actions may not be taken. Therefore, the key objective of this research was to develop a theoretically driven index that can be utilized to measure national disaster resilience.

Fully aware of the inconsistency of the definition, this research embraces the contemporary evolution of disaster resilience as a building ground for its framework. It proposes the framework for understanding national disaster resilience, namely DROP-3D, which is the hybrid framework between Cutter et al.'s DROP model and Bene's 3D framework. Here, the working definition of resilience is defined as *an ability or capacity of its systems to bounce back from, withstand and cope with, adjust to the impact of, and recover from the effects of disturbances or shocks in a timely and effective manner through shock anticipation, absorption, adaptation, transformation and restoration of its essential basic structures and functions. It is an ability that is inherent within a country and the product of the country's systems.* This research also discusses the concept of vulnerability as a close 'sibling' to resilience. Here, vulnerability and resilience are viewed as discreet but often linked concepts.

This research argues that a comprehensive evaluation of a country's disaster resilience should address issues of relevance to all the three resilience capacities: absorptive coping capacity, adaptive capacity, and transformative capacity. Additionally, a practical approach to evaluate disaster resilience is to assess it in terms of systems which are categorized into domains. The PINE structure for national disaster resilience was developed, where it proposes that national disaster resilience is the product of

capacities from the four domains of systems: People, Infrastructure, Nature, and Enabling Environment. To distinguish resilient countries from just prosperous countries, resilience qualities were extracted from literature, which are reflective, strong, engaged, resourceful, comprehensive, flexible, and diverse. Based on these outputs, a pathway to national disaster resiliency can be further developed.

Based on the PINE structure, indicators were selected with criteria that they must be (1) theoretically sound, (2) reality-reflective, (3) consistent with international expectations regarding disaster resilience, and (4) data available. The framework for indicator selection was also developed to help reduce the level of subjectivity and misleading effects. The chosen indicators were re-scaled to a comparable unit and normalized by using Z-score approach. A composite index was calculated using average method which is based on equal weighting. Furthermore, the index was validated by using two types of validation: content and construct validation. The results yielded empirical evidence that the index is valid.

The application of the measurement pointed that countries in Africa and Asia are among the lowest in terms of disaster resiliency, while countries in Oceania and Europe rank among the highest. The key users of the framework can be divided into two levels: international and national levels. For the international level, PINE gives directions where international aids and funds should be sent to. It also helps keep track of progress made by each country and make comparative analysis. For the national level, PINE helps raise awareness of a country towards enhancing disaster resilience. The scores by domains and categories can be utilized by policymakers to identify areas of interventions.

In sum, the overall objectives set for this research have been met. The primary outputs are the national disaster resilience framework and the PINE structure for national disaster resilience measurement. They are valid, theoretically driven, and reality reflective. The findings of this research gave empirical evidence that the framework has an ability to enhance understanding and operationalization of the concept of disaster resilience. The methodology used in this research is theoretically reasonable and empirically practical.

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Like a soldier in a battle, this piece of work could not be achieved without supportive hands. First of all, I would like to thank my dissertation committee chair, Professor Kimiro MEGURO, for guiding me throughout the time. I could not count the times when you saved me from waving a white flag. Your extraordinary support and encouragement reminded that I was not in this battle alone. Also, I would like to extend my gratitude to the committee members in an alphabetical order, Professor Kazumasa OZAWA, Associate Professor Miho OHARA, Dr. Muneyoshi NUMADA, and Professor Riki HONDA, for their kind assistance and valuable inputs to this work.

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CHAPTER 1
INTRODUCTION

1.1. Background on Disaster Paradigm

The images and debris of the recent disasters, especially the Tōhoku Earthquake in 2011 and Indian Earthquake and Asian Tsunami in 2004, are still in our remembrance as their impacts, both emotional and physical, were unimaginable and almost impossible to quantify in tangible terms. Over the past decades, the intensity, frequency, and magnitude of disasters have increased; and everyone with vulnerability and/or without resilience have been greatly affected.

In order to capture the loss that disasters bring, scholars have attempted to develop frameworks to address disasters and how to mitigate them. Until a few decades ago, disasters were viewed as one-off events and responded by governments without taking into account the social and economic implications and root-causes of these events. With more investigations, disaster paradigms came into existence. They originated from the belief that we could only deal with disasters with our geophysical and engineering knowledge.

This disaster-related thinking evolved gradually and the critical turn of disaster paradigm emerged with the investigation that from the 1960s to the 1990s there was an exceptional increment in human and material losses from disasters yet there was no reasonable confirmation that the recurrence of disasters had expanded. This indicated that the rise in disasters and their consequences was related to the rise in the vulnerability of people all over the world (Cuny, 1983). From this realization, emphasis later shifted towards using vulnerability analysis as a tool in disaster management. Table 1.1 shows major elements of the paradigm shifts in disaster discourses.

In a more contemporary paradigm, a more comprehensive approach has loomed. With three distinct but interrelated components: hazard assessment, vulnerability analysis, and enhancement of management capacity (resilience). It is more closely integrated with the ongoing development processes; and in turn, this evolution of disaster paradigm has influenced the way disaster management programs are now being planned and financed. Even more recently, the concept of 'being resilient' has been a subject of debates and infused into the disaster management arena where it has come at the forefront of development agenda against the risk of disasters and formed the shape

of policies and development, perhaps forever or until another disaster paradigm proves it impotent.

Table 1.1 Key elements of the paradigm shift in disaster discourse

Conventional Paradigm→→→→→→→→→→→→→→→→→→→Contemporary Paradigm

	Conventional		Intermediate		Contemporary
Focus	Hazards	→	Vulnerability Risk	→	Resilience (including vulnerability and risk)
Sciences	Natural Science, Engineering	→	Social science, Humanities	→	Integrated Sciences (Multidisciplinary)
Disaster Risk Management	Response, Relief	→	Prevention, Mitigation, Preparedness	→	Comprehensive Disaster Risk Management

In terms of terminology, 'Disaster' can be of various implications (Quarantelli, 1998). As disaster paradigms have evolved over times, the term has been shaped in different ways. In the contemporary paradigms, Wisner et al. (2004, p. 49) give a simple yet vibrant illustration of risk or disaster in their book 'At Risk' that *'the risk of disaster is a compound function of the natural hazard and the number of people, characterized by their varying degrees of vulnerability to that specific hazard, who occupy the space and time of exposure to the hazard event.'* In other words, the crucial point that Wisner and his group aimed to assert is that not only do natural events make them occur, but also '*social political and economic environments*', which to the simplest end can be translated into a pseudo-equation 1:

Risk (Disaster) = $f(Hazard \cdot Vulnerability)$ ....*Equation 1*

However, Wisner et al. perspectives seem to miss the crucial dimension of disaster management. United Nations Inter-Agency Secretariat of the International Strategy for Disaster Reduction (UNISDR, 2009, p. 9) defines disasters as *'a serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources'*. This definition adds up the dimension of capacity or measures to reduce or cope with the potential negative consequences, which can be translated into a pseudo-equation 2:

$$\text{Risk (Disaster)} = f\left(\frac{Hazard \cdot Vulnerability}{Capacity}\right) \quad \text{.....Equation 2}$$

This thinking signifies that (1) disasters are no longer viewed as extreme events created solely by natural forces: For a catastrophic event whether precipitated by natural hazards or human activities, the state of a disaster occurs when the community or society affected fails to cope; (2) Natural hazards themselves do not necessarily lead to disasters. In other words, natural hazards become disasters only to the extent that people are unprepared to respond, incapable to cope, and, consequently, severely affected. (3) The system's resilience against and human's vulnerability to the impact of natural hazards are, to a significant extent, determined by human action or inaction.

Therefore, disasters could, in fact, be mitigated, if not averted. With today's advancements in science and technology, including early warning and forecasting of natural phenomena, together with innovative approaches and strategies for enhancing resilience and capacities, the impact of natural hazards, somehow could be predicted and reduced, their effects on populations reduced, and the communities adequately protected.

This research embraces the contemporary treatment of disaster that have arisen for the last few decades. However, it does not try to rule out natural hazards as trigger events, but shifts the focus to the more vibrant ways where the systems themselves are the key actors to generate disasters, as well as, enhance resilience to arrest the impact of them.

1.2. Problem Statements

This section is dedicated to show that the following sub-sections have pointed to the need for a national resilience framework that can evaluate the level of disaster resilience and provide some guiding directions to improve it.

1.2.1. Recent Global Trend of Disasters

In order to draw investigate global trends and patterns in disaster occurrence, this research substantially harvested statistics mainly from (1) Emergency Events Database (EM-DAT)[1], maintained by the Centre for Research on the Epidemiology of Disasters (CRED), and partially from (2) Asian Disaster Reduction Centre (ADRC)[2]. EM-

[1] http://www.emdat.be/
[2] http://www.adrc.asia/

DAT is compiled with criteria[3] from various sources, including UN agencies, the US Office of Foreign Disaster Assistance (OFDA), national governments, the International Federation of Red Cross and Red Crescent Societies (IFRC), NGOs, research institutes and the media.

At first, this research intended to trace disaster footprints as far back as possible, preferably the whole period of the twentieth century. It collected data from ADRC website, covering data of 24 Asian countries[4] on 12 Types of Disasters[5], spanning from 1900-2000. The 24x12-dimensioned data was processed into almost 40 charts and brought up for discussions among academics. Unfortunately, the preliminary observation unveiled that data collected in the first half of the twentieth century was not as vibrant as that in the remaining half, particularly the last three decades of the twentieth. This can be seen as the result of immature methodology and inadequacy of disaster-related data collection. Thus, the following analysis will be based on EM-DAT for the time span of 1970-2014, with the hope to point out that the world is of increasing probability of disasters and magnitude of their impacts.

Disasters have spread its negative impacts on every continents of the world, and Asia is the heaviest-hit continent in terms of frequency and the total numbers of people affected (Figures 1.1 and 1.2). This is mainly due to Asia's large area – with a large number of river basins, flood plains, mountains, active seismic and volcanic zones, as well as its high number of population clustered densely in disaster-prone regions (UNISDR, 2015).

[3] According to EM-DAT, for a disaster to be entered into the database, at least one of the following criteria must be fulfilled: 10 or more people reported killed; 100 or more people reported affected; declaration of a state of emergency; and/or call for international assistance.
[4] 1) Armenia, 2) Bangladesh, 3) Cambodia, 4) China, 5) India, 6) Indonesia, 7) Japan, 8) Kazakhstan, 9) Korea, 10) Kyrgyz, 11) Lao, 12) Malaysia, 13) Mongolia, 14) Myanmar, 15) Nepal, 16) Papua New Guinea, 17) Philippines, 18) Russia, 19) Singapore, 20) Sri Lanka, 21) Tajikistan, 22) Thailand, 23) Uzbekistan, and 24) Vietnam
[5] 1) Drought 2) Earthquake, 3) Epidemic, 4) Extreme Temperature, 5) Famine, 6) Flood, 7) Insect Infestation, 8) Slide, 9) Volcano, 10) Wave/Surge, 11) Wild Fire, and 12) Wind Storm

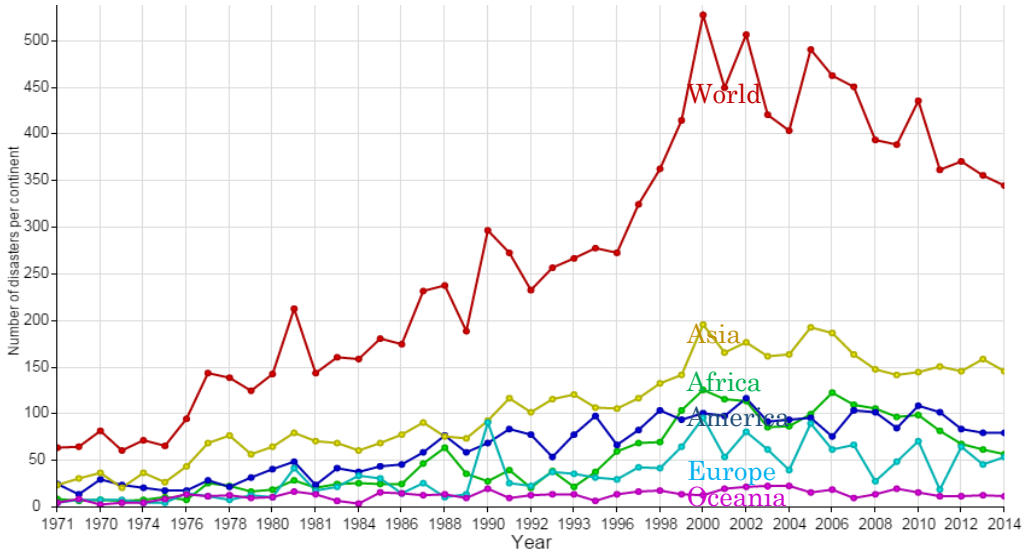


Figure 1.1 Number of disasters reported worldwide by continent (1970-2014)

Source: EM-DAT, http://www.emdat.be/

Figure 1.1 shows that disaster occurrence had increased dramatically in the early 1990s. Later, the trend has shifted downward from its peak in 2000. Yet, the UN said that *'this decline did not signify that the world has become safe from disasters'* (UNISDR, 2015). Overall, however, the number of disasters reported annually was significantly higher from 1996 onwards than it was at the start. This increasing projection in disaster frequency was chiefly owing to a rise in the number of climate-related disasters such as storms and floods (Figure 1.3).

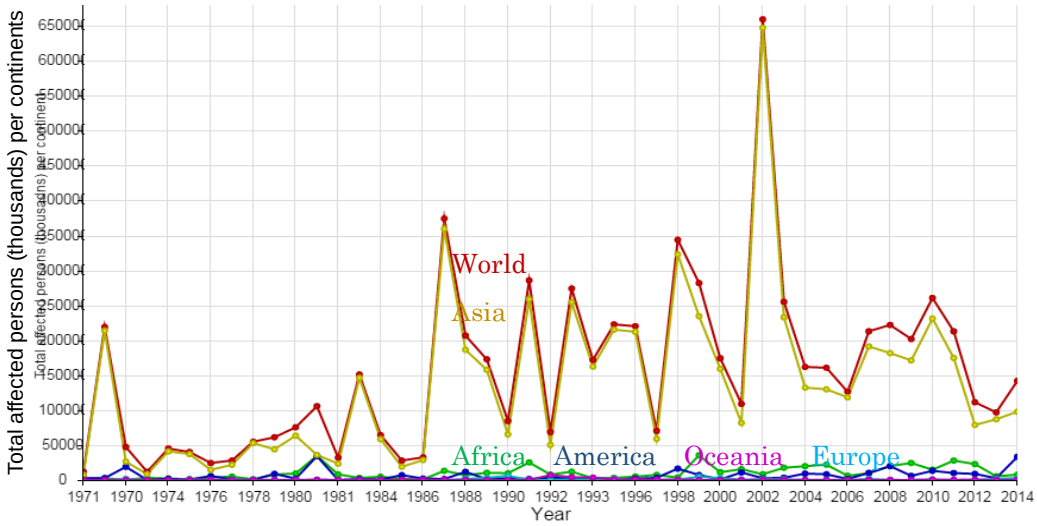


Figure 1.2 Numbers of people affected by
disasters reported worldwide by continent (1970-2014)

Source: EM-DAT, http://www.emdat.be/

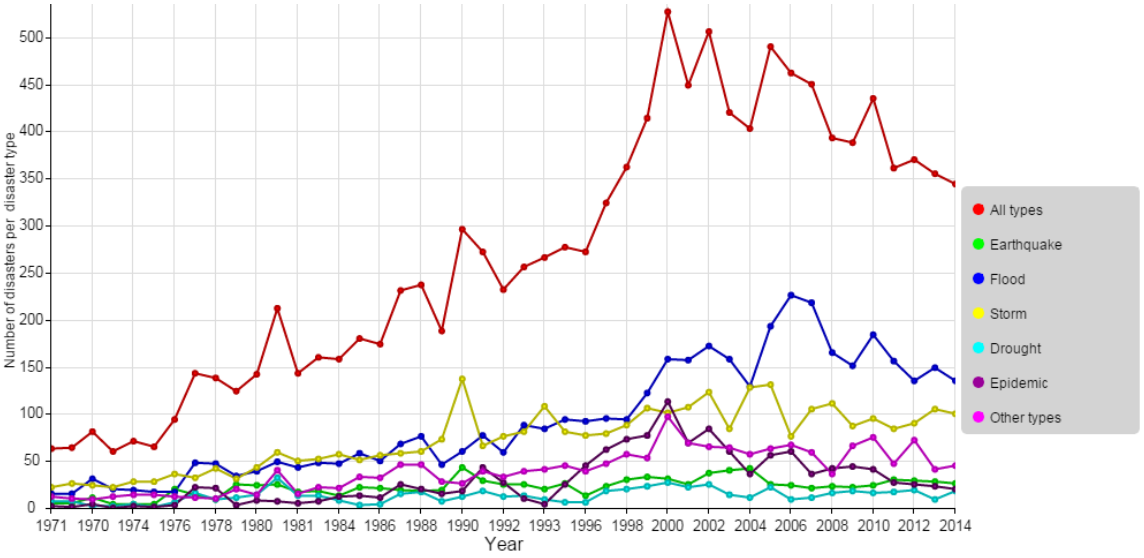


Figure 1.3 Number of disasters reported worldwide by hazard types (1970-2014)

Source: EM-DAT, http://www.emdat.be/

According to the Centre for Research on the Epidemiology of Disasters (CRED)'s report (2015), while occurrences of climate-related disasters have declined from their peak in the last decade, they remain at more than double the levels recorded in 1980-1989 (an average of 140 climate-related disasters per year) and 50% higher than in 1994. Meanwhile, the numbers of geophysical disasters (mainly earthquakes, tsunamis and volcanic eruptions) have remained more or less stable throughout the past 20 years (see Figure 1.3).

In terms of economic losses, Global Assessment Report on Disaster Risk Reduction (GAR) 2015 reported that losses from disasters has reached an average of US$250-300 billion each year, and the expected annual losses are estimated at US$314 billion (UNISDR, 2015). It simply implies that countries should prepare this amount of finance each year to cover future disaster losses.

The seeds of such disasters are diverse. Whether cyclic or human-instigated, changes in worldwide atmospheric patterns brought about an Earth-wide temperature rising and a heightening ocean level are among the most powerful reasons for disaster's upward pattern. Unsustainable growth in world's population and socioeconomic inequities further disturb the circumstance as development in high-risk zones has increased the probability that a regular hazard will turn into a big disaster.

The development with regard to the increase in global warming is observed by many institutions and organizations. According to the *Synthesis Reports of Climate Change 2014* published the Intergovernmental Panel on Climate Change (IPCC), warming of the climate system is unequivocal: The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, and sea level has risen (IPCC, 2014). Greenhouse gas emissions have increased driven largely by economic and population growth, and are now higher than ever. This has led to atmospheric concentrations of greenhouse gases unprecedented in at least the last 800,000 years (IPCC, 2014).

A number of scientific evidences confirm the link between global warming and tropical storm intensification. Global warming will intensify the maximum wind speed by 0.5 on the Saffir–Simpson hurricane wind scale and precipitation by 18% in hurricanes until 2050 (Knutson et al., 2004). Of all the factors that drive a major storm, only the steady increase in sea surface temperatures over the last 35 years can account for the rising strength of storms in six ocean basins around the world (Hoyos et al., 2006)

The United Nations Department of Economic and Social Affairs' *World Urbanization Prospects 2014* reports that the world's urban population is expected to surpass six billion by 2045. Globally, a larger number of individuals live in urban regions than in rural regions. Today, 54 per cent of the world's population lives in urban regions, an extent that is forecast to increment to 66 per cent by 2050. Mega-cities with more than 10 million people are increasing in number, and rural populations expected to decrease as urban populations continue to grow (UNESA, 2014). Also, the absolute gap between incomes per capita of low and upper-middle income countries has more than doubled, from around $ 3,000 in 1980 to $ 7,600 in 2010 (UNESA, 2013). The magnitude of income disparities across countries is large, but so are disparities across individuals within each country (UNISDR, 2015).

In spite of the fact that there is no measurable and clear proof between these aforementioned trends and an increase in human and material losses from disaster events, it is likely to infer that the rising number of disasters and their effects has been related to human-maneuverer ways of development. The increase in population and consumption has skyrocketed to an unsustainable level and threatened the quality and quantity of global biodiversity and natural resources. The utilization of national resource at a disturbing pace aggravate the environmental degradation and ecosystem decay. Most importantly, urban growth has led to an increase in people's vulnerability to

disasters. It is forecast that the vulnerability of the society and the human environment as well as the threat by natural hazards will intensify continuously in the future (UNESA, 2014).

1.2.2. Mainstreaming Disaster Risk Reduction and Resilience Enhancement

The findings in the aforementioned section 1.2.1 point to where disasters could increasingly threaten the world and its sustainable development. To reverse this tendency, there has been international acknowledgement that (1) resilience must be enhanced to increase capacity to deal with future disasters and (2) efforts to decrease disaster risks must be systematically integrated into policies, plans and programmes for development, and supported through cooperation and partnerships (Mitchell, 2003; Tearfun, 2005; Word Bank, 2006). This momentum of enhancing disaster resilience and mainstreaming disaster risk reduction has been accentuated and reflected in international conferences and seminars worldwide. The series of UN World Conference on Disaster Risk Reduction (Yokohama in 1994, Kobe in 2005, and Sendai in 2015) are among the leading attempts that have put the resilience concept into practicality. Since the adoption of the Hyogo Framework, endorsed by the UN General Assembly in the Resolution A/RES/60/195, the main goal of hazard planning and disaster risk reduction has shifted to focusing more on building resilience at all levels rather than merely decreasing vulnerability.

It is no doubt that links between mainstreaming disaster risk reduction and resilience enhancement are strong. However, resilience evaluation has often been left out from the framework. That is perhaps the reason why the post-2015 framework has put increasing emphasis on resilience measurement.

Contrast to its popularity and frequent usage, there is a limited theoretical understanding of disaster resilience as a concept. For instance, it is inconsistent how resilience should be defined, assessed, and/or measured. As a result, making the concept of resilience practical and operational for disaster risk reduction has always been a challenge. The key challenge, for instance, is how to define and develop indicators that truly discuss resilience. The challenge was echoed by a number of scholars (for example, Béné, 2013; Gall, 2013; Mitchell, 2013) pointing out that the identification of metrics and standards for measuring resilience remains a significant challenge. No consensus exists currently on how to measure resilience. It appears that without a conceptual framework where indicators can both be defined and assessed, resilience will never be meaningful

and useful for policies intervention and national development strategies. Therefore, the main objective of this research is to develop a conceptual framework that can be used to measure national disaster resilience and helpful for policy makers or disaster managers to decide appropriate intervention or resource allocation for resilience enhancement.

1.2.3. Ongoing Attempts of National Resilience Measurement

To take on the issue more seriously, this research has further investigated ongoing efforts in evaluating resilience at the national level. Based on Winderl's (2014) stocktaking of efforts in measuring resilience, this research have complied six measurements at national level shown in table 1.2 (see Annex 2 for more details). It is very likely to conclude that there has been **no framework that directly discusses resilience at the national level**, except (1) AGIR results framework and (2) Country Resilience Rating. AGIR Results Framework intends to measure resilience in terms of food security and nutritional vulnerability, while World Economic Forum's Country Resilience Rating is still being developed. Though some potential indicators of the latter have been defined, the majority of them were drawn significantly from economic perspectives. Also, almost all of them try to assess risk and vulnerability. This is primarily because they have been largely influenced by the disaster paradigm that put emphasis on hazards, risk, and vulnerability.

Table 1.2 Ongoing efforts in measuring resilience at national level

Names	Developer(s)	Focus	Status
1. AGIR[6] Results Framework	AGIR	Food and nutritional vulnerability and resilience	Potential Indicators: defined
2. Country Resilience Rating	World Economic Forum	Resilience assessment	Potential indicators: partially defined
3. Global Focus Model	UN/OCHA[7] & Maplecroft	Risk and Vulnerability assessment	Implementation: annually since 2007 (commercially available)
4. Index for Risk Management (INFORM)	Inter-Agency Standing Committee Task Team for Preparedness and Resilience and the European Commission	Risk and Vulnerability assessment	Implementation: 2015
5. Indicators of Disaster Risk and Risk Management	Inter-American Development Bank	Risk and Vulnerability assessment	Implementation: only in the Latin America
6. World Risk Index	UNU-EHS[8]	Risk and Vulnerability assessment	Implementation: annually since 2011

[6] Global Alliance for Resilience
[7] United Nations Office for the Coordination of Humanitarian Affairs
[8] The United Nations University (UNU) Institute for Environment and Human Security (EHS)

However, there are two frameworks that are the product of the contemporary disaster paradigm: Hyogo Framework for Action (HFA) monitor and the post-2015 indicators for disaster risk reduction. The former was translated into 3 numeric high-level outcome indicators, 22 yes/no questions according to 22 core indicators for the 5 priority areas. The latter was proposed by UNISDR and will be integrated into HFA 2. These two frameworks will be discussed and considered to merge into national resilience measurement framework proposed in this research.

Additionally, though the development of resilience measurement gives a country a tool to learn more about and where to put particular emphasis to enhance its level of resilience, the next step is still a challenge - how to enhance resilience. Hyogo Framework for Action (HFA) can be one of the attempts to lay out activities in disaster risk management. However, '*it does not necessarily include actions under agendas such as the environment, poverty reduction, energy or climate change that may have contributed to disaster risk reduction or actions from other stakeholders, including the private sector and civil society'*(UNIDSR, 2015, p.115). This points to the need of a framework that can not only be able to measure national disaster resilience but also be interpreted in terms of policymaking to enhance the level of national disaster resilience.

1.3.Research Objectives

The three problem statements have directed this research to develop a comprehensive framework for national disaster resilience that is consistent with the contemporary disaster paradigm, comprehensive, and used to identify indicators for the measurement purpose. To achieve this task, this research has substantially put an emphasis on the development of national disaster resilience framework, disaster resilience measurement, spatial analysis of the national resilience score, and meaningful interpretations in terms of policy interventions. The general goal of this study is to observationally operationalize the idea of disaster resilience, where it seeks to address the following research objectives.

1. To explore and review the theory, conceptual models, definitions, related topics and applications of the concept of disaster resilience.
2. To develop an analytical framework that is distinct from the conventional frameworks and comprehensively discusses disaster resilience at national level.
3. To create a balanced methodology that is derived from both theories and reality (actual disaster events), as well as concurrent with the most up-to-date international expectations of disaster risk reduction.

4. To be able to empirically operationalize the framework
5. To identify related indicators and sub-indicators as proxies of national disaster resilience
6. To validate the framework by correlating the results with external factors.
7. To produce spatial and meaningful analysis of the national disaster resilience scores.

1.4. Research Significance

The significance of this research manifests in two unique ways. It timely addresses the urgent need in the disaster literature of a framework that truly brings the concept of national disaster resilience to meaningful operation. The concept of disaster resilience has indicated extraordinary potential but turned out to be a troublesome concept to operationalize, especially at national level. This research attempts to propose a model framework that will be empirically used as a tool in the process of operationalizing the concept.

This research provides a comprehensive measurement instrument, distinct from the conventional ones, which will improve comparative evaluations of national disaster resilience. Moreover, the national disaster resilience framework can be an important planning instrument that government officers and policymakers can utilize side by side in a decision making process or intervention formulation.

1.5. Methodology

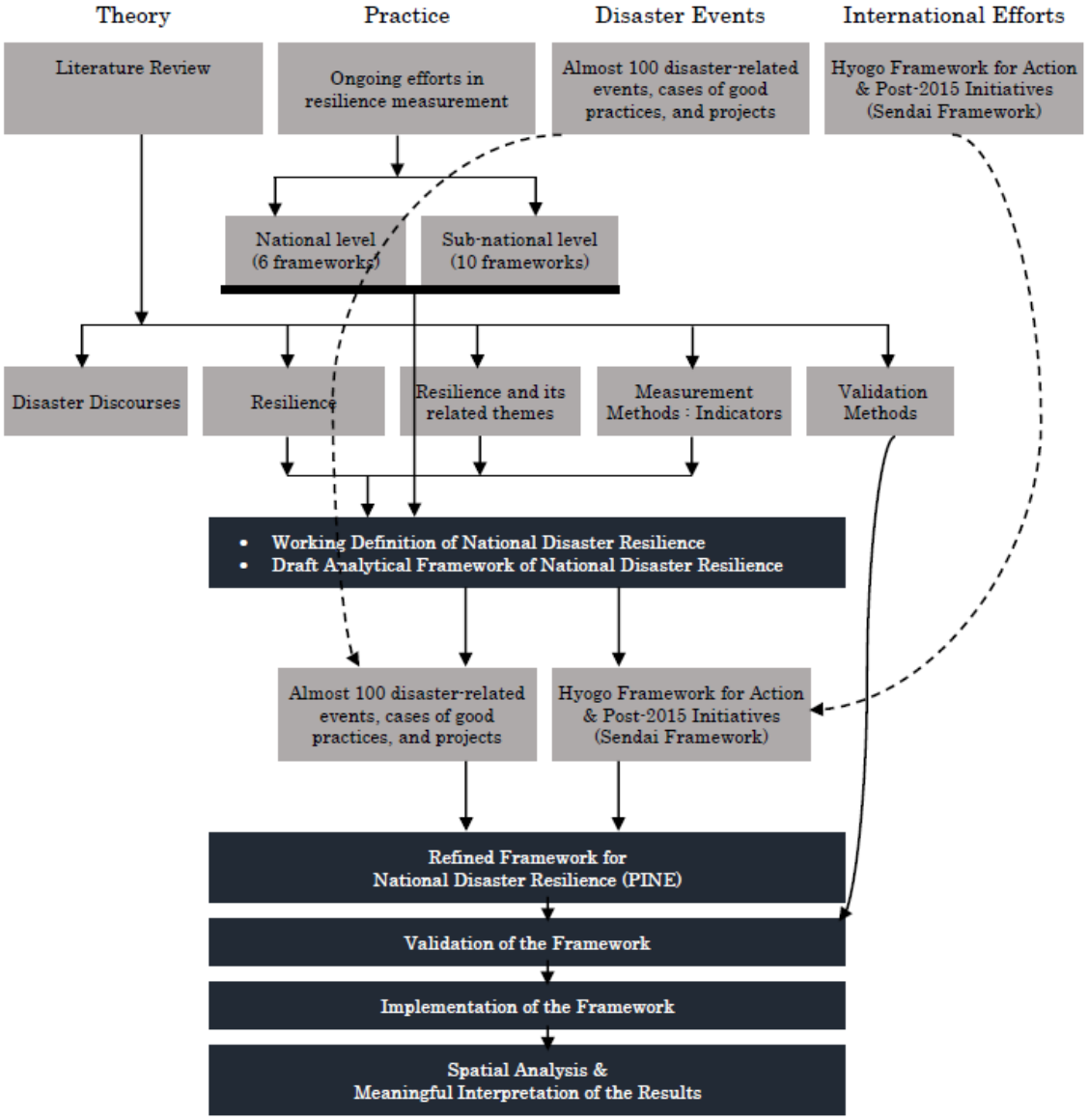
Figure 1.4 shows the bird-eye-view diagrammed structure of the methodology, where it has been broken into 4 streams of review: (1) literature, (2) practice, (3) reality (disaster-related events), and (4) international efforts in mainstreaming disaster risk reduction and enhancing resilience.

Following the review on the literature, 5 key elements that are related to the research have been identified: (1) disaster discourses, (2) resilience as a concept and its definition, (3) resilience and its related themes, (4) Index or indicators as a resilience measurement method, and (5) validation method.

For the review over ongoing practices, this research investigated into various disaster resilience frameworks, where most of them have been developed very recently. The purpose was to understand what the frameworks actually say about disaster

resilience, how it really measures resilience, and what methodology is used. However, the investigation revealed that there is a limited number of frameworks discussing national resilience measurement. Therefore, it is essential to expand the scope into frameworks at the sub-national level. Altogether, this dissertation studied fifteen frameworks of resilience measurement.

Figure 1.4 Research methodology and outputs



What has gained from the review over literature and ongoing practices paved a way towards developing the working definition of resilience, drafting analytical framework of national disaster resilience, and selecting indicators and sub-indicators.

However, the outputs at this stage were not balanced because they were based heavily on theories and literature.

To make it balanced, the dissertation gathered information from 'reality' - almost 100 disaster-related events, cases of good practices, and disaster resilience enhancement projects - with the hope to find elements of resilience and potential indicators. It further looked into international efforts in mainstreaming disaster risk reduction and enhancing resilience: Hyogo Framework for Action (HFA) and post-2015 initiatives (Sendai framework). Both gave invaluable inputs and perfecting the draft national disaster resilience framework by adding contemporary edge of international expectations and elements of resilience in terms of performance and management skills.

After finalizing the national disaster resilience, indicators and sub-indicators were selected by using the five criteria (theoretical support, better selection than the current efforts, reality reflectiveness, consistency with current paradigm, and data availability) and a framework for indicator selection. Secondary data were collected from reliable sources such as World Bank, World Economic Forum, International Labour Organization, UN, and UNESCO, while data regarding disaster performance was calculated based on HFA monitor's self-assessment questionnaires submitted by UN members. All data were processed, normalized, and weighted. The results was validated by correlating with external statistics, for instance, vulnerability, risk, estimated damage caused by disasters.

The results were then translated into meaningful reading where each country would know the level of disaster resilience and what areas it should put emphasis on. Policy recommendations for policy recommendations were also implied through the framework operationalization.

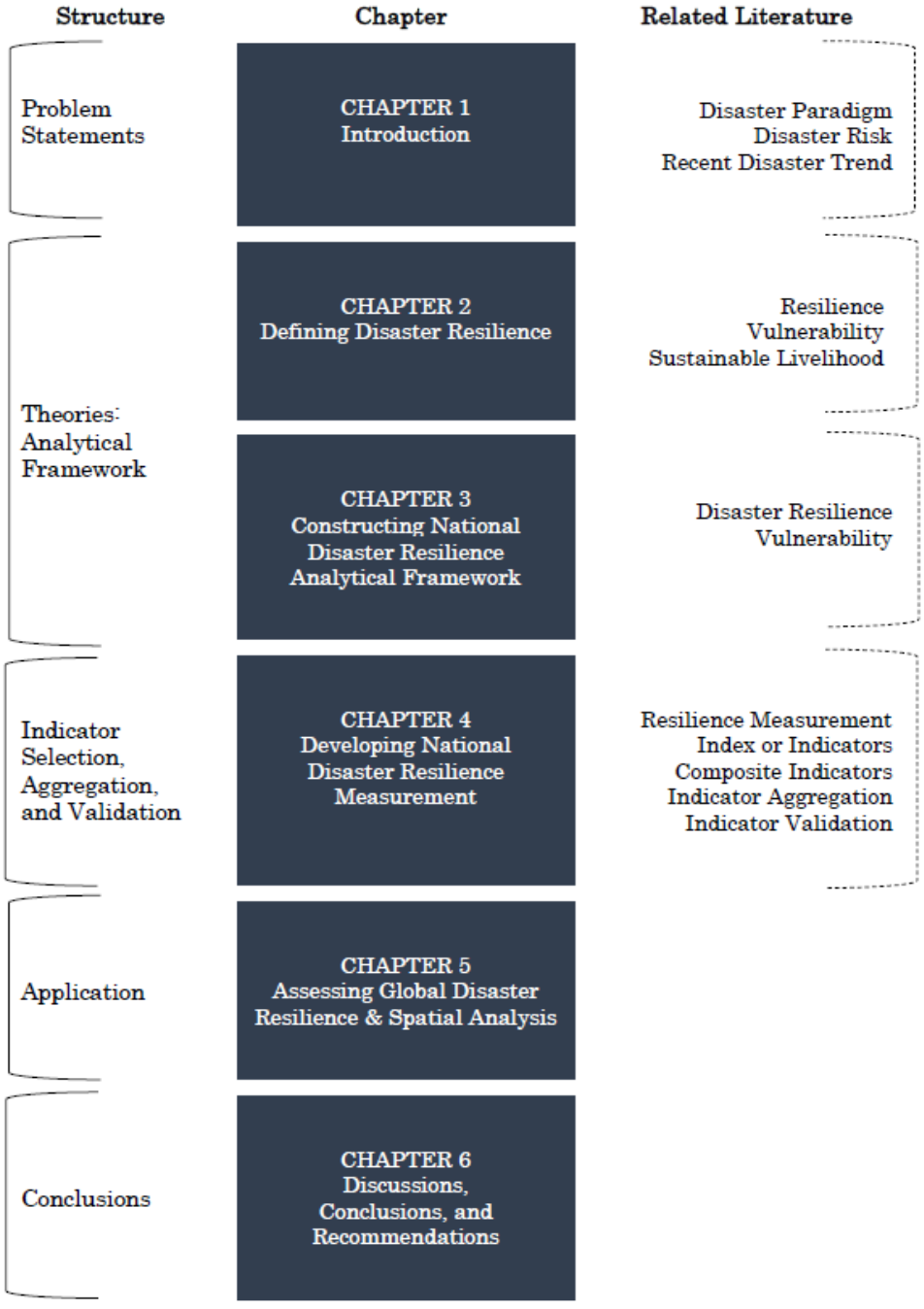
1.6. Structure of the Dissertation

To be able to see the overall picture of the literature review structure with relation to the structure of this research, a diagrammed figure 1.5 was drawn.

In terms of literature review, literature was collected from various sources mainly using keyword-based database searches websites. Documents suggested were studied and included in the full review if they were deemed relevant to the research's goals. The utilization of the search engines allowed collation of a series of books, journal

articles, and popular press articles which related to the core thematic areas. Relevant documents were reviewed and have been incorporated. For the purposes of this research, the review was also expanded to ongoing efforts in developing frameworks for measuring national disaster resilience, disaster-related events, cases of good practices, and disaster resilience enhancement projects.

Figure 1.5 Dissertation structure



In terms of the dissertation structure, the content of the research is organized into six chapters, including this introduction. Chapter 1 gives the reasons behind the need for developing a national disaster resilience framework. Backgrounds, problem statements, research objectives, and research significance are discussed to give a broad scenario of this research. Chapter 2 takes the issue of resilience deeper into the area of theories and concepts. It reviews literature over the concept of resilience, and its related topics, vulnerability and sustainable livelihood, as to build the theoretical foundation for the whole research. It also attempts to stocktake the definitions of resilience from various perspectives in order to formulate the working definition for this research. Chapter 3 is still in the theoretical area where the national disaster resilience framework in which national disaster resilience can be identified is constructed. Chapter 4 takes on what Chapter 3 has built to develop national disaster resilience measurement. It further studies an approach employed in this research to evaluate national disaster resilience. The process starts with indicators selection, then moves on to the mathematical aggregation used to combine the index, and validation of the index. Chapter 5's main purposes are to put the framework into practicality. The score of national disaster resilience will be calculated. The results are discussed vibrantly and meaningfully. The application of the framework can be considered as another way to assess the validity and utility of the national disaster resilience framework. The spatial analysis is used to visualize the score and draw some conclusions. The last chapter presents further discussions of the results, conclusions, research limitations, recommendations for future research.

CHAPTER 2
REVISIING DISASTER RESILIENCE DEFINITIONS

2.1. Introduction

The resilience concept has been translated in an assortment of directions and uses, which at times can be quite conflicting and inconsistent, and there has been quite a large collection of academic discussions over the meaning of resilience (MacAskill el al., 2014). However, resilience, regardless of disagreement, appears to link a conceptual gap that other concepts, namely vulnerability to climate change, appear not to have been able to fulfil (Twigg, 2009; Tyler et al., 2014). It is crucial to clarify that reaching a strict consensus on the definition of resilience is not what this research intends to. On the contrary, an acceptance that there are manifold and valid interpretations of resilience is encouraged, with the hope that they would bring about vibrant analysis and multi-disciplinary understandings of resilience.

2.2. Resilience as a Concept and its definitions

The *resilience* concept originated in the field of social ecology in the late 1960s and early 1970s (Lewontin, 1969; Rosenzweig, 1971; May, 1972; Holling, 1973). Its etymology is Latin, derived from the word *resilire*, meaning to spring back, or rebound. Holling (1973), the most notable scholar in the field, used resilience to describe a '*measure of the persistence of systems and their ability to absorb change and disturbance and still remain the same relationships between populations or state variables* (Holling, 1973, p. 14).'

In the 1980s and 1990s, resilience had come to being utilized in disaster discourse particularly by engineering society, largely referring to physical infrastructure. This marked a significant shift away from its ecological influence towards engineering resilience (See a list of widely recognized definitions of resilience in table 2.1). In other words, it does not incorporate coping capacity, but signifies resisting change and maintaining the steadiness of the system. Structural hazard mitigation is a good example.

Table 2.1 List of some resilience definitions

Year	Definition	Author(s)
1973	An ecosystem is the measure of the ability of an ecosystem to absorb changes and still persist.	Holling
1981	The measure of a system's or part of the system's capacity to absorb and recover from occurrence of a hazardous event.	Timmerman
1984	The speed with which a system returns to its original state following a perturbation.	Pimm
1988	The capacity to cope with unanticipated dangers after they have become manifest, learning to bounce back.	Wildavsky
1995	The buffer capacity or the ability of a system to absorb perturbation, or the magnitude of disturbance that can be absorbed before a system changes its structure by changing the variables.	Holling et al.
1998	A fundamental quality of individuals, groups and organisations, and systems as a whole to respond productively to significant change that disrupts the expected pattern of events without engaging in an extended period of regressive behaviour.	Horne and Orr
	The ability of an individual or organisation to expeditiously design and implement positive adaptive behaviours matched to the immediate situation, while enduring minimal stress.	Mallak
	The capacity that people or groups may possess to withstand or recover from the emergencies and which can stand as a counterbalance to vulnerability.	Buckle
1999	A locale is able to withstand an extreme natural event without suffering devastating losses, damage, diminished productivity, or quality of life without a large amount of assistance from outside the community.	Miletti
	The capacity to adapt existing resources and skills to new systems and operating conditions.	Comfort
2000	The ability of groups or communities to cope with external stresses and disturbances as a result of social, political and environmental change.	Adger
2001	The ability to resist downwards pressures and to recover from a shock. From the ecological literature – property that allows a system to absorb and use and even Bénéfit change .Where resilience is high; it requires a major disturbance to overcome the limits to qualitative change in a system and allow it to be transformed rapidly into another condition.	Alwang et al.
	The ability to recover from the shock. Households with a low resilience are in an extremely hazardous state and may be forced to sell off or neglect the accumulation of productive assets in order to survive.	Carter and May
	An active process of self-righting, learned resourcefulness and growth— the ability to function psychologically at a level far greater than expected given the individual's capabilities and previous experiences	Paton et al.
	The capacity to cope with uncertainty and surprises while maintaining overall system persistence. It is about learning from error how to bounce back in better shape.	Barnett
2002	A potential of a system to remain in a particular configuration and to maintain its feedbacks and functions, and involves the ability of the system to reorganize following the disturbance driven change.	Walker et al.
2003	The ability to respond to singular or unique events.	Kendra and Wachtendorf
	The capacity of the damaged ecosystem or community to absorb negative impacts and recover from these	Cardona
	The ability of an actor to cope with or adapt to hazard stress.	Pelling
2004	Resilience of a system needs to be considered in terms of the attributes that govern the system's dynamics. Three related attributes of social-ecological systems (SESs) determine their future trajectories: resilience, adaptability, and transformability. Resilience is 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, having four components—latitude, resistance, precariousness, and panarchy.	Walker et al.
2005	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. This is determined by the degree to which the social system is capable of organising itself to increase this capacity for learning from past disasters for better future protection and to improve risk reduction measures.	UNISDR
2006	The resilience approach is concerned with how to persist through continuous development in the face of change and how to innovate and transform into new more desirable configurations.	Folke
2007	A resilient unit 'absorbs shocks and reorganizes itself following stresses and disturbance while still delivering Bénéfits for poverty reduction'.	Allison et al.
2008	Resilience refers to a system's capacity to deal with change and to continue to develop.	Boyd et al.
	Resilience involves the ability of systems to restart quickly after a hazard has struck, and to 'adapt existing resources and skills to new systems and operating conditions'... the ability of an actor to cope with or adapt to hazard stress.	Cannon
2013	The ability of people, households, communities, countries, and systems to mitigate, adapt to and recover from shocks and stresses in a manner that reduces chronic vulnerability and facilitates inclusive growth.	USAID
	Resilience has the capability to 1) adapt to changing contexts, 2) withstand sudden shocks and 3) recover to a desired equilibrium, either the previous one or a new one, while preserving the continuity of its operations. The three elements in this definition encompass both recoverability and adaptability.	World Economic Forum
	Resilience is not just about the ability to maintain or return to a previous state; it is about adapting and learning to live with changes and uncertainty. There are three types of capacity that are important in helping people do this: (i) absorptive capacity; (ii) adaptive capacity; (iii) transformative capacity.	Béné et al.
	Resilience is the capacity of a system, be it an individual, a forest, a city or an economy, to deal with change and continue to develop. It is about the capacity to use shocks and disturbances like a financial crisis or climate change to spur renewal and innovative thinking.	Stockholm Resilience Centre

These two dimensions of resilience drawn from ecological community (the ability to bounce back quickly) and engineering community (the ability to maintain the system's constancy against disturbances) epitomises the need for flexibility on the one hand, and sturdiness on the other, as a formula for managing disasters. The divergence and convergence of these two dimensions has given birth to an overwhelmingly large number of concepts for discussions and understandings of resilience.

In the more contemporary context, the 'capacity to recover' and 'degree of preparedness' are parts of what scholars are inclined to refer to 'resilience'. For example, Cutter et al. (2008, p. 600) explain that '*resilience within hazards research is generally focused on engineered and social systems, and includes pre-event measures to prevent hazard-related damage and losses and post-event strategies to help cope with and minimise disaster impacts*'. Among the more recent ones, UNISDR (2009, p. 24) defines resilience 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*'; and many more technical definitions have been introduced in the literature (e.g. Manyena, 2006; Bahadur et al., 2010).

Furthermore, resilience has sometimes been presented or understood in the past as **an outcome**. However, an increasing number of academics and practitioners now recognises resilience in a more useful way that resilience conceptualization should be understood as **an ability** or **a process** leading to a desired outcome(s) (Pfefferbaum et al., 2005; Norris et al., 2008; UNISDR, 2009; Mitchell and Harris, 2012). From the ability perspective, resilience is the ability to resist, recover from, or adapt to the effects of a shock or a change. While, from the process perspective, it is a continual process of learning and taking responsibility for making better decisions to improve the capacity to handle hazards. These dynamic interpretations have been added up to the resilience discourses as opposed to the conventional perceptions that were considered on the basis of equilibrium and constancy.

As the list of some definitions of resilience indicates, the definitions are diverse, reflecting the complex and multidisciplinary nature of the concept. McEntire et al. (2002) argue that individuals, or communities may possess resilience of different aspects and degrees which varies over times. This poses one of the challenges that obstructs scholars from reaching an agreement on a universal definition of resilience. Hence, finding

consensus or common basis on the definition of resilience concept is challenging, or even not fruitful to do so (MacAskill and Guthrie, 2014).

However, resilience definitions relatively have some similarities. In general, key aspects of resilience can be gathered as follows.

- From socio-ecology, resilience is often understood as the functionality of a system and its dynamics and self-reorganizing ability after stresses or shocks. Hence, resilience is perceived as *a process or ability rather than an outcome*.
- Some definitions consider resilience in *a long term perspective,* which is likely resemble to the notion of bouncing-back, specially emphasizing the recovery process. Therefore, it suggests that one of the factors for evaluating disaster resilience be the recovery time that a system takes to return to its previous conditions or status quo.
- Resilience can be conceptualized as an ability of the systems or units within the system to absorb, reduce, or modify impacts or consequences of potential shocks. This implies preparedness or being able to predict or take a precautionary measures before actual events occurs.
- An ability to adapt is also cited as an element of a resilient system. This includes the ability to adapt to an impact of a disaster, to adapt to the new environment after a disaster, and/or to learn from past experiences. This points out that the system will adapt to better address future disasters. This implies mitigation and preparedness.
- Resilience is perceived as a 'sibling concept' of vulnerability. It is sometimes understood as an opposite of vulnerability; yet, they are sometimes viewed as resembling concepts. This line of thinking has pushed both concepts the subjects of circular reasoning. Section 2.3.1 discusses the issue in details.
- Resilience is often linked to *sustainability or sustainable livelihoods.* It implies that increasing livelihoods can somehow contribute to the level of resilience. In other words, enhancing resilience can come in the form of enhancing livelihoods. Section 2.3.2 discusses the issue in details.

2.3. Resilience and its related topics

2.3.1. Resilience VS Vulnerability

Although resilience and vulnerability have separate epitomic roots, resilience is often used as a synonym for vulnerability reduction. Yet, some the differences between them can be identified. Béné et al. (2012, p. 15) point out that both concepts are seen as

a '*sibling concept, yet siblings do not always see eye to eye. Despite the ongoing debates over their content and definition, identifying the convergence and divergence of resilience and vulnerability is necessary because discussions on resilience will have to refer to vulnerability at some points as both concepts overlap and provide their own instruments which can be incorporated in some cases*'.

The term 'vulnerability' has entered into the disaster discourse as the disaster paradigm shifted towards the notion that disasters are more a result of socio-economic vulnerability more a natural phenomenon. Since then, there has been a large variation of vulnerability definitions. The large number of definitions is a mirror of diversities and differences in terms of theories, philosophies, and methodologies which disaster scholars have put their efforts into. In spite of the fact that vulnerability has given credit in disaster risk management and planning, it faces a number of restrictions and limitations in terms of conceptualization and practicality. Vulnerability measurement and evaluation are often inadequate to capture complexity of systems when dealing with disasters.

Peter Timmerman (1981)'s article entitled 'Vulnerability, Resilience and the Collapse of Society' has chiefly generated a momentum of the widespread utilization of vulnerability in relations to resilience. A number of scholars propose the inclusion of some elements of resilience to the understanding of vulnerability (Cardona, 2003; Adger, 2006; Miller et al., 2010). This justifies the connection between vulnerability and resilience that they are both about responding to disturbances and its implications to reduce the impact of them. Adger (2006) argues that the level of vulnerability is influenced by the aggregation or corrosion of social-ecological resilience. Another example of vulnerability definitions that seems almost resemble to resilience includes that of Blaikie at al. (1994, p. 11): '*By vulnerability we mean the characteristics of a person or a group in terms of their capacity to anticipate, cope with, resist and recover from the impact of a natural hazard*.'

Additionally, both concepts have put themselves into the subjects of circular reasoning: a system lacks resilience because it is vulnerable; it is vulnerable because it lacks resilience. The problem is not of the circular explanations, but rather it is the line of thinking that being more vulnerable can often, though not necessarily, be less resilient (Béné et al., 2011). Maybe this could answer why practitioners have attempted in doing vulnerability analysis as it as it somehow identifies related methodology for resilience

improvement.

While some scholars discuss differences of both concepts in their articles (Manyena, 2006; Miller et al. 2010), Gallopín (2006) and Klein et al. (2003) warn against breaking the both concepts as North-South opposites due to its ability to comprehend and catch human systems in the development studies. Therefore, it could provide a stepping stone in the way that could encourages convergence of resilience and vulnerability, rather than adopting one approach at the expense of the other (Béné et al., 2011). Resilience also fills gaps in vulnerability thinking (Gallopín, 2006) as follows:

- Resilience represents the need to level up the capacity of systems in order to deal with, reduce the impact of, and speed up the recovery from disasters.
- Resilience focuses on the complete cycle of disaster management by putting emphasis on increasing the ability to address damages from disasters.
- Resilience is a proactive concept. It encourages collective efforts to better address disasters because resilience is a broader concept covering a large part of the risk spectrum and focuses the capacities and how to enhance them.

2.3.2. Resilience and Sustainable Livelihoods

The ability of 'bouncing back' has influenced the discussion and debates over resilience on what it should really entails. From the viewpoint of sociology, bouncing back is interpreted and implied the returning or recovering to the previous conditions (status quo) that may have been good or bad to be in (Klein et al., 2003; Adger, 2000). Smithers and Smit (1997) often demonstrate the relations between resilience and the state of 'entrenchment'. Handmer et al. (1996) view it as 'resistance'. This way of thinking may influence us to think that promoting and enhancing resilience is almost resemble with the maintenance of the current state or status quo, instead of advancing towards enhancing and empowering capacities within. Brooks (2003) proposes that, instead of emphasizing on developing resilience of existing units, it may be rational or fruitful to replace the units with ones that are better suited to the conditions.

Apart from the resistance or entrenchment implication of the resilience concept, Dodman et al. (2009) highlights the expansion of resilience to include improvement in development. From this line of thinking, resilience can be related to sustainable livelihoods, in the manner that improving or enhancing livelihoods can be considered a way to promote resilience (Chambers and Conway, 1992). Frankenberger et al. (2014) even encourage that resilience policy should aim at positive livelihoods enhancement

rather than resilience itself. They developed Resilience Programming Framework that suggests resilience can be evaluated by development and livelihoods indicators.

A number of research and models that include sustainable livelihoods into resilience development often gathers around the Sustainable Livelihoods Framework (SLF), shown in Figure 2.1. Especially for an attempt to evaluate resilience, the five livelihoods assets, highlighted within the yellow circle) are used as a starting point.

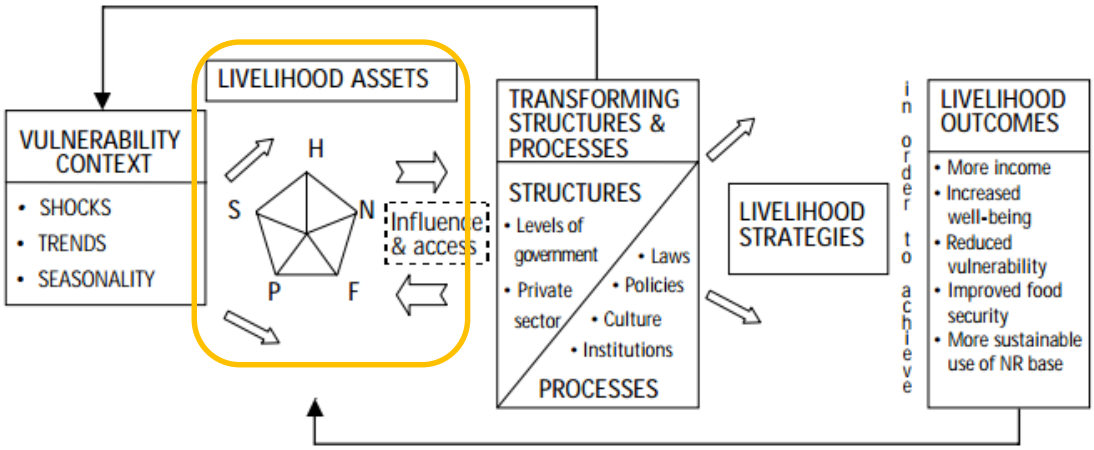


Figure 2.1 Sustainable livelihood framework

Source: Department for International Development

2.4. Summary

This chapter reviews a wide range of related literature to evaluate and capture the fundamental essence of the resilience concept. The existing definitions and various conceptualizations studied in the chapter provide better understanding about resilience. The similarities of resilience definitions points to the ability of a system to deal with, address disaster impact, and, when affected, recover fast and learn to better cope with future risks.

Furthermore, it suggests that (1) there are challenges in terms of conceptualization of resilience; and (2) resilience concept has more potential in advancing disaster research than vulnerability. Generally, the literature review provides the theoretical ground for this research to further develop an analytical framework for national disaster resilience, which is illustrated in Chapters 3 and 4.

Fully aware of the inconsistency of the resilience definitions, this research is likely to build its working ground on the notion which discusses that vulnerability and resilience are viewed as separate but often linked concepts, and includes the *ex-ante* conditions and the *ex-post* processes strengthening the ability to anticipate, reorganize, change, and learn in response to disturbances.

CHAPTER 3
CONSTRUCTING AN ANALYTICAL FRAMEWORK FOR NATIONAL DISASTER RESILIENCE

3.1. Introduction

The key objective of this chapter is to create an analytical framework where national disaster resilience can be measured and indicators can be identified. To attain the objective, a number of related frameworks from the literature were thoroughly studied in order to identify key elements that can be used to measure national disaster resilience. Based on the review, a working definition of national disaster resilience and an analytical framework for national disaster resilience are developed. This chapter presents the journey of constructing an analytical framework. The following questions will be made clear: How is disaster resilience understood? What makes a system resilient? What are resilience characteristics and its components? With what framework is resilience measured?

3.2. Literature Review

Because of the findings that (1) the definition of the concept of disaster resilience is highly inconsistent, and that (2) the interactive dynamism of the systems within a country are complex, evaluating national disaster resilience is challenging. It requires the knowledge on how resilience is determined, measured and enhanced, as well as clear understanding of the components of national disaster resilience. There are currently a number of conceptual frameworks or models that intend to measure or give a general comprehension of resilience. Yet, it is not apparent what really prompts resilience or what parameters ought to be used to measure it, due to the multidimensional nature of resilience and its multifaceted components. Therefore, it is crucial to review those frameworks, particularly to develop an instrument to understand national disaster resilience because they might give some valuable guidance. Above all, those frameworks exemplify a structure where relevant indicators and indices of resilience can be identified and assessed.

For the purpose of this study, four frameworks of resilience and two frameworks of vulnerability are studied and discussed in this chapter. The reason why it is important to additionally review concept of vulnerability is the link between resilience and vulnerability as measuring resilience at some points will have to come to vulnerability.

3.2.1. Resilience Frameworks

3.2.1.1. Resilience as a System of Systems: Panarchy

This is perhaps the most ambitious conceptual framework to explain resilience. The system theory is based on the idea that the various systems have resilience and share synergies, connections and interactions across temporal and spatial scales. Resilience can therefore be interpreted as a '*system of systems*' (Bristow et al., 2012) or '*complex adaptive system*' (Allen et al., 2005). The system complexity comes from the continuous interactions between participants and the resulting responses. The interacting participants within as well as between systems (and across scales) range from individuals and households to communities and national states. Resilience as a product of a system of systems is also known as 'Panarchy', coined by Gunderson and Holling (2001) to describe **the interaction and linkages between coupled human–natural systems and their continual cycles of adaptation, growth and restructuring**.

The ability of the panarchic characteristic, or resilience, to cope with stress or disturbance depends on both **its actors (or participants)** and, more importantly, on how these actors influence each other. Yet, understanding the multiplex interactions within and between them remains highly challenging because system's actors interact and produce unpredictable and unintended impacts and consequences (Bristow et al., 2012). It is argued that the dynamic characteristics of a system cannot be completely comprehended in lieu of accounting for the dynamics of other cross-scalar and hierarchical influences within the system.

There is also disagreement on the type and timing of when and how resilience can be spotted. Haimes argues that, *'resilience of a system can be measured only in terms of the specific threat (input) and the system's recovery time and the associated composite costs and risks'* (2009, p. 498). This contradicts the comprehensive approach, which do not specify a specific stressor (Cutter et al., 2010). In regard to the timing of resilience, Allen et al. (2005) question whether resilience can be evaluated or measured before disturbances or shocks occur because there would not be reaction or response from a system without stressors. Others claim that, *'at any given time, the actual or potential performance of any system can be measured as a point in a multidimensional space of performance measures'* (Bruneau et al., 2003, p. 736).

3.2.1.2. R4 Framework and TOSE domain

In the hazards field, the resilience models are largely developed around

engineering field. The R4 framework of resilience, developed by the Multidisciplinary Center of Earthquake Engineering Research (MCEER), was developed based on the assumption that resilience diminish the possibilities of failure and its consequences, and the recovery time. There are four determinants of resilient infrastructure, namely 4R: Robustness, Redundancy, Resourcefulness, and Rapidity (Bruneau et al., 2003; Tierney and Bruneau, 2007).

1. Robustness is the capacity of systems, system elements, and other units of analysis to withstand hazard events without significant degradation of performance.
2. Redundancy is the extent to which systems, system elements, or other units are substitutable, that is, able of satisfying functional requirements, if significant degradation or loss of functionality occurs.
3. Resourcefulness is the ability to diagnose and prioritize problems and to initiate solutions by identifying and mobilizing material, monetary, informational, technological, and human resources.
4. Rapidity is the capacity to restore functionality in a timely way, containing losses and avoiding disruptions.

Tierney and Bruneau (2007) also identified four dimensions or domains of resilience known as TOSE: Technical Domain, Organizational Resilience, Society, and Economies. TOSE is further elaborated into PEOPLES resilience framework, aiming at defining and measuring disaster resilience for a community at various scales. PEOPLES attempts to address simultaneously the assets of the community and their functionality at various geographic and temporal scales and identifies seven dimensions that characterize community functionality: (1) Population and demographics, (2) Environmental/Ecosystem, (3) Organized governmental services, (4) Physical infrastructure, (5) Lifestyle and community competence, (6) Economic development, (7) Social/cultural capital.

3.2.1.3. Disaster Resilience of Place: DROP model

Disaster Resilience of Place (DROP) is proposed by Cutter et al. (2008). Their effort is (1) to ameliorate the shortcomings in existing vulnerability and resilience models and (2) to provide a conceptual basis for establishing baselines for measuring resilience. DROP is formed to show the relationship between vulnerability and resilience. It is largely based on that the model is made to address natural hazards. The fundamental focus is on social resilience of place. It also presents resilience as both an

antecedent condition and a process, where the antecedent conditions can be viewed as a snapshot in time or as a static state.

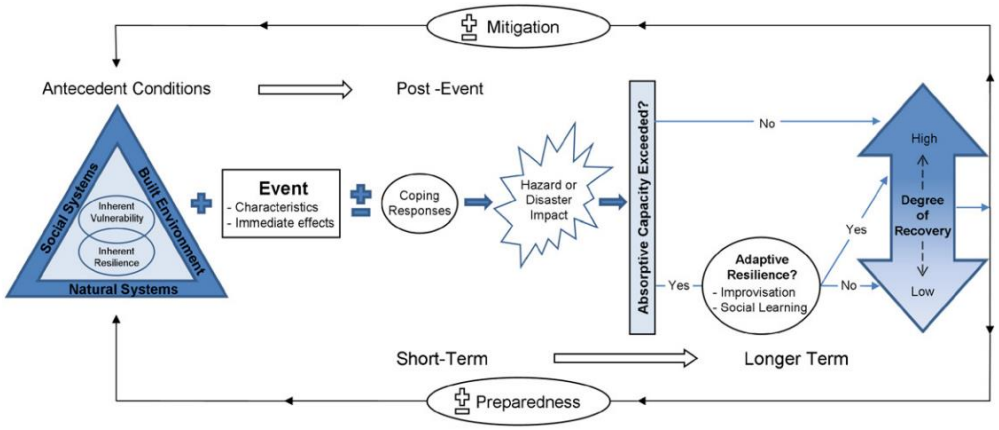


Figure 3.1. The schematic representation of the DROP model

Source: Cutter et al., 2008

In sum, the DROP model has two main components (see Figure 3.1). The first segment comprises the antecedent conditions (the inherent vulnerability and inherent resilience) which are the product of the interactions of the social, natural and built environment systems. The hazard impacts are the consequences of the antecedent conditions, hazard events, and the capacity to cope and respond. The second segment comprises the abilities to manage the disaster impacts, which incorporate coping, absorptive and adaptive capacities.

3.2.1.4. 3-D Resilience Framework

Béné et al. (2012) propose the utilization of the three components of resilience, absorptive, adaptive, and transformative capacity (see Figure 3.2), the elements of an analytical framework aimed at capturing what really 'strengthening resilience' means. Béné and his team build their model on the multicity of resilience features such as 'buffering impacts', 'returning to pre-shock situation' or 'bouncing back', 'shock absorbing', 'evolving and adapting' and 'transforming'. The multicity of resilience points to the need for a more elaborated concept that grasps these components. The essential point of the framework is that resilience emerges as the result not of one but all of these three capacities: absorptive, adaptive and transformative capacities, each of them leading to different outcomes: persistence, incremental adjustment, or transformational responses.

These distinctive reactions can be connected theoretically to different intensities

of shock or change. The lower the intensity of the shock, the more likely the system will be able to cope with it effectively, for instance, to absorb its impacts without consequences on its function, status, or state. The ideal outcome after a crisis is resistance, meaning that the system has enough capacity to effectively shield off the stress and, accordingly, there is virtually no dysfunction. Béné et al. exemplify the human immune system as one of the most effective resistance strategies known to exist.

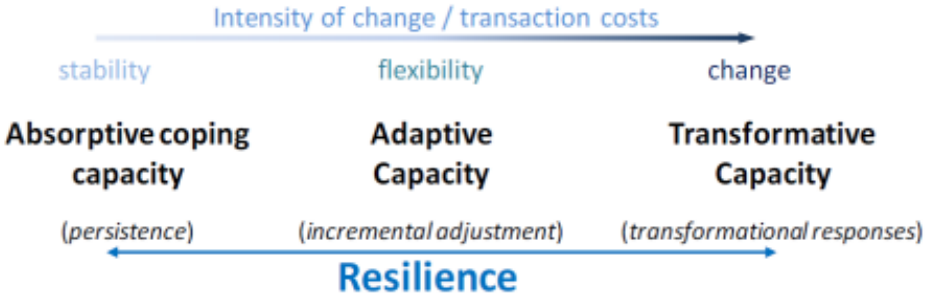


Figure 3.2. The 3D resilience framework

Source: Béné et al., 2012

3.2.2. Vulnerability Frameworks

Like resilience, vulnerability research has encountered the multiplicity of approaches, scopes, and interpretations. It is also not surprising that vulnerability models diverge in terms of explaining the root causes of vulnerability. Few researchers have attempted to combine all the factors that contribute to vulnerability. This research reviews 2 interrelated frameworks of hazard vulnerability: (1) Wisner et al.'s pressure and release model (Wisner et al., 2004); and (2) Turner et al.'s (2003) framework of vulnerability analysis. The latter is built on the former and extended to include resilience into its framework.

3.2.2.1. Pressure and Release Model (Vulnerability Progression)

The general Pressure and Release (PAR) model is proposed by Wisner and Blaikie et al. (2004) shown in Figure 3.3. Its fundamental point is that a disaster is the crossing point of two forces: the procedures creating vulnerability on one side, and the natural hazard event on the other. Wisner and Blaikie et al. (2004, p. 50) compare it as a '*nutcracker, with increasing pressure on people arising from either side – from their vulnerability and from the impact of the hazard of those people*'. The circumstances that determine vulnerability are grouped into three categories: (1) roots causes, (2) dynamic

pressures, and (3) an unsafe conditions. **Root causes** includes well-established, widespread processes within a society and economy: the political and economic ideologies, which affect the allocation and distribution of resources, and reflect the distribution of power. **Dynamic pressures** are processes and activities that translate the effects of root causes into vulnerability of unsafe conditions. **Unsafe conditions** include the specific forms where the vulnerability of a population is expressed in time and space in conjunction with a hazard. The pressure and release model is designed to track the progression of vulnerability from root causes to dynamic pressures to unsafe conditions.

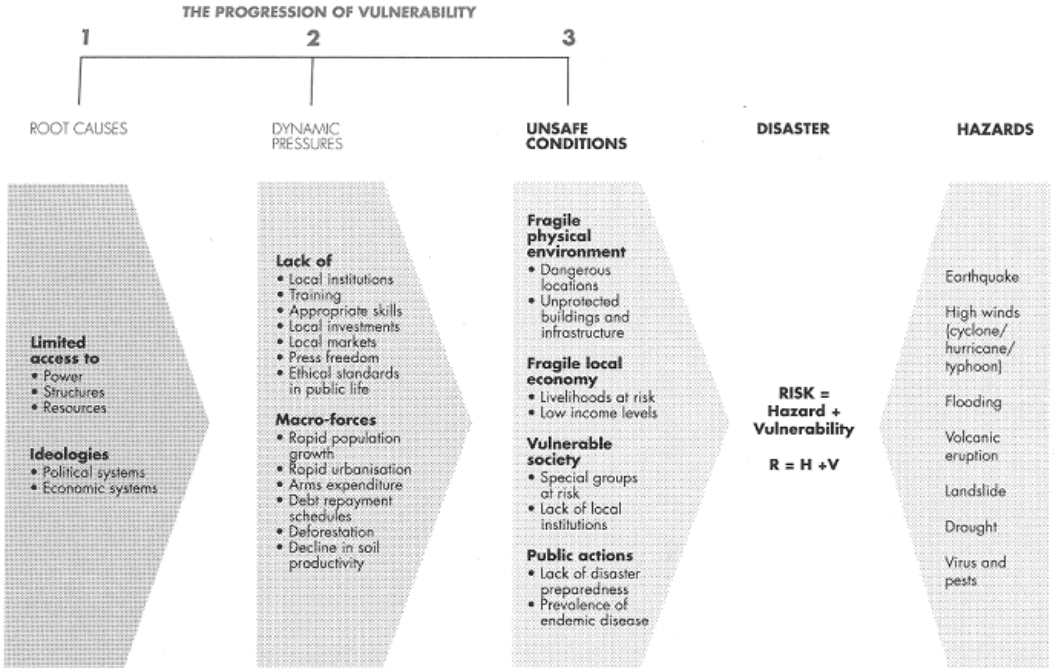


Figure 3.3. Pressure and Release (PAR) model

Source: Blaikie and Wisner et al., 2004

3.2.2.2. Framework of Vulnerability Analysis

Turner et al. (2003) proposed the Vulnerability Analysis framework. It is an extension of PAR model, where it captures the complexity and interactions involved in vulnerability analysis. It fills the gap that PAR model insufficiently addresses in terms of the coupled human-environment systems by drawing attention to the different variables and multiple linkages that potentially influences the vulnerability. The framework makes use of the flowchart (Figure 3.4) to show how social and environmental forces interact to create situations vulnerable to sudden changes. It also demonstrates that vulnerability is registered not by exposure to hazards (perturbations and stresses) alone but also resides in the sensitivity and resilience of the system experiencing such

hazards.

Here, resilience is seen in relations to vulnerability. Resilience is determined collectively by coping mechanisms, whether autonomous action or planned, public or private, individual or institutional, tactical or strategic, short- or long-term, anticipatory or reactive in kind, and their outcomes.

To summarize the frameworks discussed above, generally have demonstrated that there is important component that can be used to conceptualize national disaster resilience: capacities (coping, absorptive, adaptive, and transformative) and (2) factors that influence resilience which can be categorized in many ways.

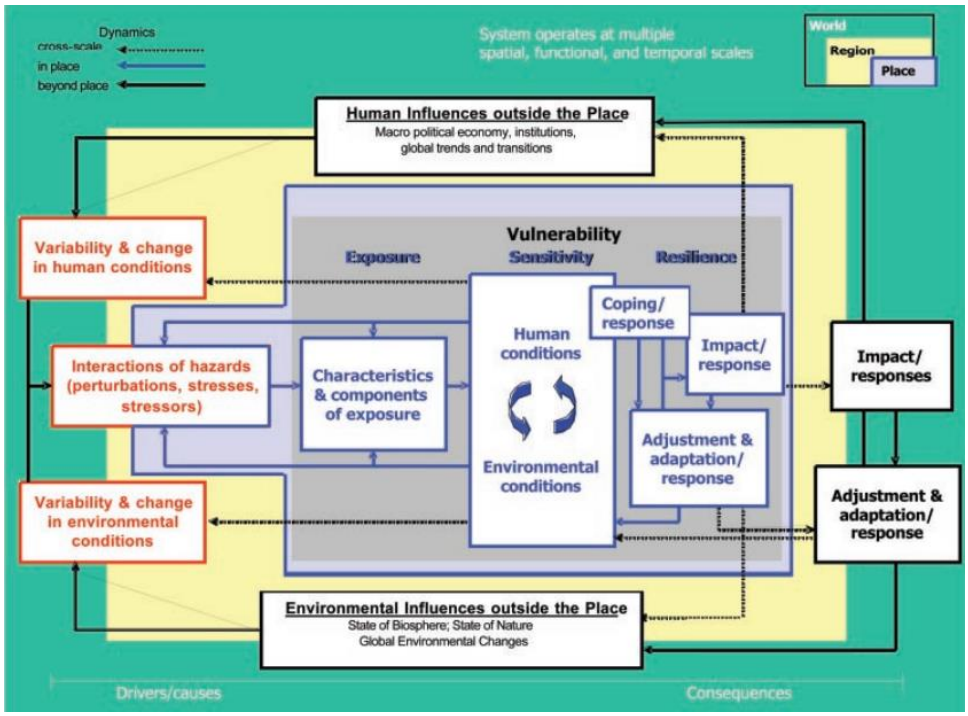


Figure 3.4. Turner et al.'s vulnerability framework

Source: Turner et al. (2003)

3.3. Working Definition of Resilience

In the wake of the new millennium, resilience has become a principal theme across a wide range of disciplines. Each discipline, including ones in the disaster discourse, attributes its own working definition to the term. For the purpose of this dissertation, disaster resilience is defined as:

An ability or capacity of its systems to bounce back from, withstand and cope with, adjust to the impact of, and recover from the effects of disturbances or shocks in a timely and effective manner through shock anticipation, absorption, adaptation, transformation and restoration of its essential basic structures and functions. It is an ability that is inherent within a country and is the product of the country's systems.

Implied by its working definition, this dissertation embraces the influence of the 3D resilience framework, the DROP framework, and the system theory over resilience concepts, see Figure 3.5. It is because resilience applies to varied entities, ranging from individuals to countries, and the critical aspect is to avoid investigating any of them in isolation. It is necessary to consider a country as a system that is comprised of smaller systems or sub-systems. National disaster resilience is inherent and the result of resilience of those smaller systems or sub-systems.

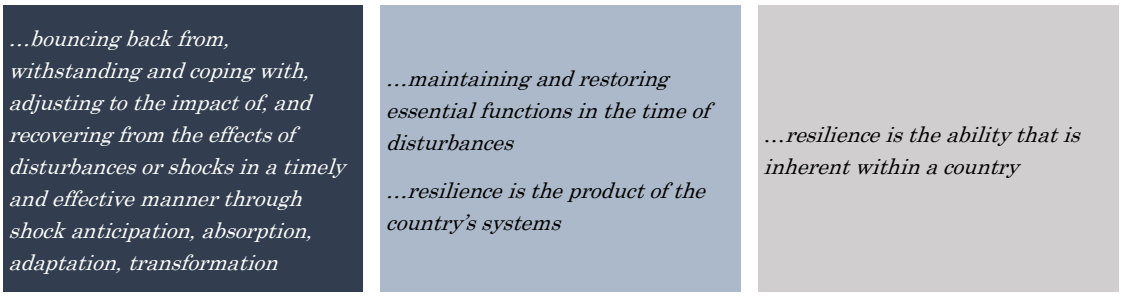


Figure 3.5. The working definition of national resilience

3.4. Understanding National Disaster Resilience through a Framework

In order to understand resilience, the following proposed analytical framework, DROP/3D, is derived chiefly from Cutter et al. (2008) DROP model and Béné et al. (2015) 3D framework of resilience. The DROP model originally focuses on community resilience; but, this reserach proposes that the model can be adjusted to understand resilience at national level when combine with others. It paves the way to utilize the inherent resilience as its conceptual basis; and its simplification of reality makes it easier to understand resilience, though some details are left implicit. The 3D framework of resilience comes to fill the gap where the DROP model does not seem to do. The model's classification of resilience capacity helps explain what capacities resilience has. Figure 3.6 shows schematic presentation of the DROP/3D.

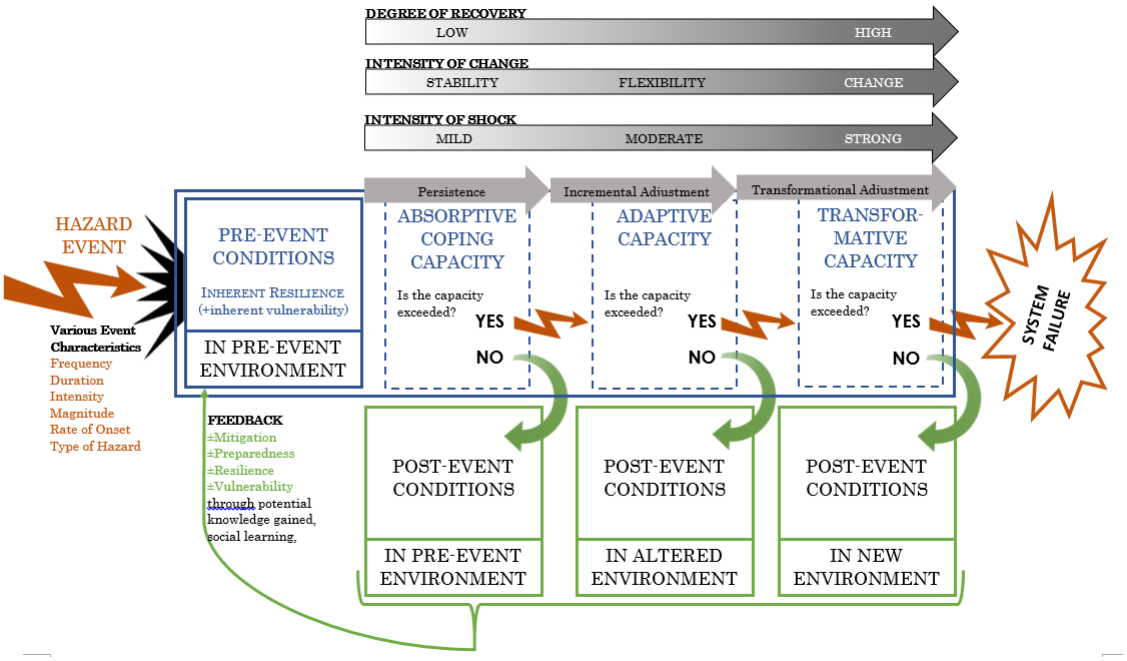


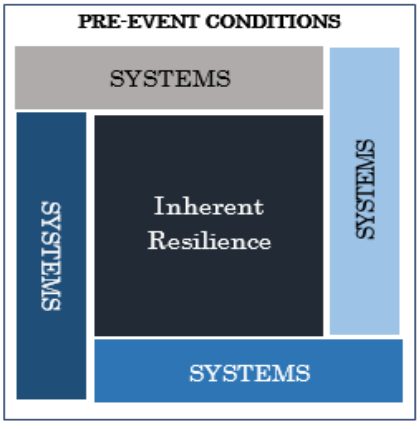
Figure 3.6. DROP/3D

Drawn from Béné et al. (2012), resilience is the result of three capacities: absorptive, adaptive and transformative capacities. When a country interacts with hazards (shocks, stressors, or disturbances), its immediate impacts are increased or decreased by the level of absorptive coping capacity. However, when the absorptive capacity is exceeded, the system will then exercise their adaptive resilience. This adaptive resilience can be referred to the various adjustments that people (or participants in the system) undergo in order to continue basic functions or structural identity. These adjustments can be in many forms (for instance, embracing new farming techniques, altering farming practices, diversifying livelihood bases, engaging in new social networks, etc.). These adaptations can be made by an individual or a collective action, and they can take place at any levels (intra-household, groups of individuals/households, community, nation, village etc). Béné et al. (2012) point out that adaptation is a continuous, incremental process which is challenging to track or evaluate. People may not even be aware of how they adapt to changing circumstances or how they improve their work skills. In addition, people don't adapt to one specific stressor, but rather to a broad combination of changes. In fact, it is rarely possible to disentangle the multiple changes to which people are responding, and it makes little sense to try to do so as what would be perceived as an adaptation for one household could be part of a coping strategy for another.

Eventually, if the change required is so large that it overwhelms the adaptive capacity of the system, transformation has to occur. It results in alterations in primary structure and function. These transformational changes often involve shifts in the nature of the system, the introduction of new state variables and possibly the loss of others. It can be a deliberate process, initiated by the people involved, or it can be forced on them by changing environmental or socioeconomic conditions. What the growing body of literature that discusses transformational changes highlights is that the main challenges associated with transformation are not of a technical or technological nature only. Instead, as pointed out by O'Brien (2011), these shifts might incorporate a blend of mechanical developments, institutional changes, behavioural movements and social changes; they often include the scrutinizing of qualities, the testing of suppositions, and the ability to nearly analyse settled convictions, characters and generalizations. In other words, they challenge status quo.

To be fruitful, these transformational changes therefore require changes to entrenched systems maintained and protected by powerful interests. There are, consequently, enormous barriers to transformation, rooted in culture and cognition and expressed through economic and social policies, land-use legislation, resource management practices, and other institutions and social practices.

Like the DROP model, the DROP/3D emphasizes the pre-event conditions. The pre-event conditions can be called in many ways, e.g. inherent or antecedent conditions (Cutter et al., 2008) or prevalent or baseline conditions (Cardona, 2005). They are a product of systems within a country and include inherent resilience. Cutter et al. (2008) proposes that the antecedent conditions are a product of place-specific multi-scalar processes that occur within and between social, natural, and built environment systems. Antecedent conditions include both inherent vulnerability and inherent resilience. However, this dissertation sees the need to extend the concept. Combined with the system theory, it proposes that inherent resilience is a product of systems resilience.



3.5. Identifying Resilience Components

Through literature review, attempts to identify the presence of resilience has

traditionally aimed at assessing country's assets or capitals (Mayunga, 2007). This depends on the idea that frameworks are by and large consisted of capitals or resources, while they rely upon frameworks for their presence and upkeep. They can be both physical (basic) and non-physical. However, there are key shortcomings of asset- or capital-based approaches to resilience. To consider a country just as a set of capitals neglects the fact that a country is a social, economic and political construction as well as a physical one. Many non-structural capitals within countries are often overlooked due to difficulties to identify and assess. A country is built on social assets as much as the physical assets of buildings and roads. The relationship between physical and social networks is instrumental to understanding how physical assets may contribute to city resilience.

From the DROP/3D model proposed, the pre-event conditions, entailing inherent resilience, is the result of resilience of those smaller systems or sub-systems. Although each country is uniquely shaped by its geographical characteristics, its population, and its history, the systems within a country generally perform similar services; to name a few, providing basic infrastructure, facilitating good flow of trade and services, developing and enforcing legislation. Therefore, systems within a country are easier to compare in terms of their characteristics or qualities of resilience than countries themselves. It is more common to investigate the resilience of specific systems rather than the resilience of 'the country' as a system in itself (Gall, 2013). The systems approach gives advantages to the analysis as it recognises both structural and non-structural components, and human and physical systems (Gall, 2013). For example, da Silva et al. (2012) divide systems into three categories, which reflect these institutional, human and physical groupings: institutional networks; knowledge networks; and networked infrastructures as shown in table 3.1.

Table 3.1 da Silva et al.'s three categories of systems

Source: da Silva et al. (2012)

Category	System type	Example types
Networked infrastructure	Basic Infrastructure	Food
		Water
		Shelter
		Sanitation
		Waste management
	Community wellbeing infrastructure	Education
		Health
		Power supply
	Advanced infrastructure	Acute health care
		Further education
		Manufacturing and processing (factories, industrial units)
		Service industries (banking, offices, others)
	Enabling infrastructure	Public transport - local level
		Transport - regional and global levels
		Transport of goods (freight, ports)
		Communications
Knowledge networks	Information flows	Systems for the dissemination of information (e.g. radio stations, the internet, others)
	Technology	Networks to develop and access technology (e.g. research and development centres)
	Education	Institutions for education and knowledge generation (e.g. schools, universities)
Institutional networks	Governance	Systems for governing and decision making (e.g. government structures, community associations, business associations) and rules and practices supporting interaction (e.g. justice, tenure & rights, markets)
	Social systems	Systems of social relationships, hierarchy, status, power, exchange, social reproduction
	Culture	Systems for interpretation, including issues of faith, myth and user behaviour (e.g. religious beliefs and ethical positions)
	Economic systems	Systems regulating production, exchange, and finance (e.g. markets, labour conditions, funding tools)

To build its own list of systems for a country, this dissertation stocktook eleven overlapping understandings of resilience in various fields, proposed by socio-ecologists. It broke down their potential components as shown in Table 3.2. (for more details, refer to Annex 1). From the study, the key findings regarding systems within a system are as follow:

- There is no limit on the number or an exact number of systems or subsystems that a resilient system should have.
- Systems within a system can be classified according to various criteria e.g. sectors, institutions, capitals, and assets, etc.
- A resilient system has distinct qualities or characteristics to differentiate it from ones that is simply proper or sustainable.

Table 3.2. Metric table of resilience understandings

Author(s), Year	Conceptualisations	Perspective Elements/components	Potential Components/Systems	Perspective Qualities/ Characteristics
Adger, 2000, 2002	Social resilience as the ability of human communities to withstand external shocks	• Economic growth • Distribution of wealth • Degree of dependency on natural resources • Environment variability • Stability of Livelihoods • Mobility and migration • Level of functional diversity • Degree of legitimacy of institutions • Resource dependency	• Economic system • Livelihood • Environmental system • Legislative system • Social institution	• Diverse natural resources • Low frequency and intensity of extreme events • Stable livelihoods • Equitable distribution of assets • Responsive • Dynamic
Berkes, 2007	Resilience as 4 components	• Good knowledge of past disturbances, tools, and codes of conduct • Large number of species in ecological system • Local and indigenous knowledge • Decentralization • Self-organization	• Education • Ecological system • Political system	• Learning • Diversity • Self-organization
Cutter et al., 2008	DROP model of resilience	• High biodiversity • Large number of social networks • High rate of employment • Wealth distribution • High community participations • High level of functioning of critical infrastructure	• Ecological System • Social system • Economic system • Infrastructure	• Diverse • Supportive • Redundancy
Folke, 2006	Disturbances in a resilient social-ecological system have the potential for innovations and development	• Network Government System • Learning • Governance • Diverse Actors	• Political System • Education	• Learn to manage • Embrace uncertainty • Interaction between system components • Non-equilibrium dynamics
Holling, 1973	Resilience as persistence of systems, ability to absorb change and still maintain its function	• Mainstreaming Disaster Risk Reduction • Levels of well-being • Strong social, political, cultural, economic and natural links	• Political System • Livelihoods • Environmental system	• Flexible • Dynamic • Ability to cope • Open and dispersed • Heterogeneous
Manyena, 2006	Resilience as a sum of processes	• Community awareness towards disasters • Human development • Information sharing • Political Participation • People-involvement in policies	• Human Development • IT • Infrastructure • Governance • Civil Society	• Recovery and Bounce back focus • Proactive adaptation to risk • Local knowledge and culture

Author(s), Year	Conceptualisations	Perspective Elements/components	Potential Components/Systems	Perspective Qualities/ Characteristics
Mayunga, 2007	Resilience as 5 Capitals	• International involvement • Economic growth: employment, income, investment • Education • Infrastructure • Environment	• Social system • Economic system • Human development • Infrastructure • Natural system	• Trust • Community cooperation • High level of knowledge and skills • Full of resource • Protection of environment
Osbahr, 2007	Resilience as a measure of the amount of change a system can undergo while retaining the same controls on structure and function	• Substantial remittance income in community • Adaptation actions based on autonomous efforts • Existence of indigenous knowledge • Existence of effective labour exchanges and agricultural associations • Decentralization of decision making • Existing social and economic networks • High degree of community knowledge • Capacity building initiatives • Degree of innovation	• Economic system • Financial system • Education • Political system • Social network • Livelihoods	• Heterogeneity • Supportive • Robust • Participatory • Polycentric and multi-layered • Accountable • Flexible • Engagement
Rockefeller Foundation, 2009	Resilience is capacity to dynamically and effectively respond to shifting climate impact circumstances while continuing function at an acceptable level	• Decentralized systems of decision making • Available financial services • Existence of sustainability • Mainstreaming of disaster risk management • High degree of knowledge • Insurance • Reducing stressors	• Infrastructure • Financial system • Education	• Dynamic • Flexible • Multi-faceted skills • Redundancy • High level of planning and foresight • Diverse and decentralized
Resilience Alliance, 2009	Resilience as stability, self-organization and learning	• Land tenure systems that promote equity and sustainable land use • Diverse groups of species in ecological systems • Local knowledge	• Legislative system • Ecological system • Education • Civil Society	• Self-organisation • Diversity • Flexibility • Dynamic • Supportive
Twigg, 2009	Resilience as an ability to absorb stress, to manage or maintain certain basic functions and structures during disastrous events and bounce-backability after a disaster	• Policy, planning, priorities and political commitment • Legal and regulatory systems • Public awareness, knowledge and skills • Education and training • Environmental and natural resource management • Health and well-being • Sustainable livelihoods • Social protection • Financial instruments • Organizational capacities and coordination • Preparedness and contingency planning • Emergency resources and infrastructure	• Governance • Risk assessment • Knowledge and education • Risk management and Vulnerability • Disaster preparedness an response • Livelihoods • Environmental system	• Participatory • Resourceful • Skilful • Dynamic • Accountable • Flexible • Engagement

From the table 3.2, the potential systems, for evaluation purposes, can be summarized into seven systems with underlying variables shown in table 3.3.

Table 3.3. Summary of potential systems for evaluation purposes

Systems	Variables
1. Human Development	• Education • Health and Well-being • Sustainable Livelihoods • Variety of Cultures • Experience- and Knowledge-Sharing • Promotion of local and indigenous knowledge • Innovation
2. Politics	• Decentralization • Participatory Decision Making • Self-organization • Governance
3. Legislation	• Regulatory Quality • Rule of Law • Control of Corruption
4. Economy	• Economic Growth • Distribution of Wealth • Employment • Savings • Insurance • Financial services
5. Infrastructure	• Clean water • Electricity • ICT Access • Transportation • Accommodations • Land tenure
6. Environment	• Resource Dependency • Quality of air • Water and sanitation
7. Ecology	• Environmental Variability • Species Variety in Ecological System • Biodiversity

The tables 3.2 and 3.3 will be used as a guidelines to develop composite indicators, to be explained in the next chapter. The list will be studied in line with ongoing efforts in measuring a country's resilience, as well as the consistency with Hyogo Framework for Action and Post-2015 Framework for Disaster Risk Reduction, then shortlisted according to data availability, and arranged into thematic categories.

3.6. Identifying Qualities/ Characteristics of Resilience Systems

Conceptualisations of the components of resilience are a significant part of the 'new' wave of resilience thinking, which is linked to promoting resilience as a development agenda (e.g. Manyena, 2006; Rockefeller Foundation, 2009; World Economic Forum, 2013). Qualities or characteristics of system distinguish a resilient country from one that is simply sustainable, lively, and prosperous. These characteristics are perceived to be crucial in preventing failure or breakdown, or enabling timely action

to be taken. Bahadur at al. (2010) proposed ten characteristics of resilience systems: (1) high diversity, (2) effective governance, institutions/ control mechanisms, (3) acceptance of uncertainty and change, (4) preparedness, planning and readiness, (5) high degree of equity, (6) social values and structures, (7) non-equilibrium system dynamics, (8) learning, (9) community involvement and inclusion of local knowledge, and (10) adoption of a cross-scalar perspective.

The Rockefeller Foundation (2009) presents seven 'qualities' of resilient cities: (1) flexibility, (2) a multi-faceted skill set, (3) Redundancy, (4) collaborative multi-sector approaches, (5) planning and foresight, (6) diversity and decentralization, and (7) plan for failure. They are similar in function and purpose to the Stockholm Resilience Centre's seven principles of resilience: (1) maintain diversity and redundancy, (2) manage connectivity, (3) manage slow variables and feedbacks, (4) foster complex adaptive systems thinking, (5) encourage learning, (6) broaden participation, and (7) promote polycentric governance systems, in that they provide guidance for how to achieve resilience (Stockholm Resilience Centre, a). In other words, adherence to the 'qualities' or 'principles' of resilience should put one on the path toward resilience. World Economic Forum (2013) also proposes an assessment of three resilience characteristics: Robustness, Redundancy, and Resourcefulness as a way to measure a country's disaster resilience.

This dissertation found that characteristics proposed by Stockholm Resilience Centre (a), Bahadur et al. (2010), World Economic Forum (2013), and the Rockefeller Foundation (2014) draw out areas of convergence. Here, literature review is also carried out with the hope to extract characteristics or qualities of resilient systems (Table 3.2.). Some concepts are stated to be characteristics of resilient systems in a number of different pieces of literature. These characteristics can be assembled into the following qualities shown in Table 3.4.

Table 3.4 Key Qualities of Resilient Systems

Quality	Explanation	Supporting Literature
Comprehensive	Integration and alignment between systems promotes consistency in decision-making and ensures that all investments are mutually supportive to a common outcome. Integration is evident within and between resilient systems, and across different scales of their operation. Exchange of information between systems enables them to function collectively and respond rapidly through shorter feedback loops throughout the country. Comprehensive quality is often referred to as 'Integrated'.	Adger, 2000 Carpenter et al., 2001 Béné et al, 2012
Diverse	Redundancy refers to spare capacity purposely created within systems so that they can accommodate disruption, extreme pressures or surges in demand. It includes diversity: the presence of multiple ways to achieve a given need or fulfil a particular function. Examples include distributed infrastructure networks and resource reserves. Diverse quality is often referred to as 'Redundant'.	Folke, 2006 Holling, 1973 Resilience Alliance, 2009 Carpenter et al., 2001
Engaged	Inclusion emphasizes the need for broad consultation and engagement of communities, including the most vulnerable groups. Addressing the shocks or stresses faced by one sector, location, or community in isolation of others is an anathema to the notion of resilience. An inclusive approach contributes to a sense of shared ownership or a joint vision to build resilience. Engaged quality is often referred to as 'Inclusive'.	Mayunga, 2007 Nelson et al., 2007 Twigg, 2009
Flexible	Flexibility implies that systems can change, evolve and adapt in response to changing circumstances. This may favour decentralised and modular approaches to infrastructure or ecosystem management. Flexibility can be achieved through the introduction of new knowledge and technologies, as needed. It also means considering and incorporating indigenous or traditional knowledge and practices in new ways. Flexible quality is often referred to as 'adaptive'.	Berkes, 2007 Manyena, 2006 Mayunga, 2007 Nelson et al., 2007 Osbahr, 2007 Ostrom, 2009
Reflective	The systems that are reflective accepts the prevalent uncertainty and change. They have mechanisms to evolve continuously and will modify standards and norms based on emerging events, rather than seeking permanent solutions based on status quo. Therefore, the systems learn from their past experiences, and leverage this learning to inform future decision making. Reflective quality is often referred to as 'aware of uncertainty and change'.	Berkes, 2007 Folke, 2006 Holling, 1973 Rockefeller Foundation, 2009
Resourceful	Resourcefulness implies an ability to rapidly find different ways to achieve their goals or meet their needs during a shock or when under stress. This may include investing in capacity to anticipate future conditions, set priorities, and respond, for example, by mobilising and coordinating wider human, financial and physical resources. Resourcefulness is instrumental to restore functionality of critical systems, potentially under severely constrained conditions. Resourceful quality is often referred to as 'Effective'.	Cutter et al., 2008 Twigg, 2009 Holling, 1973
Strong	Robustness incorporates the concept of reliability and refers to the ability to absorb and withstand disturbances and crises, without significant damage or loss of function. Strong quality is often referred to as 'Robust'.	Béné et al., 2012 Twigg, 2009

3.7. Proposed Structure for National Disaster Resilience Measurement

The dissertation proposes PINE - the structure for national disaster resilience measurment - shown in Figure 3.7. The middle layer represents the four domains of systems within a country. The outer layer represents the seven qualities of resilient systems.

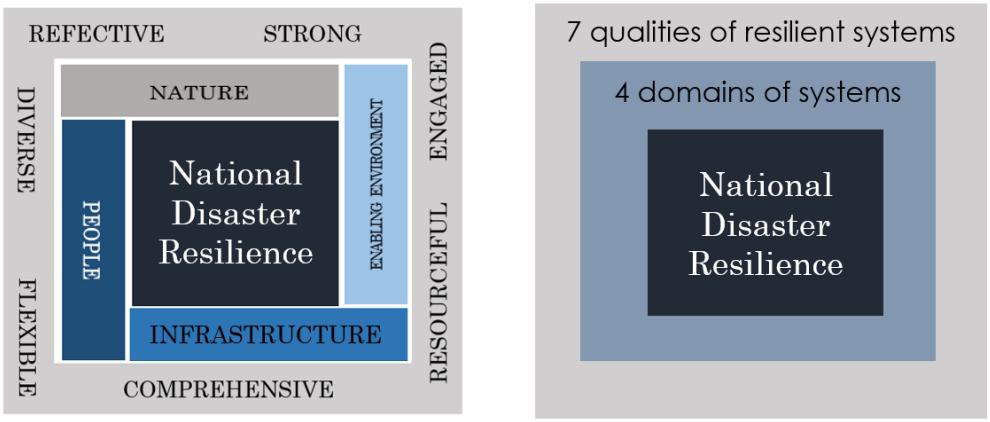


Figure 3.7 Proposed structure for national disaster resilience measurement (PINE)

Given that a country's systems are varied and that a country's systems can be classified in different themes, this research proposes a classification of systems within a country into four domains: People, Infrastructure, Nature, and Enabling Environment (represented by the acronym PINE).

People domain represents country's human capital and aspects that support human development. It catches distinctive sustenance that empowers the people of a country, including (1) education that equips people with soft power to achieve life objectives, (2) livelihood that portrays people's quality of life in terms of physical and mental strength, and (3) employment where it represents human security, sources of income, and career opportunity in terms of training. This domain is based on the fact that the strength of people in terms of knowledge, skills, health, and physical ability, is an important asset in building national disaster resilience. They also determine the level of disaster resilience.

Infrastructure domain discusses built-in, physical, tangible and intangible infrastructure. Traditionally, infrastructure is often referred to as the built environment, which comprises hard structures, e.g. e.g. buildings, dams, and bridges, as well as lifelines such as communication facilities, electricity, transport systems, water supplies. Yet, in a more intangible sense, infrastructure includes managerial skills of unexpected events, shocks, hazard events, or disasters. This domain is developed based on the fact that infrastructure is essential elements for proper functioning of a country. Critical infrastructure also ensures that a country have resources and support arrangements in case of disasters.

Nature domain discusses environmental health and eco-system strength. It covers stocks of national assets from which resource flows and services essential for livelihoods are derived. Such resources include forest, biodiversity, marine abundancy, and minerals. It also includes environmental health, and national regulations regarding ecological management and preservation. This domain is formed based on the positive relationship between nature and disaster resilience.

Enabling Environment domain facilitates actors and participants in a country to involve in development processes in a sustained, efficient, and effective manner. Enabling environment is different from infrastructure in the sense that enabling environment reflects elements that comes from main institutions of a country, e.g. governance, legislation and socio-economics, that are the product of interactions between civil society and governmental bodies, and that helps people to achieve their optimal goals. Whereas, infrastructure is what the government provides for its people.

This domain is formed based on the fact that enabling environment allows people to draw on resources in their countries to increase the likelihood to address disaster concerns, as well as increase the level of preparedness and ability to take protective measures. In socio-economic terms, this denotes financial resources that people use to support their well-being and livelihoods, increase the ability to absorb disaster impacts, and speed up the recovery process. In terms of governance, it allows people to express freely. People voices are heard and translated into feedback for betterment. Control of corruption and government effectiveness play an important role in time of emergency. It brings about timely response, and fast recovery. In terms of efficient legislation, it create a levelled environment for competitiveness, orderly society, and security of a country.

In terms of qualities of a resilient system, the research echoes the seven areas of convergence found in literature. In Table 3.5, it is the seven qualities of a resilient systems with summarized explanation bullets:

Table 3.5 Seven qualities summarized in explanation bullets

Qualities	Explanations
1. Comprehensive	• Bringing together systems and institutes • Catalysing additional benefits as resources are shared and collective actions are enabled to achieve greater ends.
2. Diverse	• Being spare capacity purposely created to accommodate disruption, extreme pressures or surges in demand • Having multiple ways to achieve a given need or fulfil a particular function
3. Engaged	• Having 'many seats at the table' for broad consultation • Contributing to a sense of shared ownership or a joint vision to build resilience
4. Flexible	• Being willing to adopt alternative strategies in response to changing circumstance or sudden crises • Flexibility can be made through introducing new technologies and knowledge, as well as incorporating traditional practices in new ways. • Favouring decentralization
5. Reflective	• Being aware of prevalent uncertainty and change • Having mechanisms to evolve continuously based on emerging events, rather than status quo • Having an ability to learn from the past, and leverage the learning to inform future decision making
6. Resourceful	• Having an ability to rapidly recognise alternative ways to use resources at time of crisis • Having an ability to anticipate future conditions, set priorities and respond. • Being instrumental to restore functionality of critical systems, potentially under severely constrained conditions
7. Strong	• Being well-conceived, well-constructed, and well-managed • Making provision to ensure failure is not disproportionate to the cause • Having an ability to absorb and withstand disturbances without significant damage or loss of function

CHAPTER 4
DEVELOPING AN APPROACH FOR NATIONAL DISASTER RESILIENCE MEASUREMENT

4.1. Introduction

In this chapter, the utilization of indicators and indices is discussed as an instrument to assess national disaster resilience. Its emphasis is on the significance and utilization of indicators and indices and the challenge emerging from creating and applying them. Then, it outlines an analytical framework where indicators for measuring national disaster resilience were shortlisted and selected, and summarizes the final set of indicators. Last, the methods used in aggregating and validating the indicators are discussed.

National disaster resilience is a highly flexible and multifaceted concept that has many underlying factors. Therefore, developing a comprehensive instrument to evaluate national disaster resilience, which represents its related elements and dimensions, is challenging. At present, there is no settled methodological procedure in theories and past literature to assess national disaster resilience. As discussed in the previous chapters, a comprehensive way to measure national disaster resilience should discuss resilience capacities within a system. Furthermore, the literature on disaster resilience suggests that a fruitful approach for measuring national disaster resilience is to assess various forms of systems. This research has identified the four domains of systems: People, Institution, Nature, and Enabling Environment. This chapter discusses how these systems are employed to assess national disaster resilience with respect to the three resilience capacities (absorptive coping, adaptive, and transformative) and how to form a national disaster resilience index.

4.2. Indicators as Proxies of Disaster Resilience

The utilization of indicators and indices in sociology-related research has significantly gained popularity. Especially in the disaster research, there are now a number of set of indicators and system of indices, which are currently being utilized. The increasing number of goals and objectives under inter-governmental frameworks for developmental sustainability, which extends to disaster risk management and climate change, signifies the necessity to develop an ability to evaluate progress. A set of seven global targets was agreed on at the World Conference on Disaster Risk Reduction in Sendai in March 2015. The UN Sustainable Development Goals were adopted in

September 2015; and new targets for reduction of greenhouse gas emissions under the UN Framework Convention on Climate Change (UNFCCC) are expected to be adopted at the end of this year. Without a way to assess movement toward these targets, these global initiatives lose credibility, but more importantly, the interventions and proactive actions beneficial to human and world's sustainable development may not be strategically implemented.

The usage of indicators and indices have been embraced by various scientists in various fields for different purposes. There is no universally accepted definition of an indicator. Generally, an index is composed of several different indicators combined together using some mathematical formulae to give a single value called an index. Indicators are a standout amongst the most-utilized forms of monitoring progress. The key to good indicators is credibility rather than volume of data or precision in measurement. Sandhu-Rojon (2003) argues that a quantitative observation is no more inherently objective than a qualitative observation, but suggests that large volumes of data can bring confusion rather than focus. It is more helpful to have approximate answers to a few important questions than to have exact answers to many unimportant questions (Spearman and McGray, 2011). **Underlying this is the important question of how many indicators are necessary to accurately tell a story of resilience. Furthermore, what can be done when no information is available for the most important indicators? These are major questions that need to be considered in the development of measurement framework.**

Another important dimension of indicators is the type of indicators that are being collected. This is because indicators can measure inputs, processes, outcomes, or outputs; and the distinction matters. The distinction between the various types of indicators is able to bring to the attention of both developers and users of resilience frameworks what type of information can be extracted from different types of questions and indicators. This offers a more nuanced and informed approach because it makes it clear that there are different dimensions of resilience.

Furthermore, there is not a single group of indicators that represent and discuss all policy perspectives. Indicators are designed to give information that will help executives make better choices and eventually improve resilience, but will not provide answers alone. It often appears easier to interpret composite indicators than to identify common patterns across different individual indicators, and they have also proven

beneficial in benchmarking level of ability or performance among countries (Saltelli, 2007). However, composite indicators can send misleading policy messages if they are poorly constructed or misinterpreted. Their "big picture" results might welcome decision-makers to draw oversimplified analytical or policy conclusions. Hence, indicators must be seen as a method for starting debates and raising public interest.

A lack of consensus regarding the usability and potential of numerical indicators to successfully measure resilience has led to debates. Levine and Mosel (2014) proposes that numerically measuring resilience is impractical, highlighting that resilience cannot be measured as a 'singular entity' because of the various degrees of threat or risk to which individuals are exposed. However, despite these limitations, the use of indicators and indices has continued to grow mainly because of the following advantages;

1. If they are properly constructed, indices can be an effective communicative and planning instrument, and utilized effectively to compare performance and progress over space and time.
2. Indices provide the big picture. They can be simpler to translate than trying to find a pattern in many different individual indicators. They encourage ranking on complex issues.
3. Indices can be used to summarize complex or multi-dimensional issues, in view of supporting decision-makers.
4. Indices can help attract public enthusiasm by giving a summary figure that can compare the performance across communities and their progress over time.

4.3. Constructing composite indicators of national disaster resilience

It is significant and helpful to evaluate the conditions that prompt national resiliency and the country's performance regarding its comparative national disaster resilience. Composite indicators are one of the viable ways to achieve the objective. In this research, composite indicators are utilized to designate individual variables to produce a national disaster resilience index.

There are a limited number of resilience measurements that utilize composite indicators at the national scale. On the contrary, at the sub-national scales there are a number of frameworks attempting to evaluate resilience. Among those efforts are metrics created to assess the susceptibility of small states to fluctuations within international economies (Briguglio 1995; Easter 1999) and indicators designed to measure national wellbeing (Neumayer 2001; Prescott-Allen 2001). Also significant are

composite indicators of social vulnerability to natural or technological hazards. Cutter et al.'s Social Vulnerability Index (SoVI) is perhaps the most well-known and widespread example (Cutter et al., 2003). Additional indices that focus explicitly on aspects of social vulnerability include the Prevalent Vulnerability Index (Cardona, 2005), and World Risk Index.

Development of a composite index is a systematic procedure. These steps include: (1) Developing a framework for indicator selection; (2) Identifying and developing relevant indicators; (3) Standardizing indicators to allow comparisons; (4) Weighting indicators and groups of indicators; and (5) Validating the index.

4.4. Framework for indicator selection

The objective of choosing indicators is to make sure that the chosen indicators are on point, measurable, and most importantly discuss the concept that the measurement intends to measure (Nardo et al., 2008). Table 4.1 shows the theoretical framework or matrix that was used as a guide to achieve this goal. The framework represents a matrix of 3x4 cells. In total there are twelve cells which represent 3 capacities and 4 domains of systems. The columns of the framework represents the domains of systems while the rows represent the 3 capacities of a resilient country.

Based on this indicator selection framework, disaster resilience indicators were chosen by identifying the four domains of systems and the three capacities of resilience. The initial step was to recognize the related components of each resilience capacities. Then, the second step was to identify indicators for each system domain that are relevant to undertake each activity under each capacities. In the framework, these indicators are represented by the word *indicator 1 to x*. These indicators will be discussed in detail in the next section.

Generally, this cross-classification technique is helpful to distinguish exceptional components of a country's domains of systems essential to undertaking activities of each resilience capacities. In addition, the cross-classification technique guaranteed content validity of the chosen indicators. This research takes a more theoretically driven approach by first identifying elements relevant to each resilience capacities and then indicators from each domain of systems. In other words, the technique used in this research constructs the overall national disaster resilience index from the ground influenced by both theoretical and empirical decisions. The final

selection will be crosschecked with the resilience elements identified and implied by actual disaster-related events.

Table 4.1. Framework for indicator selection

Resilience capacities	PINE Domains			
	People	Infrastructure	Nature	Enabling Environment
1. Absorptive coping capacity Definition: The ability to prepare for, mitigate or prevent the impacts of negative events using predetermined coping responses in order to preserve and restore essential basic structures and functions.	*Indicator 1 to Indicator x*	*Indicator 1 to Indicator x*	*Indicator 1 to Indicator x*	*Indicator 1 to Indicator x*
2. Adaptive capacity Definition: The ability to adjust, modify, or change its characteristics and actions to moderate potential, future damage and to take advantage of opportunities, all in order to continue functioning without major qualitative changes in function or structural identity.	*Indicator 1 to Indicator x*	*Indicator 1 to Indicator x*	*Indicator 1 to Indicator x*	*Indicator 1 to Indicator x*
3. Transformative capacity Definition: The ability to create a fundamentally new system when ecological, economic or social structures make the existing system untenable.	*Indicator 1 to Indicator x*	*Indicator 1 to Indicator x*	*Indicator 1 to Indicator x*	*Indicator 1 to Indicator x*

Note: x is the number of indicators. The definitions of the three capacities are taken from Béné et al. in OECD (2014).

4.5. Selection of indicators

Apart from the framework for indicator selection presented in Table 4.1, this research reviewed twelve understandings on resilience, sixteen ongoing efforts in measuring resilience, and ninety-nine disaster-related events to identify resilience elements that signify or imply indicators relevant to national disaster resilience measurement. The selected indicators were crosschecked to make sure of their consistency with two international frameworks of disaster risk reduction and resilience enhancement: Hyogo Framework for Action (HFA) and Sendai Framework for DRR. Then, they were evaluated by data availability.

One of the critical elements of this research is the issue of data availability. Generally, the indicator selection was partly limited by the unavailability of data. Data for some potential indicators were not available or not easily accessible; for example, data on efficiency of land-use planning, insurance penetration, efficiency of emergency response teams. To make the matter worse, some of the data can only be obtained by conducting a field survey. In general, data for this research were obtained from a variety

of secondary and reliable sources and international organizations, mainly from World Bank, the United Nations, and World Economic Forum.

REVIEW			INCORPORATE		CHECK
12 resilience understandings /literature	16 ongoing efforts in measuring resilience (6 at national level & 10 at sub-national level)	disaster-related events	Hyogo Framework for Actions	Sendai Framework for DRR	data availability
Annex 1	Annex 2	Annex 3			

The review of resilience understandings and theories is discussed in Table 3.2., Chapter 3. The review over ongoing efforts in measuring resilience revealed that there are a limited number of frameworks directly discussing national disaster resilience. Therefore, the scope of the review had to expend to cover the ongoing efforts at sub-national level as to gain wider picture on methodology, frameworks, and indicator selection. Table 4.2 shows a summary matrix of elements derived from the study of 16 ongoing efforts in measuring resilience (for more details, refer to Annex 2). A preliminary set of indicators was selected; yet, the composure of the set was chiefly based on theories, not the reality.

Table 4.2. Matrix of Elements Derived from Ongoing Efforts in Resilience Measurement

Name (Developer)	Objectives	Framework/Model	Components	Methodology			Data Sources	
				Quantitative Assessment	Qualitative Assessment	Participatory Method	Primary	Secondary
National Level								
1. AGIR[9] Results Framework (AGIR)	Assessing resilience in terms of food and nutritional vulnerabilities	4 food and nutritional security policies: 1) the CILSS Strategic Framework for Food Security; 2) the Agricultural Policy of the West African Economic, 3) the Common Agricultural Policy of the Economic Community of West African states, 4) the Policy on Disaster Risk Reduction, 5) the Labour and Employment Policy; and 5) the Humanitarian Policy	4 pillars: 1) strengthen and secure livelihoods & improve social protection, 2) strengthen nutrition, 3) sustainably strengthen agricultural and food productivity, and 4) strengthen the governance for food and nutritional security	○	×	×	×	○
2. Global Focus Model (UN/OCHA[10] & Maplecroft)	Assessing Risk and Vulnerability	Commercially available	4 scopes: 1) political, 2) economic, 3) social, and 4) environment	-	-	-	-	-
3. Country Resilience Rating (World Economic Forum)	Assessing resilience of countries to global risks with emphasis on economic terms	Resilience : Panarchy (System of systems)	4 components: robustness, redundancy, resourcefulness, response and recovery	○	○	Perception Surveys	○	○
4. Index for Risk Management (INFORM) (Inter-Agency Standing Committee Task Team for Preparedness and Resilience and the European Commission)	Assessing risk for humanitarian crisis and disasters	Risk = Hazard X Vulnerability X Lack of Coping Capacity	3 dimensions: 1) hazard & exposure (natural and human), 2) vulnerability (socio-economic and vulnerable groups), and 3) lack of coping capacity (Institutional & Infrastructure)	○	×	×	×	○
5. Indicators of Disaster Risk and Risk Management (Inter-American Development Bank)	Assessing disaster risk and risk management (Program for Latin America and the Caribbean)	Risk = Hazard X Vulnerability X Lack of Resilience	4 composite indicators: 1) Disaster Deficit Index, 2) Local Disaster Risk Index, 3) Prevalent Vulnerability Index, and 4) Risk Management Index	○	○	Perception Surveys	○	○
6. World Risk Index (WRI)	Measuring disaster risk value for 173 countries	Risk = Hazard X Vulnerability (Susceptibility, Coping, and	4 components: 1) exposure, 2) susceptibility, 3) coping capacities,	○	×	×	×	○

[9] Global Alliance for Resilience
[10] United Nations Office for the Coordination of Humanitarian Affairs

Name (Developer)	Objectives	Framework/Model	Components	Methodology			Data Sources	
				Quantitative Assessment	Qualitative Assessment	Participatory Method	Primary	Secondary
(UNU-EHS[11])		Adaptation)	and 4) adaptation					
Sub-national Level								
1. Baseline Resilience Indicators for Communities (BRIC) (University of South Carolina)	Measuring baseline or antecedent resilience at community level	Resilience of Place (DROP) model	4 sets of metrics: 1) social vulnerability, 2) Built Environment and Infrastructure, 3) Natural Systems and Exposure, and 4) Hazards Mitigation and Planning for Resilience	○	×	×	×	○
2. Community Based Resilience Analysis (CoBRA) (UNDP Drylands Development Centre)	Developing community-based resilience analysis and assessing resilience based on food and basic needs	context specific measurement framework	5 categories: 1) Physical, 2) Human, 3) Financial, 4) Natural, and 5) Social	○	○	Question-naire	○	○
3. DRLA/UEH Evaluation Resilience Framework for Haiti (Tulane University / University of Haiti)	Measuring the relationship between a shock, humanitarian assistance and resilience	DRLA/UEH Evaluation Resilience Framework, known as 'Haiti Resilience Impact and Change Model'	7 components: 1) wealth, 2) debt and credit, 3) coping behaviours, 4) human capital, 5) protection and security, 6) community networks, and 7) psychosocial status	○	○	Question-naire	○	○
4. FAO Resilience Tool (FAO[12])	Understanding the most effective combination of short and long term strategies for lifting families out of cycles of poverty and hunger and measuring households resilient to food security shocks	Rationale for measuring resilience to food insecurity	6 components: 1) assets, 2) income and food access, 3) access to basic services, 4) social safety, 5) adaptive capacity, and 6) stability	○	×	×	×	○
5. Livelihoods Change Over Time (LCOT) (Tufts University, Mekelle University)	Assessing ability to "bounce back" from major regional food security crises in Northern Ethiopia	Resilience trajectories, based on Frankenberger et al. (2012), and "poverty traps" framework	3 types of analysis: 1) household welfare over time, 2) food security dynamics, 3) poverty traps	○	○	Twice-a-year Survey	○	○
6. PEOPLES Resilience Framework (Multidisciplinary Center for Earthquake Engineering Research: MCEER)	Comprehensive measurement framework building upon MEERC R4 resilience framework and TOSE domain to assess resilience in a community	Extended R4 resilience framework	7 components: 1) population & demographics, 2) environmental & ecosystem, 3) Organized governmental services, 4) Physical infrastructure, 5) Lifestyle and community	○	×	×	×	○

[11] Institute for Environment and Human Security (EHS) of the United Nations University (UNU)
[12] Food and Agriculture Organization of the United Nations

Name (Developer)	Objectives	Framework/Model	Components	Methodology			Data Sources	
				Quantitative Assessment	Qualitative Assessment	Participatory Method	Primary	Secondary
			competence, 6) Economic development, and 7) social-cultural capital					
7. Resilience Capacity Index (RCI) (Network on Building Resilient Regions (BRR))	Gauging of a region's foundation for responding effectively to a future stress Assessing regional strengths and weaknesses in the US, and comparing their region's capacity profile to that of other metropolitan areas	Not given	3 components: 1) regional economic capacity, 2) socio-demographic capacity, and 3) community connectivity capacity	○	×	×	×	○
8. ResilUS (Western Washington University)	Prototyping simulation model of community resilience in U.S. in terms of disaster recovery from disasters; and operationalizing community resilience across multiple, hierarchical scales in relation to a range of policy and decision variables associated with each scale	Model of community capital resilience	5 components according to 5 elements of community capitals: 1) Physical, 2) Economic, 3) Socio-cultural, 4) Personal, and 5) Ecological capitals.	-	-	-	-	-
9. Risk Reduction Index (RRI) (DARA)	Measuring local perception on risk drivers (For Latin America and Western Africa)	Risk drivers, in line with HFA Priority for Action 4	4 components of risk drivers: 1) environment and natural resources, 2) socio-economic conditions, 3) land use and the built environment, and 4) governance	○	○	Question-naire	○	○
10. USAID resilience domain framework (USAID[13])	Developing matrix with a set of indicators for 3 objectives and the goal of increased resilience of chronically vulnerable populations and measuring community resilience	FAO resilience domain framework	6 domains: 1) income & food access, 2) assets, 3) adaptive capacity, 4) social capital and safety nets, 5) governance, and 6) nutrition and health	○	○	surveys	○	○

Note : This table is adapted, extended, and updated from UNDP's mapping the ongoing resilience measurement prepared by Winderl (2014).

[13] The United States Agency for International Development

Therefore, disaster-related hazard events were studied with two main purposes: 1) to identify resilience elements, and 2) to extract good and best practices as examples for countries to use to improve their levels of resilience. For an event included into the analysis, at least one of the following criteria was fulfilled: 10 or more people reported killed; 100 or more people reported affected; declaration of a state of emergency; call for international assistance; and/or proof of good practices verified by at least one international organization. Table 4.3. shows resilience elements identified from disaster-related events (for more details, refer to Annex 3).

Table 4.3. Resilience Elements Identified from Disaster-related Events

Categories	Resilience Identified	Supporting Cases
Preparedness	Early Warning System	• Comoros, Karthala Volcano Eruption, 2005 • Congo, Nyiragongo Volcano Eruption, 2002 • Haiti, Hurricane Jeanne, 2004 • International event, Indian Ocean Earthquake and Tsunami, 2004 (Indonesia, Sri Lanka, Thailand, India) • Italy, Etna Volcano Eruption, 2013 • Jamaica, Hurricane Ivan, 2004 • Philippines, Leyte island landslide, 2006 • Russia, North Ossetia Landslide, 2002
	Emergency Training	• Indonesia, Merapi Volcano Eruption, 2001-2003
	Experience Sharing	• Comoros, Karthala Volcano Eruption, 2005
	Level of awareness (Low level of normalization bias)	• Columbia, Galeras Volcano Eruption, 2002, 2006, 2008, 2009, 2010 • Indonesia, Merapi Volcano Eruption, 2001-2003
Emergency Response	Prompt and well-planned emergency response	• Afghanistan, Hindu Kush Earthquake, 2004 • Columbia, Galeras Volcano Eruption, 2002, 2006, 2008, 2009, 2010 • Congo, Nyiragongo Volcano Eruption, 2002 • Haiti, Hurricane Jeanne, 2004 • Indonesia, Merapi Volcano Eruption, 2001-2003 • Iran, Bam Earthquake, 2004 • Italy, Etna Volcano Eruption, 2013 • Jamaica, Hurricane Ivan, 2004 • Philippines, Leyte island landslide, 2006 • USA, Hurricane Katrina, 2005
	Timely Evacuation	• Afghanistan, Baghlan Earthquake, 2002 • Fiji, Hurricane Wallis and Futuna, 2010 (successful evacuation) • Indonesia, Merapi Volcano Eruption, 2001-2003 (Refuse of evacuate for fear of job availability) • Russia, North Ossetia Landslide, 2002 • Philippines, Leyte island landslide, 2006 (overcrowded & Refuse to evacuate) • Switzerland, Flood and landslide, 2005 (successful evacuation) • USA, New Orleans' Gustav Hurricane, 2008 (half-million people evacuation)
	Emergency Communication	• Afghanistan, Baghlan Earthquake, 2002 • Columbia, Galeras Volcano Eruption, 2002, 2006, 2008, 2009, 2010
Recovery	Recovery	• Haiti, Port-au-Prince Earthquake 2010 (2.3 million displaced people) • New Zealand, Christchurch Earthquake, 2011 (Vast structural damage as building weaken by 2010 earthquake) • USA, Hurricane Katrina, 2005
	Plans for secondary disasters	• El Salvador, San Miguel Earthquake, 2001 (Landslide) • Bolivia, Flood, 2004, 2008 (Communicable diseases) • India, Uttarakhand Monsoon, 2013 (Heavy Rain, Landslide & Flash flood) • Japan, Tohoku Earthquake and Tsunami, 2011 (Nuclear accidents) • Pakistan, Balochistan flood, 2005 (waterborne diseases) • Russia, North Ossetia Landslide, 2002 • USA, Hurricane Katrina, 2005 (Storms surge, Floods, Oil spill)

Categories	Resilience Identified	Supporting Cases
Infrastructure	Lifeline Facilities	• Congo, Nyiragongo Volcano Eruption, 2002 • Cook Islands, Cyclone Percy, 2004-2005 • El Salvador, San Miguel Earthquake & Landslide, 2001 (Drinking water & Sanitation) • Fiji, Hurricane Wallis and Futuna, 2010 (Lifeline facilities vastly destroyed) • India, Gujarat Earthquake, 2001 • Indonesia, Nias island landslide, 2001 • Japan, Tohoku Earthquake and Tsunami, 2011 • Pakistan, Kashmir Earthquake, 2005 • Philippines, Leyte island landslide, 2006 • Switzerland, Flood and landslide, 2005 • USA, Hurricane Katrina, 2005 (Roads, Electricity) • USA, Hurricane Sandy, 2012 (Electricity)
	Hospitals Capacity	• Italy, Stromboli Volcano Eruption, 2001-2002 • Iran, Bam Earthquake, 2004 (90% of hospital destroyed)
Governance	Government Effectiveness. Good Governance.	• Columbia, Galeras Volcano Eruption, 2002, 2006, 2008, 2009, 2010 • Comoros island, Karthala Volcano Eruption, 2005 • Congo, Nyiragongo Volcano Eruption, 2002 • Dominican Republic, Haiti flood, 2007, 2015 (lack of government finance) • Pakistan, Balochistan flood, 2005 • Philippines, Leyte island landslide, 2006 (corruption) • Russia, North Ossetia Landslide, 2002 (lack of government finance) • Switzerland, Flood and landslide, 2005
	Political Stability	• Afghanistan, Baghlan Earthquake, 2002
	Fast government procurement	• South Africa, flood, 2008
Law Enforcement	Efficient law enforcement	• Philippines, Leyte island landslide, 2006
Environment	Animal and endangered species protection	• Congo, Nyiragongo Volcano Eruption, 2002
	Environmental Protection	• Dominican Republic, Haiti flood, 2007, 2015 • Indonesia, Nias island landslide, 2001 (Illegal logging) • Philippines, Leyte island landslide, 2006 (Deforestation) • USA, Hurricane Katrina, 2005
	Water management	• Pakistan, Balochistan flood, 2005 • Suriname, flood, 2013
	Waste Management	• Suriname, flood, 2013
	Vulnerable Group: Tourists	• Italy, Stromboli Volcano Eruption, 2001-2002 • Indonesia, Merapi Volcano Eruption, 2001-2003
	Financial Support (from the government)	• Columbia, Galeras Volcano Eruption, 2002, 2006, 2008, 2009, 2010 • Indonesia, Merapi Volcano Eruption, 2001-2003
Mitigation Policies	Building code (Seismic Design Code	• Afghanistan, Baghlan Earthquake, 2002 (House damage) • China, Great Sichuan Earthquake, 2008 (Massive Destruction) • Iran, Bam Earthquake, 2004 (Mud brick construction) • Japan, Northern Japan, 2008 (Best Practice – No death reported) • Morocco, Earthquake, 2004 (Traditional house damage) • New Zealand, Christchurch Earthquake, 2011 (Vast structural damage as building weaken by 2010 earthquake) • Pakistan, Balochistan flood, 2005 (mud-bamboo-chatee house) • Pakistan, Kashmir Earthquake, 2005 • Turkey, Bingol Earthquake, 2013 (Traditional Himis buildings) • USA, Hurricane Sandy, 2012 (Roof blown off)
	Dam, Dyke reinforcement	• Pakistan, Balochistan flood, 2005 • Siberia, Yukutsk flood, 2001
	Well urban planning	• El Salvador, San Miguel Earthquake & Landslide, 2001 (Pushing the poor to risky areas) • Iran, Bam Earthquake, 2004 • Philippines, Leyte island landslide, 2006

Through the study of disaster-related events, the following bullets were observed and they directed to the need to add an indicator that discusses disaster management in the analysis.

- Disaster management is highly important for a country to deal with a hazard event and directly affects the level of resilience. It is essential to consider every elements of the disaster management cycle, including mitigation, preparedness, response, and recovery.
- Lifeline facilities does not only provide means to increase public livelihood, but also facilitates actions during emergency. For example, after the Kashmir Earthquake, the affected areas were located in the mountain where there was no connecting road, therefore, making rescue and evacuation difficult.
- These resilience elements match the elements derived from the review over theories. There are available indicators that discuss Lifeline facilities, good governance, and law enforcement; however, none discusses disaster management.

Since measuring disaster management concerns primary data collection and its concept is difficult to quantify, Hyogo Framework for Action (HFA) is the only resource that discusses aspects of disaster management. Therefore, this dissertation attempted to relate the resilience elements from disaster-related events to HFA especially its monitoring mechanism that comes in the form of self-assessment questions. The findings (Table 4.4.) include 1) HFA fills the gap of disaster management where there is no indicator to discuss, 2) its monitoring mechanism supplies primary data equivalent to those received from questionnaire, and 3) it can be used as disaster management index. As a result, HFA is utilized as part of the national disaster resilience.

Table 4.4. Resilience Identified from Disaster-related Events in Relation to HFA Monitor

Categories	Resilience Identified	Hyogo Framework for Actions (HFA) Monitor		
		Priorities	Core Indicators	Questions
Preparedness	Early Warning System	2. Identify, assess and monitor disaster risks and enhance early warning	3. Early warning systems are in place for all major hazards, with outreach to communities	Do risk prone communities receive timely and understandable warnings of impending hazard events?
		5. Strengthen disaster preparedness for effective response at all levels	1. Strong policy, technical and institutional capacities and mechanisms for disaster risk management, with a disaster risk reduction perspective are in place	Are future disaster risks anticipated through scenario development and aligned preparedness planning?
	Experience Sharing. Learning from the past	3. Use knoweldge, innovation and education to build a culture of safety and resilience at all levels	1. Relevant information on disasters is available and accessible at all levels, to all stakeholders	Is there a national disaster information system publicly available?
			2. School curricula, education material and relevant trainings include disaster risk reduction and recovery concepts and practices	Is DRR included in the national educational curriculum?
			3. Research methods and tools for multi-risk assessments and cost Bénéfit analysis are developed and strengthened	Is DRR included in the national scientific applied-research agenda/budget?
			4. Countrywide public awareness strategy exists to stimulate a culture of disaster resilience, with outreach to urban and rural communities	Do public education campaigns for risk-prone communities and local authorities include disaster risk?
	Financial Support (from the government)	1. Ensure that disaster risk reduction is a national and local priority with a strong institutional basis for implementation	3. Community participation and decentralization are ensured through the delegation of authority and resources to local levels	Do local governments have legal responsibility and regular / systematic budget allocations for DRR?
		5. Strengthen disaster preparedness for effective response at all levels	3. Financial reserves and contingency mechanisms are in place to support effective response and recovery when required	Are financial arrangements in place to deal with major disaster?
Emergency Response	Prompt and well-planned emergency response	5. Strengthen disaster preparedness for effective response at all levels	1. Strong policy, technical and institutional capacities and mechanisms for disaster risk management, with a disaster risk reduction perspective are in place	Are there national programmes or policies for disaster preparedness, contingency planning and response?
				Are future disaster risks anticipated through scenario development and aligned preparedness planning?
	Timely Evacuation Emergency Communication		2. Disaster preparedness plans and contingency plans are in place at all administrative levels, and regular training drills and rehearsals are held to test and develop disaster response programmes	Are the contingency plans, procedures and resources in place to deal with a major disaster?
			4. Procedures are in place to exchange relevant information during hazard events and disasters, and to undertake post-event reviews	Has an agreed method and procedure been adopted to assess damage, loss and needs when disasters occur?
Recovery	Recovery	1. Ensure that disaster risk reduction is a national and local priority with a strong institutional basis for implementation	2. Dedicated and adequate resources are available to implement disaster risk reduction plans and activities at all administrative levels	What is the ratio of the budget allocation to risk reduction versus disaster relief and reconstruction?
		4. Reduce the underlying risk factors	5. Disaster risk reduction measures are integrated into post-disaster recovery and rehabilitation processes	Do post-disaster programmes explicitly incorporate and budget for DRR for resilient recovery?
Infrastructure	Lifeline Facilities Hospitals Capacity	5. Strengthen disaster preparedness for effective response at all levels	1. Strong policy, technical and institutional capacities and mechanisms for disaster risk management, with a disaster risk reduction perspective are in place	Are there national programmes or policies to make schools and health facilities safe in emergencies?

In order to make the national disaster resilience most reflective the current standard of disaster resilience, the post-2015 framework for disaster risk reduction (Sendai framework) was also studied. Though the Sendai conference have just ended in 2015 with meaningful progress, its monitoring mechanism and indicators for success are still under development. The proposed architecture of indicator system for the post-2015 framework breaks resilience indicators into two levels: input and output levels (UNISDR, 2013, and 2014). For the input level, the focus is on strengthening the resilience of a country in different levels, the state, households, and business, covering 11 sectors as follow:

1. Disaster Risk Management Organization
2. Economics and Finance sector
3. Trade and investment sector
4. Public works or infrastructure sector
5. Energy sector
6. Housing and urban development
7. Agriculture and rural development
8. Social welfare sector
9. Education sector
10. Health sector
11. Employment sector

For the output level, the proposed indicators covers 6 following categories that cover three economic regions: household and community resilience, business resilience, and macro-economic resilience.

1. Economic and fiscal structure
2. Poverty and social vulnerability
3. Environmental degradation and climate change
4. Coping capacity
5. Urbanization
6. Governance

Through the observation of the post-2015 framework for disaster risk reduction, the following findings are used as inputs to be incorporated into this dissertation analysis.

- Data availability is a major challenge in measuring resilience. There is no available date or indicator that directly discuss aspects in the input level.

Therefore, the measurement will have to be in the form of self-assessment. In the output level also, a number of indicators will have to be developed to suit the measuring goals, e.g. financial market, insurance penetration, dependence on critical infrastructure.

- The majority of indicators reflects the school of thought that resilience comes from livelihoods, e.g. wealth distribution (GINI index), employment, GDP growth, access to infrastructure, ecosystem health, which has already incorporated in the national disaster resilience.

In summary, more than 100 indicators were identified. However, after being evaluated by data availability, only 66 indicators met the selection criteria and were classified according to domains and categories illustrated in Figure 4.1. Tables 4.4 to 4.7 presents the final set of selected indicators summarized by the 4 domains of systems. In total, there are 66 indicators representing four domains of systems. 58 indicators are individual indicators. The remaining 8 is high-level indicators having more than 10 sub-indicators.

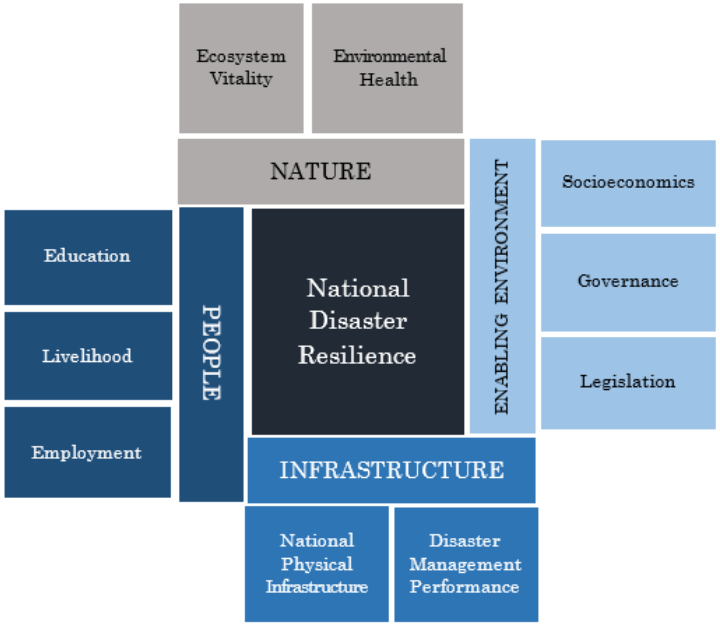


Figure 4.1. The final structure of PINE's national disaster resilience

Table 4.5. The final set of indicators used in the People domain

Indicators	Source
Category: Education	
1. Primary enrolment rate (%)	UNESCO
2. Secondary enrolment rate (%)	UNESCO
3. Tertiary enrolment rate (%)	UNESCO
4. Primary education attainment (% of population age 25+)	UNESCO
5. Secondary education attainment (% of population age 25+)	UNESCO
6. Tertiary education attainment (% of population age 25+)	UNESCO
7. Literacy rate, adult total (% of people ages 15 and above)	UNESCO
8. Quality of education system	WEF[14]
9. Quality of primary school	WEF
10. Quality of Math & Science	WEF
11. Quality of Management school	WEF
Category: Livelihood	
12. Life expectancy	WHO
13. Mortality rate: infant (per 1,000 live births)	WHO
14. Stunting and wasting (% in children under 5)	WHO
15. Unhealthy life years (% of life expectancy)	WHO
16. Death under 60 from non-communicable diseases (% of all NCD deaths)	WHO
17. Obesity (% of adults with BMI ≥30)	WHO
18. Survival gender gap	WEF
19. Healthcare quality	WEF
20. Healthcare accessibility	WEF
Category: Employment	
21. Labour force participation rate, (% of total population ages 15-64)	ILO[15]
22. Labour force participation rate, (% of total population ages 65 and above)	ILO
23. Unemployment rate (% of total labour force)	ILO
24. Country capacity to attract talent	WEF
25. Country capacity to retain talent	WEF
26. Ease of finding skilled employees	WEF
27. Firm level of technology absorption	WEF
28. Staff training	WEF
29. Training services	WEF
30. Capacity of innovation	WEF

Table 4.6. The final set of indicators used in the Infrastructure domain

Indicators	Source
Category: National Physical Infrastructure	
31. Access to electricity (% of population)	World Bank
32. Improved water source (% of population with access)	WHO
33. Improved sanitation facilities (% of population with access)	WHO
34. Quality of domestic transport	WEF
35. Hospital beds (per 1,000 people)	WHO
36. Physicians (per 1,000 people)	WHO
37. Mobile users (per 100 people)	ITU[16]
38. Internet users (per 100 people)	ITU
39. Fixed-telephone subscriptions (per 100 people)	ITU
40. Mobile-telephone subscriptions (per 100 people)	ITU
41. International Internet bandwidth (bit/s) per Internet user	ITU
42. Percentage of households with a computer	ITU
43. Percentage of households with Internet access	ITU
44. Percentage of individuals using the Internet	ITU
45. Fixed (wired)-broadband subscriptions (per 100 people)	ITU
46. Wireless-broadband subscriptions (per 100 people)	ITU
Category: Disaster Management Performance	
47. ✶Hyogo Framework for Action (22 indicators)	UNISDR

[14] WEF = World Economic Forum
[15] ILO = International Labour Organization
[16] ITU = International Telecommunication Union

Table 4.7. The final set of indicators used in the Nature domain

Indicators	Source
Category: Ecosystem Vitality	
48. ✶Ecosystem Vitality Covering 6 issues: 1) Climate and energy (3 indicators) 2) Biodiversity and habitat (4 indicators) 3) Fisheries (2 indicators) 4) Forests (1 indicator) 5) Agriculture (2 indicators) 6) Water resources (1 indicator)	Yale University
Category: Environmental Health	
49. Environmental Health Covering 3 issues: 1) Health impacts (1 indicator) 2) Air quality (3 indicators) 3) Water and sanitation (2 indicators)	Yale University

Note: ✶ = high-level indicator that contains more than 10 sub-indicators

Table 4.8. The final set of indicators used in the Enabling Environment domain

Indicators	Source
Category: Socioeconomics	
50. State of cluster development	WEF
51. Business and university R&D collaboration	WEF
52. Social safety net protection	WEF
53. Intellectual property protection an property rights	WEF
54. Social mobility	WEF
55. Age dependency ratio (% of working-age population)	World Bank
56. Gross savings (% of GDP)	World Bank
57. GDP growth	World Bank
58. Personal remittances, received (% of GDP)	World Bank
59. Ease of doing business	World Bank
60. GINI index	World Bank
Category: Governance	
61. ✶Control of Corruption	World Bank
62. ✶Voice & Accountability	World Bank
63. ✶Political Stability & Absence of Violence/Terrorism	World Bank
64. ✶Government Effectiveness	World Bank
Category: Legislation	
65. ✶Rule of Law	World Bank
66. ✶Regulatory Quality	World Bank

Note: ✶ = high-level indicator that contains more than 10 sub-indicators

4.6. Calculating the national disaster resilience scores

To calculate the national disaster resilience scores, there are three procedures: 1) scale adjustment of indicators, 2) normalization of indicators, and 3) aggregation of the PINE score. These three procedures are described below.

4.6.1. Scale adjustment of indicators

A scale adjustment of the selected indicators is the first task in calculating the sub-index scores and the total PINE score. From the numerical point of view, it is a significant step to do a scale change before performing the mathematical blend of

indicators in order to change the indicators to a common scale. Essentially, indicators ought to be adjusted to a common dimensional scale; for instance, number of deaths per live births. Indicators chosen for this research were adjusted by the size of population. The indicators were converted into either percentage or rate (per 1,000), dependant on the sort and unit of an indicator. This research chose the rate of per 1,000 on the grounds that this scale appeared reasonable as it avoids getting small fractions of numbers.

4.6.2. Normalization of indicators

Statistical data used to calculate indicators is taken from various sources in a variety of measuring units, such as dollars, miles, degrees, hours, and number of people. It is crucial to standardize or normalize them before they are combined into a composite index. In addition, indicators are normalized in order to avoid having extreme values dominate and also minimize the potential issues arisen from data quality. Above all, indicators are normalized or standardized to be able to compare them and see their distribution. Several methods have been suggested in the literature that can be used to standardize or normalize indicators such as Z-score, Minimum-Maximum, and Ranking. Each of these methods has its own advantages and disadvantages.

With the goal of this research, Z-score technique was utilized to normalize the selected set of indicators. Normalization (or Z-scores) converts indicators to a common scale with a mean of zero and standard deviation of one. Indicators with extreme value have a greater effect on the composite indicator. This may not be desirable because having a few extreme values may yield rewarding results. This effect can also be corrected in the aggregation methodology, e.g. by excluding the best and worst individual indicator scores from inclusion in the index or by assigning differential weights. However, this research uses Z-score which can be calculated by using the formula as follows:

$$\text{Z-Score} = \frac{Actual\ Value - Mean\ Value}{Standard\ Deviation}$$

The Z-score technique was used primarily because it is one of the most commonly used techniques, which mirrors its strong point in normalizing indicators. Additionally, the Z-score technique was favoured over different techniques since it converts all indicators to a common scale. In this way, the Z-score figures converted from different indicators with different measurement units can be directly compared because the Z-score does not express its original measuring unit. One of the key limitations of

other techniques, for example Minimum-Maximum, is that the scaling is based on range rather than standard deviation. Subsequently, extreme values can still have an effect on the overall index, and, hence, distort the results.

4.6.3. Aggregation of the PINE score

Aggregating data is highly of subjectivity. Keeping in mind that the goal is to deliver a single, one-dimensional ranking, all statistical data must be blended into small sets of indices. A commonly accepted technique on how to data aggregation should be conducted does not exist. Assigning a relative weight to aggregate indicators is highly subjective, unless weights are defined through a sophisticated analysis. Nonetheless, if weighting takes place at multiple levels, for instance in creating indicators and then a final index, the final result will be significantly distorted, potentially leading the reader to misinterpret the data (Jollands, Lermit, & Patterson, 2003; Simpson, 2006).

In this research two mathematical aggregation methods were used: The average method (AM) (based on equally weighted indicators) and the weight method (WM) (based on the number of indicators), see Figures 4.2 and 4.3.

Figure 4.2. The Average Method (AM)

Category (number of indicators)	Weight	Domain	Weight	
Education (11 indicators)	33%	People (30 indicators)	25%	PINE score of National Disaster Resilience
Livelihood (9 indicators)	33%			
Employment (10 indicators)	33%			
National Physical Infrastructure (16 indicators)	50%	Infrastructure (38 indicators)	25%	
Disaster Management Performance (22 indicators)	50%			
Ecosystem Vitality (13 indicators)	50%	Nature (19 indicators)	25%	
Environmental Health (6 indicators)	50%			
Socioeconomics (11 indicators)	33%	Enabling Environment (71 indicators)	25%	
Governance (✶4 high-level indicators)	33%			
Legislation (✶2 high-level indicators)	33%			

Note: ✶ = High-level indicator

Figure 4.3. The Weight Method (WM)

Category (number of indicators)	Weight	Domain	Weight	
Education (11 indicators)	36%	People (30 indicators)	19%	PINE score of National Disaster Resilience
Livelihood (9 indicators)	31%			
Employment (10 indicators)	33%			
National Physical Infrastructure (16 indicators)	42%	Infrastructure (38 indicators)	24%	
Disaster Management Performance (22 indicators)	58%			
Ecosystem Vitality (13 indicators)	68%	Nature (19 indicators)	12%	
Environmental Health (6 indicators)	32%			
Socioeconomics (11 indicators)	16%	Enabling Environment (71 indicators)	45%	
Governance (✶4 high-level indicators)	56%			
Legislation (✶2 high-level indicators)	28%			

Note: ✶ = High-level indicator. For the weight calculation purpose, a high-level indicator equals 10 indicators.

In order to determine which method is appropriate for this research, correlation analysis (r^2) was conducted to examine the degree to which the score is correlated with the external criteria and others scores from reliable sources. Here, vulnerability score of two sources are utilized – Index for Risk Management (INFORM) and World Risk Index (WRI) – based on the assumption that a resilient country is likely to have low level of vulnerability.

The results of these two methods appeared to be similar but not identical (see Annex 4 for the result comparison). ***The average method seemed to yield better results than the weight method; therefore, was used to calculate the sub-index and overall scores.*** Essentially, there are reasons that make the average method more relevant to use than the weight method:

1. The correlation analysis revealed that the average method has stronger correlation with the external criteria than the weight method from both sources.

Validity Items	Pearson's Correlation Coefficient Squared (r^2)	
	PINE-Average Method	PINE-Weight Method
Vulnerability (WRI)	0.885	0.827
Vulnerability (INFORM)	0.629	0.589

2. The average method assumes equal weights among underlying indicators. This seems reasonable because there is no theoretical reason to suggest that any of the domains is more important than the others.
3. The average method implies that all indicators are conceived as equally important in contributing to the generation of national disaster resilience.

4. The average method does not rule out the fact that not all factors are equal, and the need to develop a defensible weighting scheme is important. However, determining those relative weights is highly challenging.
5. Section 4.7.2. further compares the two methods in the correlation analysis using nine external factors including vulnerability. The result also points that the average method yield stronger correlations.

4.7. Validation of the index

The key objective of this section is to validate the PINE as a measurement structure of national disaster resilience. A measurement structure is valid if it achieves to measure what it is designed to measure and vice versa. (Babbie et al., 2003; Carmines and Zeller, 1979). There are many examples of validation which entail different methods and means to assess whether a measurement is valid or not. However, it is necessary to take note that in some areas validation methods are rather well-designed, in other areas such as social science, including the concept of resilience, that are still very much subjected to interpretations, the methods are not quite systematic or well-defined. With no particular focus on the areas, to a certain extent, the literature on index and measurement has pointed out that validation of an index is a multiplex procedure (Cutter and Finch, 2008; Vincent, 2004). The main reason for this difficulty comes mainly from the data availability. The empirical information significant to the validation purposes is not available or easily attained, or may require costly in-depth field surveys.

The validation of the PINE measurement as a national disaster resilience measurement was done by utilizing the content and construct validation methods. Content validation is mainly concerned with the question whether a measurement discusses the different elements, components or the domain with the theoretical framework that it has developed for. While, in general, construct validity is the degree to which a measurement relates to external variables within the close theoretical framework (Babbie, 2005; Carmines and Zeller, 1979). It is often based on the extent to which empirical results are consistent with logically or theoretically anticipated relationships among variables (Babbie, 2005). In other words, it simply comes to the question that 'do we see the correlations or relationship pattern (negative or positive) among the measurements of concepts anticipated by the literature. Furthermore, construct validation can be expanded by investigating the ability of the PINE scores to forecast potential expected disaster outcomes (deaths, losses, etc.) in order to determine its ability to account for these outcomes after controlling for other related measurement.

4.7.1. Content validation

Content validation is at times referred to the actual content of a measurement (Carmines and Zeller, 1979; Trochim, 2006), which, to the simplest end, means **whether or not the measurement appear to capture the theoretical concept**. Babbie (2005) has defined content validation as the extent to which a measurement covers the scope of meanings included within the concept. This element of content validation is sometimes referred to as sampling validation. In that the salient point is if the measurement addresses the conceptual or theoretical "sampling space" or the domain associated with the concept. For example, if a concept is intended to capture three dimensions of theoretical area, *x, y,* and *z,* then a measurement should also discuss *x, y*, and *z,* otherwise it does not achieve with respect to the sampling validation. Generally, content validation is evaluated by using a group of expert-raters to assess the different elements proposed to be used to measure a concept to determine whether the selected elements does indeed address the domain associated with the theoretical concept. Unfortunately, an expert-rating approach couldn't be utilized here because of limited resources and time. Ideally, as Babbie (2005) points out, content validation should be a guiding principle in the initial development of a measurement to make sure that all domains of the idea to be measured are incorporated into the measurement. Indeed, content validation has been utilized and has given directions to the development of the PINE measurement structure from the beginning, in the form of framework for indicator selection (Table 4.1).

Hence, the decision was made to make sure that the PINE measurement fully evaluates and discusses systems and indicators that are significant for undertaking activities associated with all three resilience capacities: absorptive coping capacity, adaptive capacity, and transformative capacity. In other words, the PINE measurement aims to put together the extensive range of elements and indicators related to national disaster resilience. In addition, the reason why this research uses the indicator selection framework was to make sure that indicators associated with all three resilience capacities and four domains of systems were chosen to be included in the measurement.

4.7.2. Construct validation

Construct validity is the extent to which a measurement relates to other variables as expected within a system of theoretical relationships (Babbie, 2005; Carmines and Zeller, 1979). It is often based on **the degree to which the results are predictable with sensible or hypothetical connections to external variables** (Babbie, 2005). In other words, the important part of this validation is the correlation pattern

between the outcome and the external factor of the close concepts. The key question is 'Do we see the relationship pattern (negative or positive correlations) between the measurement and the external variables within a close or same concept?' In particular, this validation aims at examining the ability to predict expected outcomes (e.g., death and losses) in order to determine its ability to account for these outcomes after controlling for other related variables.

Here, construct validation was assessed and evaluated by examining a relationship between the PINE scores and the following theoretically relevant measurement: 1) Vulnerability, 2) Disaster Risk, 3) Lack of coping capacity, 4) Number of death: This is the number of people who lost their life because the disaster event happened, and 5) Estimated Damage: This is the amount of damage to property, crops, and livestock, given in US$ ('000), and corresponding to the damage value at the moment of the event.

1) to 3) are elements taken from the 2 reliable index sources, namely, Index for Risk Management (INFORM), and Work Risk Index (WRI). 4) and 5) are 10-year averaged statistics collected from EM-DAT from 2004-2014. The theoretical expectations of the relationship between the external criteria and the PINE scores were as follows:

- ***A disaster resilient country is more likely to have a low level of vulnerability.*** Several studies have pointed out that the concept of social vulnerability and disaster resilience have negative relationship (Buckle et al., 2001; Pelling, 2003). This expectation comes from disaster resilience activities that are more likely to reduce vulnerability, for example, hazard mitigation policies, early warning systems.
- ***A disaster resilient country is more likely to have a low level of disaster risk.*** Here, disaster risk means as shown in this pseudo-equation:

  $$\text{Disaster Risk} = f\left(\frac{Hazard \cdot Vulnerability}{Resilience\ (Capacities)}\right)$$

  This expectation is based on that resilience is capacities of a countries, which can reduce disaster risk. Therefore, there will be a negative relationship between PINE measurement and disaster risk.
- Based on the same thinking of disaster risk, ***a disaster resilient country is more likely to have a low level of 'lack of coping capacity'.*** Therefore, there will be a negative relationship between PINE measurement and 'lack of coping capacity.

- ***A disaster resilient country is more likely to experience a low number of death.*** In other words, there should be a negative relationship between PINE measurement and number of disaster-related deaths. This is expected because disaster resilient countries should be more likely to have effective hazards mitigation, disaster preparedness, and disaster response plans, which should result in lower disaster-related deaths.
- ***Disaster resilient countries are more likely to suffer from lower levels of damage (% of GDP) due to disaster than less disaster resilient countries.*** There should be a negative relationship between PINE measurement and estimated damage. This is based on the fact that disaster resilient countries are more likely to take protective measures to reduce disaster damage.

To assess the validity, correlational analysis is used. A Pearson's product-moment correlation (correlation of zero-order) analysis was conducted to examine the degree to which the PINE measurement is correlated with the external criteria described above. The primary focus of this analysis is on the correlations between the PINE-Averaging Method (PINE-AM) and the external criteria; however the PINE-Weighting Method (PINE-WM) score is also included for comparison purpose. Table 4.9 and Figures 4.4 presents the results of correlations between the PINE scores and external criteria.

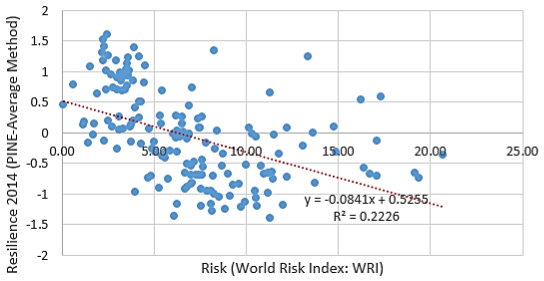
Table 4.9. Bivariate correlations between external criteria and PINE scores

Validity Items	PINE-AM		PINE-WM	
	PCC	r^2	PCC	r^2
1. Disaster risk (WRI)	-0.472	0.223	-0.446	0.199
2. Disaster risk (INFORM)	-0.796	0.634	-0.809	0.654
3. Vulnerability (WRI)	-0.941	0.885	-0.909	0.827
4. Vulnerability (INFORM)	-0.793	0.629	-0.768	0.589
5. Lack of coping capacity (WRI)	-0.932	0.868	-0.933	0.871
6. Lack of adaptive capacity (WRI)	-0.925	0.855	-0.887	0.787
7. Lack of coping capacity (INFORM)	-0.934	0.873	-0.930	0.865
8. Number of Death	-0.341	0.116	-0.304	0.093
9. Estimated damage (% of GDP)	-0.217	0.047	-0.209	0.044

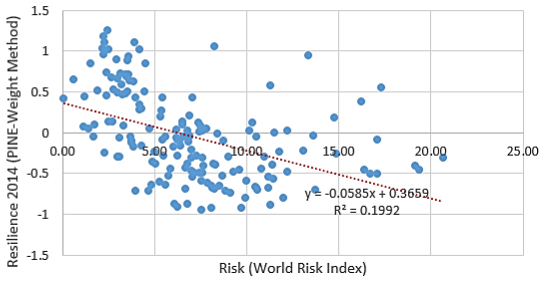
Note: PCC = Pearson's correlation coefficients, r^2 = Pearson's correlation coefficients squared

Figures 4.4 Comparison of PINE resilience score 2014 and external criteria

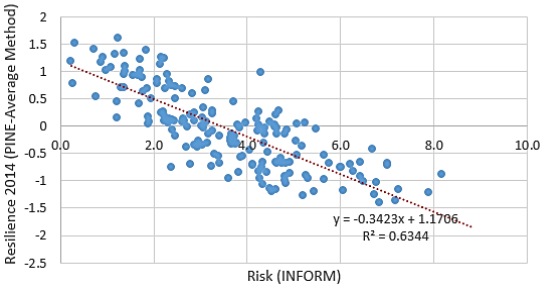
(a) Comparison: PINE-AM vs Risk (WRI)



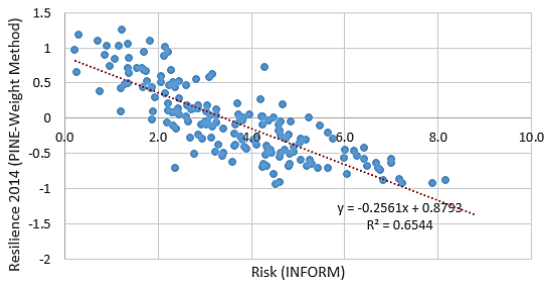
(b) Comparison: PINE-WM vs Risk (WRI)



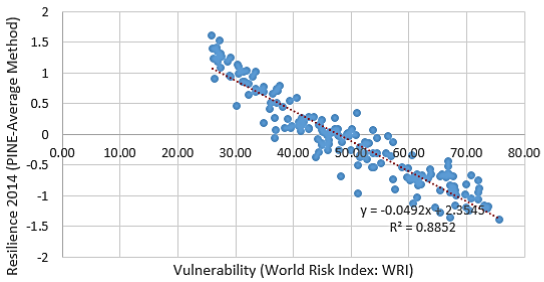
(c) Comparison: PINE-AM vs Risk (INFORM)



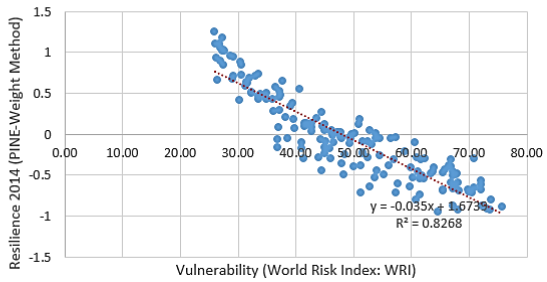
(d) Comparison: PINE-WM vs Risk (INFORM)



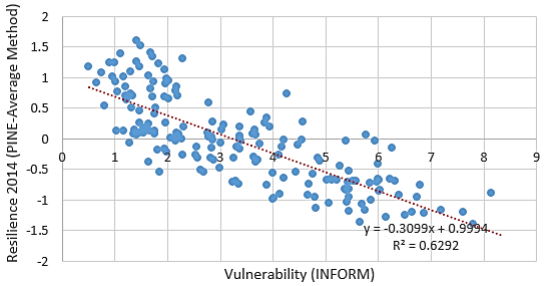
(e) Comparison: PINE-AM vs Vulnerability (WRI)



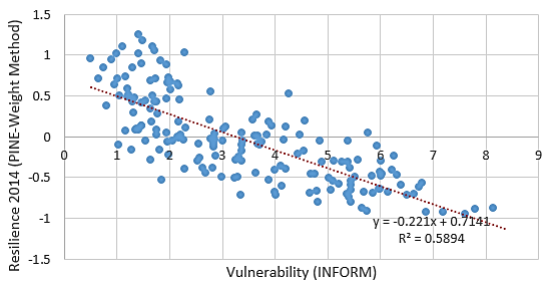
(f) Comparison: PINE-WM vs Vulnerability (WRI)



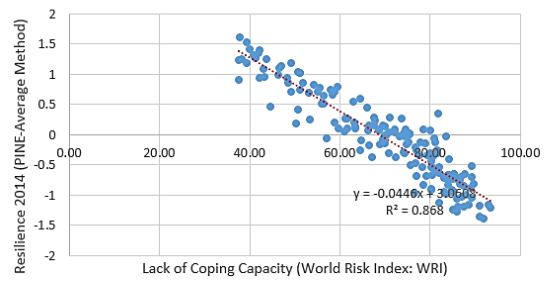
(g) Comparison: PINE-AM vs Vulnerability (INFORM)



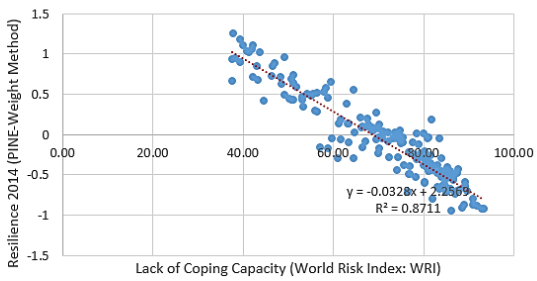
(h) Comparison: PINE-WM vs Vulnerability (INFORM)

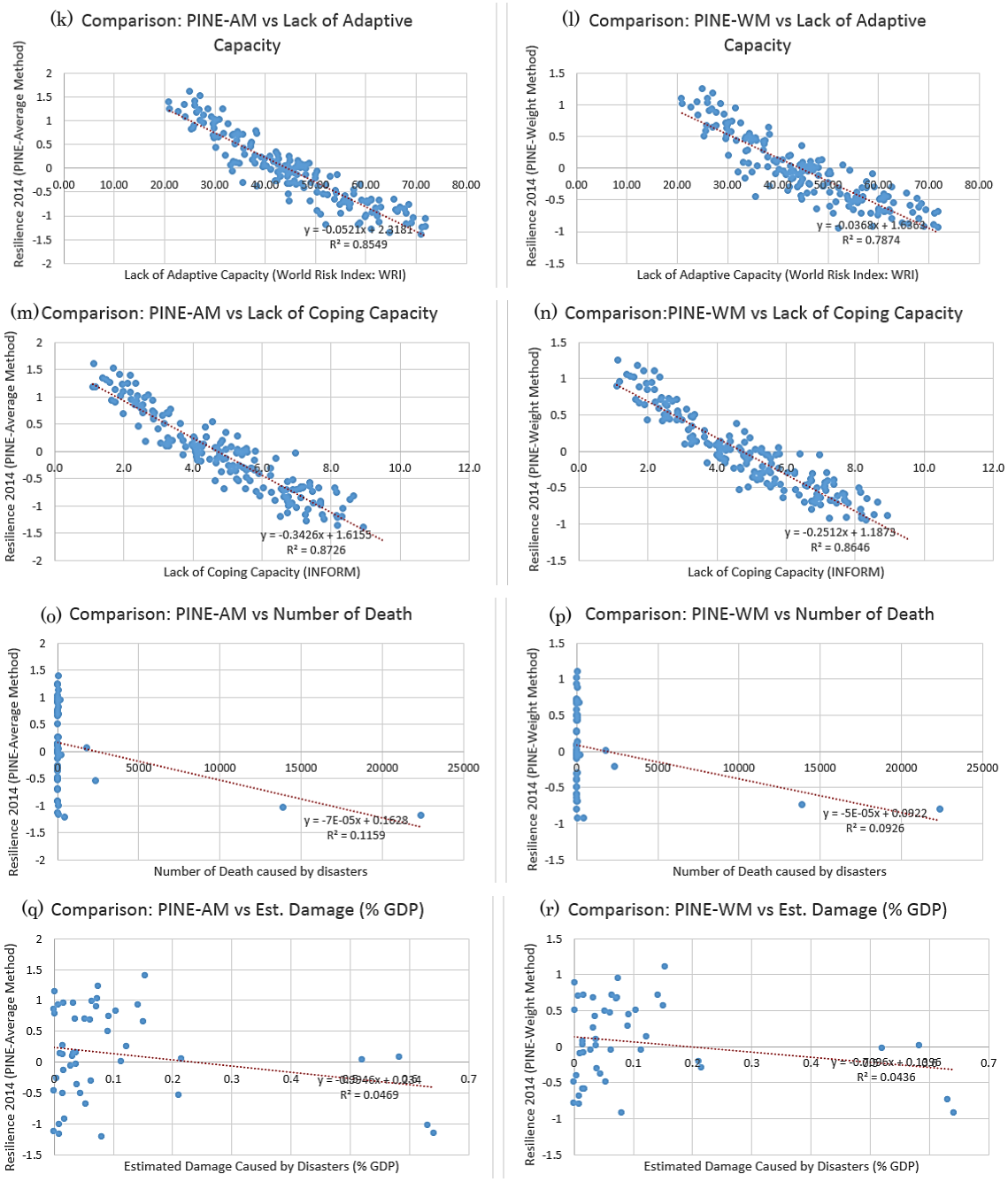


(i) Comparison: PINE-AM vs Lack of Coping Capacity



(j) Comparison:PINE-WM vs Lack of Coping Capacity





Consistent to the theoretical expectations, the outcomes show that all the external criteria inspected have statistically significant correlations with the overall PINE measurement. **The patterns of the correlations for the PINE measurement performed as predicted, although there are some variations with regard to the strength of the correlation.** On the whole, the significant statistical relationship suggests that the PINE measurement is indeed a valid measurement. The following findings are observed and can be summarized from this chapter's exercise.

- There is a negative correlation between the national disaster resilience score and vulnerability. This result suggests that countries that have high disaster resilience have low social vulnerability.
- There is a negative correlation between the national disaster resilience score and risk. This result is based on the school of thought that expands risk to include the element of capacities or resilience. Therefore, it suggests that countries that have high disaster resilience have low disaster risk. This correlation has been strengthened by the positive correlations between (1) national disaster resilience and coping capacity, and (2) national disaster resilience and adaptive capacity. These two capacities are two of the three resilience capacities. Where there is high coping and adaptive capacities, its disaster resilience is high.
- Despite the mild correlation, national disaster resilience has a negative correlation with the number of death and damage caused be disasters. This implies that disaster resilient countries are more likely to have effective disaster risk management. Therefore, it suggests that countries that has high disaster resilience has a low level of death and damage caused by disasters.

4.8. Study region and unit of analysis

The study region of this dissertation is global - **countries of the world**. This research uses the 193 UN members to represent the number of countries in the world. However, one of the critical elements of this research is the issue of data availability. There is no data for every countries, thus the number of countries for this research was adjusted to 123 countries alphabetically listed below.

1. Albania
2. Algeria
3. Argentina
4. Armenia
5. Australia
6. Austria
7. Azerbaijan
8. Bangladesh
9. Barbados
10. Belgium
11. Bhutan
12. Bolivia
13. Botswana
14. Brazil
15. Bulgaria
16. Burkina Faso
17. Burundi
18. Cambodia
19. Cameroon
20. Canada
21. Chad
22. Chile
23. China
24. Colombia
25. Costa Rica
26. Côte d'Ivoire
27. Croatia
28. Cyprus
29. Czech Republic
30. Denmark
31. Dominican Republic
32. Egypt
33. El Salvador
34. Estonia
35. Ethiopia
36. Finland
37. France
38. Germany
39. Ghana

40. Greece
41. Guatemala
42. Guinea
43. Guyana
44. Honduras
45. Hungary
46. Iceland
47. India
48. Indonesia
49. Iran
50. Ireland
51. Israel
52. Italy
53. Jamaica
54. Japan
55. Jordan
56. Kazakhstan
57. Kenya
58. Republic of Korea
59. Kuwait
60. Kyrgyzstan
61. Lao PDR
62. Latvia
63. Lithuania
64. Luxembourg
65. Macedonia FYR
66. Madagascar
67. Malawi
68. Malaysia
69. Mali
70. Malta
71. Mauritania
72. Mauritius
73. Mexico
74. Moldova Republic of
75. Mongolia
76. Morocco
77. Mozambique
78. Myanmar
79. Namibia
80. Nepal
81. Netherlands
82. New Zealand
83. Nicaragua
84. Nigeria
85. Norway
86. Pakistan
87. Panama
88. Paraguay
89. Peru
90. Philippines
91. Poland
92. Portugal
93. Qatar
94. Romania
95. Russian Federation
96. Rwanda
97. Saudi Arabia
98. Senegal
99. Serbia
100. Singapore
101. Slovakia
102. Slovenia
103. South Africa
104. Spain
105. Sri Lanka
106. Sweden
107. Switzerland
108. Tajikistan
109. Tanzania
110. Thailand
111. Trinidad and Tobago
112. Tunisia
113. Turkey
114. Uganda
115. Ukraine
116. United Arab Emirates
117. United Kingdom
118. United States of America
119. Uruguay
120. Venezuela
121. Viet Nam
122. Yemen
123. Zambia

CHAPTER 5
ASSESSING GLOBAL DISASTER RESILIENCE AND SPATIAL ANALYSIS

5.1. Introduction

The main purpose of the Chapter 5 is to assess national disaster resilience in the form of PINE scores with the goal of identifying which countries are comparatively more or less resilient in the world. The demonstration brings about two advantages: (1) information about the relative national disaster resilience of a country, as well as (2) confidence in the validity and usage of the PINE scores and the framework for national disaster resilience. Throughout the chapter, an emphasis is put on the national disaster resilience scores calculated by the average-method (PINE-AM).

5.2. PINE disaster resilience scores

5.2.1. PINE Scores by country

This section discusses the results of PINE disaster resilience scores in the study region. Reminding that in the aggregation of the PINE score, standardized scores or z-scores were used. Therefore, the scores are centred, having a mean of zero and positive scores indicate rankings **above** the mean and negative scores indicate rankings **below** the mean. Table 5.1 shows the 2014 PINE national disaster resilience score, trend, and the scores of the four domains, arranged in an alphabetical order. The following colour schemes are assigned to indicate the level of performance in each sections.

PINE	(-1.49) to (-0.38)	(-0.37) to 0.07	0.08 to 0.71	0.73 to 1.69

PINE 3 year trend	↗ Increasing resilience	→ Stable resilience	↘ Decreasing resilience

Table 5.1. The 2014 PINE score, and its trend

Country	Rank	PINE Score	PINE 3 yr. Trend
Albania	64	0.06	↘
Algeria	104	-0.72	→
Argentina	58	0.08	→
Armenia	45	0.31	↗
Australia	5	1.31	↗
Austria	11	1.15	→
Azerbaijan	67	0.03	↗
Bangladesh	105	-0.72	→
Barbados	50	0.21	↘
Belgium	21	0.89	↗
Bhutan	80	-0.21	→

Country	Rank	PINE Score	PINE 3 yr. Trend
Bolivia	83	-0.27	→
Botswana	89	-0.37	↘
Brazil	77	-0.16	↘
Bulgaria	41	0.49	↗
Burkina Faso	111	-0.89	→
Burundi	119	-1.17	→
Cambodia	100	-0.69	↘
Cameroon	98	-0.62	→
Canada	19	0.93	↗
Chad	123	-1.49	↗
Chile	38	0.60	↗

Country	Rank	PINE Score	PINE 3 yr. Trend
China	70	-0.01	↗
Colombia	71	-0.03	↘
Costa Rica	39	0.51	↘
Côte d'Ivoire	112	-0.90	↘
Croatia	42	0.48	↘
Cyprus	37	0.66	↗
Czech Republic	17	0.97	↗
Denmark	12	1.11	↗
Dominican Republic	72	-0.03	↗
Egypt	78	-0.16	→
El Salvador	75	-0.13	↘
Estonia	16	0.98	↗
Ethiopia	114	-0.98	→
Finland	2	1.40	↗
France	20	0.90	↘
Germany	23	0.87	→
Ghana	90	-0.37	↘
Greece	31	0.71	↘
Guatemala	85	-0.34	→
Guinea	117	-1.08	↘
Guyana	91	-0.38	↘
Honduras	94	-0.49	↘
Hungary	35	0.67	↗
Iceland	15	1.01	↗
India	97	-0.53	→
Indonesia	74	-0.07	→
Iran	84	-0.33	↗
Ireland	14	1.03	↗
Israel	32	0.69	↗
Italy	28	0.78	→
Jamaica	66	0.04	↗
Japan	9	1.17	↗
Jordan	56	0.10	↗
Kazakhstan	51	0.18	↗
Kenya	107	-0.73	↘
Korea (Republic)	22	0.89	↗
Kuwait	60	0.07	↗
Kyrgyzstan	79	-0.20	→
Lao PDR	106	-0.72	→
Latvia	33	0.68	↘
Lithuania	36	0.67	↘

Country	Rank	PINE Score	PINE 3 yr. Trend
Luxembourg	3	1.35	↗
Macedonia FYR	54	0.12	↗
Madagascar	115	-1.05	↘
Malawi	108	-0.76	→
Malaysia	52	0.16	↘
Mali	120	-1.29	↘
Malta	25	0.85	↗
Mauritania	121	-1.34	→
Mauritius	61	0.07	→
Mexico	68	0.03	↘
Moldova (Republic)	65	0.06	↗
Mongolia	82	-0.26	→
Morocco	93	-0.46	↗
Mozambique	102	-0.70	↘
Myanmar	118	-1.10	↘
Namibia	88	-0.36	→
Nepal	110	-0.80	↘
Netherlands	7	1.26	↗
New Zealand	10	1.17	→
Nicaragua	86	-0.35	↘
Nigeria	116	-1.07	→
Norway	4	1.32	→
Pakistan	109	-0.77	→
Panama	48	0.23	→
Paraguay	76	-0.15	↘
Peru	73	-0.03	→
Philippines	59	0.08	↘
Poland	29	0.75	↗
Portugal	24	0.87	↗
Qatar	40	0.51	↗
Romania	46	0.28	↗
Russian Federation	49	0.22	↗
Rwanda	103	-0.71	→
Saudi Arabia	53	0.15	↗
Senegal	101	-0.69	→
Serbia	43	0.43	↗
Singapore	6	1.30	↗
Slovakia	30	0.73	→
Slovenia	18	0.95	↗
South Africa	62	0.07	↗
Spain	26	0.80	↗

Country	Rank	PINE Score	PINE 3 yr. Trend
Sri Lanka	55	0.11	↘
Sweden	8	1.25	→
Switzerland	1	1.69	→
Tajikistan	96	-0.52	→
Tanzania	113	-0.91	↘
Thailand	69	0.03	↘
Trinidad and Tobago	57	0.09	↗
Tunisia	87	-0.35	↗
Turkey	47	0.25	↗
Uganda	99	-0.62	→

Country	Rank	PINE Score	PINE 3 yr. Trend
Ukraine	63	0.07	↗
United Arab Emirates	34	0.68	↗
United Kingdom	13	1.08	↗
United States of America	27	0.80	↗
Uruguay	44	0.36	→
Venezuela	92	-0.38	→
Viet Nam	81	-0.24	↘
Yemen	122	-1.42	↗
Zambia	95	-0.50	↘

Table 5.2 Countries grouped according to levels of disaster resilience

HIGH DISASTER RESILIENCE	MEDIUM DISASTER RESILIENCE
Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Estonia, Finland, France, Germany, Iceland, Ireland, Italy, Japan, Republic of Korea, Luxembourg, Malta, Netherlands, New Zealand, Norway, Poland, Portugal, Singapore, Slovakia, Slovenia, Spain, Sweden, Switzerland, United Kingdom, United States of America	Argentina, Armenia, Barbados, Bulgaria, Chile, Costa Rica, Croatia, Cyprus, Greece, Hungary, Israel, Jordan, Kazakhstan, Latvia, Lithuania, Macedonia FYR, Malaysia, Panama, Philippines, Qatar, Romania, Russian Federation, Saudi Arabia, Serbia, Sri Lanka, Trinidad and Tobago, Turkey, United Arab Emirates, Uruguay
LOW DISASTER RESILIENCE	**VERY LOW DISASTER RESILIENCE**
Albania, Azerbaijan, Bhutan, Bolivia, Botswana, Brazil, China, Colombia, Dominican Republic, Egypt, El Salvador, Ghana, Guatemala, Indonesia, Iran, Jamaica, Kuwait, Kyrgyzstan, Mauritius, Mexico, Republic of Moldova, Mongolia, Namibia, Nicaragua, Paraguay, Peru, South Africa, Thailand, Tunisia, Ukraine, Viet Nam	Algeria, Bangladesh, Burkina Faso, Burundi, Cambodia, Cameroon, Chad, Côte d'Ivoire, Ethiopia, Guinea, Guyana, Honduras, India, Kenya, Lao PDR, Madagascar, Malawi, Mali, Mauritania, Morocco, Mozambique, Myanmar, Nepal, Nigeria, Pakistan, Rwanda, Senegal, Tajikistan, Tanzania, Uganda, Venezuela, Yemen, Zambia

Note : Countries are listed in an alphabetical order.

5.2.2. PINE Scores in Rank

Before leaving the overall national disaster resilience scores, it might be illustrative to examine in more details the scores among 123 countries. Tables 5.3 presents the top 15 and bottom 15 countries of the 2014 PINE national disaster resilience.

Table 5.3. The list of Top and Bottom 15 of the 2014 PINE score

TOP 15				BOTTOM 15			
Rank	**Country**	**PINE**	**Trend**	**Rank**	**Country**	**PINE**	**Trend**
1	Switzerland	1.69	→	**109**	Pakistan	-0.77	→
2	Finland	1.40	↗	**110**	Nepal	-0.80	↘
3	Luxembourg	1.35	↗	**111**	Burkina Faso	-0.89	→
4	Norway	1.32	→	**112**	Côte d'Ivoire	-0.90	↘
5	Australia	1.31	↗	**113**	Tanzania	-0.91	↘
6	Singapore	1.30	↗	**114**	Ethiopia	-0.98	→
7	Netherlands	1.26	↗	**115**	Madagascar	-1.05	↘
8	Sweden	1.25	→	**116**	Nigeria	-1.07	→
9	New Zealand	1.17	→	**117**	Guinea	-1.08	↘
10	Japan	1.17	↗	**118**	Myanmar	-1.10	↘
11	Austria	1.15	→	**119**	Burundi	-1.17	→
12	Denmark	1.11	↗	**120**	Mali	-1.29	↘
13	United Kingdom	1.08	↗	**121**	Mauritania	-1.34	→
14	Ireland	1.03	↗	**122**	Yemen	-1.42	↗
15	Iceland	1.01	↗	**123**	Chad	-1.49	↗

5.2.3. PINE Scores by each domain

This section presents the scores of each of the four domains: people (P), infrastructure (I), nature (N), and enabling environments (E), shown in Table 5.4. In Tables 5.5 to 5.8, a list of Top and Bottom 15 of each of the four domains is illustrated. The following colour schemes are assigned to indicate the level of performance in each sections.

	Very Low	Low	Medium	High
People	(-2.49) to (-0.64)	(-0.63) to 0.08	0.09 to 0.90	0.91 to 1.76
Infrastructure	(-1.62) to (-0.37)	(-0.36) to 0.19	0.20 to 0.49	0.50 to 1.46
Nature	(-1.96) to (-0.60)	(-0.59) to 0.16	0.17 to 1.02	1.03 to 2.25
Enabling Environment	(-1.49) to (-0.36)	(-0.35) to (-0.04)	(-0.03) to 0.45	0.46 to 1.85

Table 5.4 2014 Scores of Each of the Four Domain

Country	P	I	N	E
Albania	0.00	0.15	0.25	-0.16
Algeria	-1.42	-0.52	-0.04	-0.89
Argentina	0.36	0.46	-0.07	-0.42
Armenia	0.50	0.21	0.67	-0.16
Australia	1.23	1.15	1.93	0.94
Austria	1.31	0.80	1.68	0.83
Azerbaijan	0.04	0.19	0.29	-0.39
Bangladesh	-0.90	-0.14	-1.52	-0.31
Barbados	-0.20	0.41	-0.31	0.95
Belgium	1.32	0.52	0.97	0.76

Country	P	I	N	E
Bhutan	-0.57	-0.23	-0.23	0.18
Bolivia	-0.07	-0.71	-0.01	-0.30
Botswana	-0.60	-1.16	-0.19	0.48
Brazil	-0.24	-0.41	0.14	-0.14
Bulgaria	0.53	0.60	0.81	0.03
Burkina Faso	-1.69	-0.75	-0.62	-0.50
Burundi	-1.92	-0.71	-1.51	-0.53
Cambodia	-0.81	-0.57	-0.93	-0.47
Cameroon	-0.61	-0.53	-0.85	-0.50

Country	P	I	N	E
Canada	1.48	-0.04	1.36	0.93
Chad	-2.46	-1.02	-1.19	-1.27
Chile	0.44	0.15	1.17	0.65
China	0.03	0.56	-0.47	-0.15
Colombia	0.04	0.08	0.01	-0.25
Costa Rica	0.24	1.06	0.48	0.27
Côte d'Ivoire	-1.71	-0.59	-0.67	-0.65
Croatia	0.77	0.32	0.70	0.11
Cyprus	0.96	0.36	0.94	0.40
Czech Republic	0.98	0.60	1.87	0.44
Denmark	1.44	0.43	1.59	0.98
Dominican Republic	-0.41	0.21	0.16	-0.08
Egypt	-0.55	0.15	0.63	-0.86
El Salvador	-0.03	-0.06	-0.42	-0.03
Estonia	1.20	0.52	1.46	0.75
Ethiopia	-1.60	-0.87	-0.68	-0.77
Finland	1.76	1.33	1.52	1.00
France	1.22	0.55	1.24	0.61
Germany	1.07	-0.30	1.81	0.89
Ghana	-0.43	0.06	-1.13	0.04
Greece	0.62	0.83	1.37	0.01
Guatemala	-0.55	-0.24	-0.16	-0.41
Guinea	-1.78	-0.24	-1.38	-0.94
Guyana	-0.28	-0.06	-0.77	-0.40
Honduras	-0.78	-0.73	-0.11	-0.35
Hungary	0.82	0.40	1.19	0.29
Iceland	1.10	0.64	1.57	0.73
India	-0.90	-0.01	-1.18	-0.03
Indonesia	-0.02	0.22	-0.38	-0.11
Iran	-0.37	0.10	0.02	-1.06
Ireland	1.27	0.48	1.46	0.92
Israel	0.93	0.49	0.92	0.42
Italy	0.78	0.80	1.44	0.10
Jamaica	-0.11	0.04	0.46	-0.21
Japan	1.47	1.07	1.32	0.81
Jordan	-0.15	0.16	0.31	0.06
Kazakhstan	0.70	0.21	0.02	-0.23
Kenya	-0.91	-0.66	-0.83	-0.53
Korea (Republic)	0.91	1.46	0.80	0.41
Kuwait	-0.74	0.38	0.81	-0.16
Kyrgyzstan	0.44	-0.30	-0.61	-0.32

Country	P	I	N	E
Lao PDR	-1.04	-0.87	-0.63	-0.35
Latvia	1.06	0.42	0.81	0.45
Lithuania	1.15	0.38	0.64	0.50
Luxembourg	1.10	0.59	1.98	1.72
Macedonia FYR	0.20	0.29	-0.02	0.00
Madagascar	-1.03	-0.96	-1.46	-0.76
Malawi	-1.29	-0.66	-0.65	-0.43
Malaysia	0.29	-0.47	0.52	0.29
Mali	-1.76	-0.68	-1.96	-0.77
Malta	0.81	0.48	1.02	1.10
Mauritania	-2.35	-0.77	-1.43	-0.81
Mauritius	-0.05	-0.46	0.45	0.33
Mexico	0.13	0.00	0.26	-0.27
Moldova (Republic)	-0.03	0.17	0.16	-0.07
Mongolia	0.34	-0.91	-0.37	-0.09
Morocco	-0.77	-0.97	0.07	-0.17
Mozambique	-1.24	-0.10	-1.26	-0.20
Myanmar	-1.34	-0.44	-1.41	-1.22
Namibia	-0.76	-0.37	-0.42	0.10
Nepal	-1.07	-1.27	-0.83	-0.01
Netherlands	1.43	0.95	1.64	1.01
New Zealand	1.38	0.68	1.56	1.07
Nicaragua	-0.61	-0.23	-0.02	-0.53
Nigeria	-1.86	-0.59	-0.70	-1.13
Norway	1.57	1.03	1.66	1.03
Pakistan	-1.37	-0.21	-0.98	-0.54
Panama	0.36	0.07	0.37	0.13
Paraguay	-0.14	0.62	-0.69	-0.38
Peru	0.09	0.27	-0.34	-0.15
Philippines	0.38	0.30	-0.40	0.04
Poland	0.93	0.04	1.14	0.89
Portugal	0.69	0.81	1.53	0.45
Qatar	0.18	0.44	0.75	0.65
Romania	0.64	0.26	-0.01	0.23
Russian Federation	0.98	0.32	0.17	-0.58
Rwanda	-1.23	-0.73	-0.93	0.05
Saudi Arabia	-0.55	0.36	0.97	-0.17
Senegal	-1.33	-0.72	-0.60	-0.11
Serbia	0.36	0.35	1.12	-0.11
Singapore	1.04	0.56	1.89	1.71
Slovakia	0.78	0.40	1.44	0.30

Country	P	I	N	E
Slovenia	1.21	0.67	1.56	0.38
South Africa	-0.63	0.80	0.17	-0.07
Spain	0.58	0.55	1.77	0.31
Sri Lanka	0.10	0.16	0.19	-0.02
Sweden	1.47	0.79	1.66	1.05
Switzerland	1.55	1.11	2.25	1.85
Tajikistan	0.01	0.07	-1.17	-0.98
Tanzania	-1.00	-1.62	-0.88	-0.16
Thailand	0.15	0.13	0.13	-0.28
Trinidad and Tobago	-0.01	0.21	0.10	0.07
Tunisia	-0.84	-0.81	0.50	-0.26
Turkey	-0.01	0.97	0.26	-0.21

Country	P	I	N	E
Uganda	-0.93	-0.71	-0.70	-0.15
Ukraine	0.85	0.21	-0.10	-0.70
United Arab Emirates	0.21	0.44	1.35	0.73
United Kingdom	1.12	0.66	1.62	0.93
United States of America	1.18	0.38	1.02	0.62
Uruguay	0.38	0.43	0.18	0.45
Venezuela	-0.63	0.15	0.43	-1.49
Viet Nam	0.12	0.16	-0.76	-0.46
Yemen	-2.49	-0.58	-1.25	-1.36
Zambia	-0.44	-0.70	-0.54	-0.29

Table 5.5 The list of Top and Bottom 25 of the People domain

TOP 15			BOTTOM 15		
Rank	**Country**	**Score**	**Rank**	**Country**	**PINE**
1	Finland	1.76	**109**	Malawi	-1.29
2	Norway	1.57	**110**	Senegal	-1.33
3	Switzerland	1.55	**111**	Myanmar	-1.34
4	Canada	1.48	**112**	Pakistan	-1.37
5	Japan	1.47	**113**	Algeria	-1.42
6	Sweden	1.47	**114**	Ethiopia	-1.60
7	Denmark	1.44	**115**	Burkina Faso	-1.69
8	Netherlands	1.43	**116**	Côte d'Ivoire	-1.71
9	New Zealand	1.38	**117**	Mali	-1.76
10	Belgium	1.32	**118**	Guinea	-1.78
11	Austria	1.31	**119**	Nigeria	-1.86
12	Ireland	1.27	**120**	Burundi	-1.92
13	Australia	1.23	**121**	Mauritania	-2.35
14	France	1.22	**122**	Chad	-2.46
15	Slovenia	1.21	**123**	Yemen	-2.49

Table 5.6 The list of Top and Bottom 25 of the Infrastructure domain

TOP 15			BOTTOM 15		
Rank	**Country**	**Score**	**Rank**	**Country**	**PINE**
1	Republic of Korea	1.46	**109**	Senegal	-0.72
2	Finland	1.33	**110**	Honduras	-0.73
3	Australia	1.15	**111**	Rwanda	-0.73
4	Switzerland	1.11	**112**	Burkina Faso	-0.75
5	Japan	1.07	**113**	Mauritania	-0.77
6	Costa Rica	1.06	**114**	Tunisia	-0.81
7	Norway	1.03	**115**	Lao PDR	-0.87
8	Turkey	0.97	**116**	Ethiopia	-0.87
9	Netherlands	0.95	**117**	Mongolia	-0.91
10	Greece	0.83	**118**	Madagascar	-0.96
11	Portugal	0.81	**119**	Morocco	-0.97
12	South Africa	0.80	**120**	Chad	-1.02
13	Austria	0.80	**121**	Botswana	-1.16
14	Italy	0.80	**122**	Nepal	-1.27
15	Sweden	0.79	**123**	Tanzania	-1.62

Table 5.7 The list of Top and Bottom 25 of the Nature domain

TOP 15			BOTTOM 15		
Rank	**Country**	**Score**	**Rank**	**Country**	**PINE**
1	Switzerland	2.25	**109**	Rwanda	-0.93
2	Luxembourg	1.98	**110**	Pakistan	-0.98
3	Australia	1.93	**111**	Ghana	-1.13
4	Singapore	1.89	**112**	Tajikistan	-1.17
5	Czech Republic	1.87	**113**	India	-1.18
6	Germany	1.81	**114**	Chad	-1.19
7	Spain	1.77	**115**	Yemen	-1.25
8	Austria	1.68	**116**	Mozambique	-1.26
9	Sweden	1.66	**117**	Guinea	-1.38
10	Norway	1.66	**118**	Myanmar	-1.41
11	Netherlands	1.64	**119**	Mauritania	-1.43
12	United Kingdom	1.62	**120**	Madagascar	-1.46
13	Denmark	1.59	**121**	Burundi	-1.51
14	Iceland	1.57	**122**	Bangladesh	-1.52
15	Slovenia	1.56	**123**	Mali	-1.96

Table 5.8. The list of Top and Bottom 25 of the Enabling Environment domain

TOP 15			BOTTOM 15		
Rank	**Country**	**Score**	**Rank**	**Country**	**PINE**
1	Switzerland	1.85	**109**	Ukraine	-0.70
2	Luxembourg	1.72	**110**	Madagascar	-0.76
3	Singapore	1.71	**111**	Mali	-0.77
4	Malta	1.10	**112**	Ethiopia	-0.77
5	New Zealand	1.07	**113**	Mauritania	-0.81
6	Sweden	1.05	**114**	Egypt	-0.86
7	Norway	1.03	**115**	Algeria	-0.89
8	Netherlands	1.01	**116**	Guinea	-0.94
9	Finland	1.00	**117**	Tajikistan	-0.98
10	Denmark	0.98	**118**	Iran	-1.06
11	Barbados	0.95	**119**	Nigeria	-1.13
12	Australia	0.94	**120**	Myanmar	-1.22
13	United Kingdom	0.93	**121**	Chad	-1.27
14	Canada	0.93	**122**	Yemen	-1.36
15	Ireland	0.92	**123**	Venezuela	-1.49

5.2.4. PINE scores by continent

This research utilizes the categorization of countries into five continents according to the United Nations geo-scheme, which is a system categorizing the countries of the world into macro-geographical groups for statistical purposes. The five continents include Africa, Americas, Asia, Europe, and Oceania detailed in Table 5.9.

Table 5.9 World's Geographical Regions according to the UN

Africa	North Africa	
	Sub-Saharan Africa	Western Africa Middle Africa Southern Africa Eastern Africa
Americas	Latin America and the Caribbean	Caribbean Central America South America
	North America	
Asia	Central Asia Eastern Asia Southern Asia South-Eastern Asia Western Asia	
Europe	Eastern Europe Northern Europe Southern Europe Western Europe	
Oceania	Australia and New Zealand Melanesia Micronesia Polynesia	

Figure 5.1 shows the level of disaster resilience categorized in the five continents, by averaged scores. The key findings are as follows:

- Oceania is the most resilient region. It scored the highest scores in the overall score, PINE, and sub-indices. Africa is the least resilient region and it has the lowest scores in every categories.
- Europe is the second most resilient region. It has relatively high scores in every categories.
- From the most resilient to the least resilient regions, the order is Oceania, Europe, Americas, Asia, and Africa.

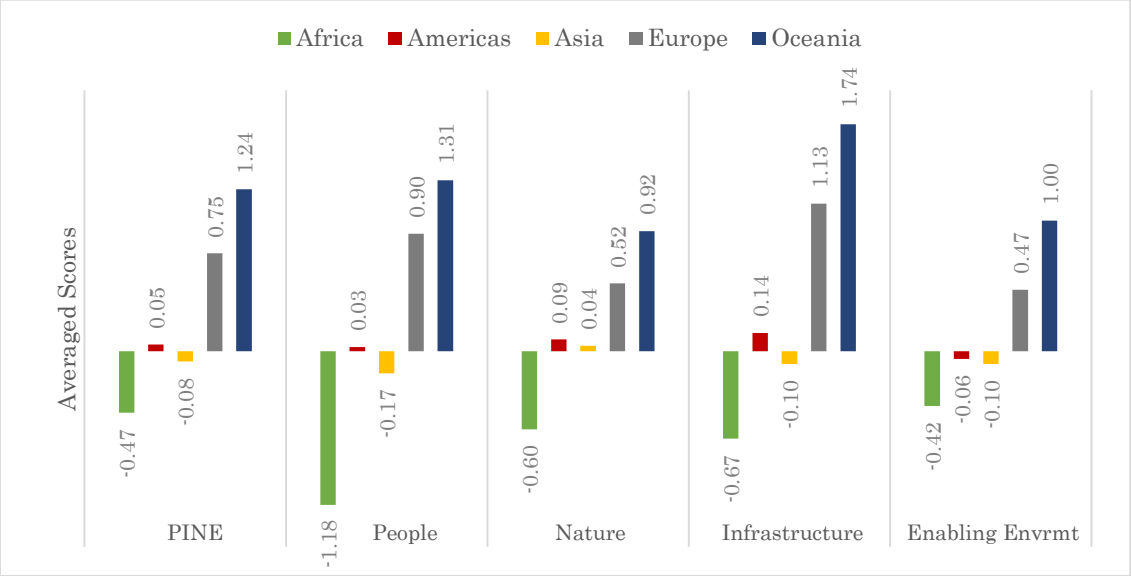


Figure 5.1 Disaster Resilience Scores by Continents

5.3. PINE disaster resilience vs external factors

5.3.1. PINE vs disaster death, damage, and number

This section employs three types of statistical information from EM-DAT: (1) Number of death caused by disasters, (2) Estimated Damage caused by disasters, and (3) Number of Disasters. The statistics shown in Table 5.10 is the summation of the 10-year average information (2004-2014) of each countries in the four categories according to PINE scores: 1) very low resilience, 2) low resilience, 3) medium resilience, and 4) high resilience. In the section 4.7.2, the negative correlation that a disaster resilient country is more likely to experience a lower number of death caused by disasters, a lower level of damage caused by disasters, and a lower number of disasters has been proved. This section gives more details to reaffirm that correlation and the validity of the index.

PINE	(-1.49) to (-0.38)	(-0.37) to 0.07	0.08 to 0.71	0.73 to 1.69
Disaster Resilience level	Group 1 Very Low	Group 2 Low	Group 3 Medium	Group 4 High

Table 5.10 Relation between disaster resilience and EM-DAT statistics

Categorization	Averaged damage (% of GDP)	Averaged number of death	Averaged number of disasters
Group 1 **Very Low**	0.212%	2,104	3.66
Group 2 **Low**	0.149%	839	3.33
Group 3 **Medium**	0.161%	608	3
Group 4 **High**	0.082%	128	2.2

The key findings are as follows:

- The relationship between the level of disaster resilience and number of death is rather strong. Group 4, which has the highest resilience, experiences the lowest level of the death caused by disaster, unlike group 1 where the number of death is about ten times higher.
- In terms of estimated damage, the relationship is as predicted that Group 4 experiences the lowest level of estimated damage. Though Group 2 and Group 3 do not imply significant difference in terms of estimated damage, Group 2 having higher resilience experiences a significant lower number of death.
- In terms of the number of disasters, it can also imply that the group of high disaster resilience experiences lower number of disasters. Despite the fact that Group 1 and Group 2 have the similar numbers of disasters, Group 1 having

higher resilience has significantly lower level of estimated damage and the number of death.

5.3.2. PINE vs hazard exposure

This section aims to map the world with a different lens, by investigating the relationship between disaster resilience and hazard exposure[17], utilizing information from World Risk Index (WRI). Figure 5.2 shows a scatter chart of resilience vs hazard exposure. The areas on the map help group countries into eight groups. Countries that fall into the green zones are considered to have low disaster risk, especially the left corner where there is high resilience and low hazard exposure. Contrast to the green zone, the red zone is considered highly sensitive to disaster risk.

[17] WRI calculates hazard exposure by including the number of people in a country who are (1) exposed to natural hazards: earthquake, cyclones, and/or flooding and (2) threatened by drought and/or sea level rise.

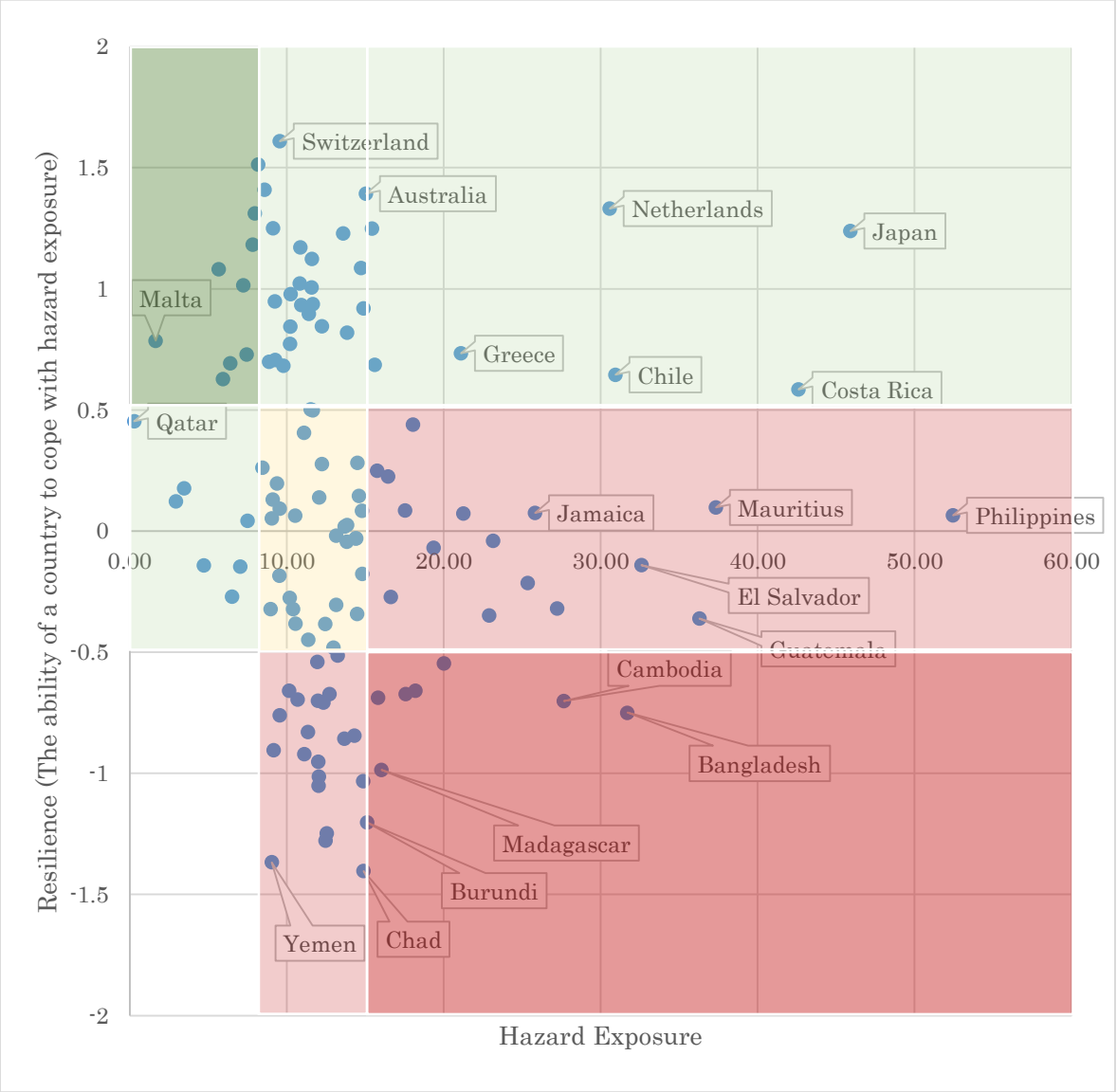


Figure 5.2 Resilience (PINE score) VS hazard exposure

Table 5.11 Identifying the 'dangerous' zones in relation to hazard exposure

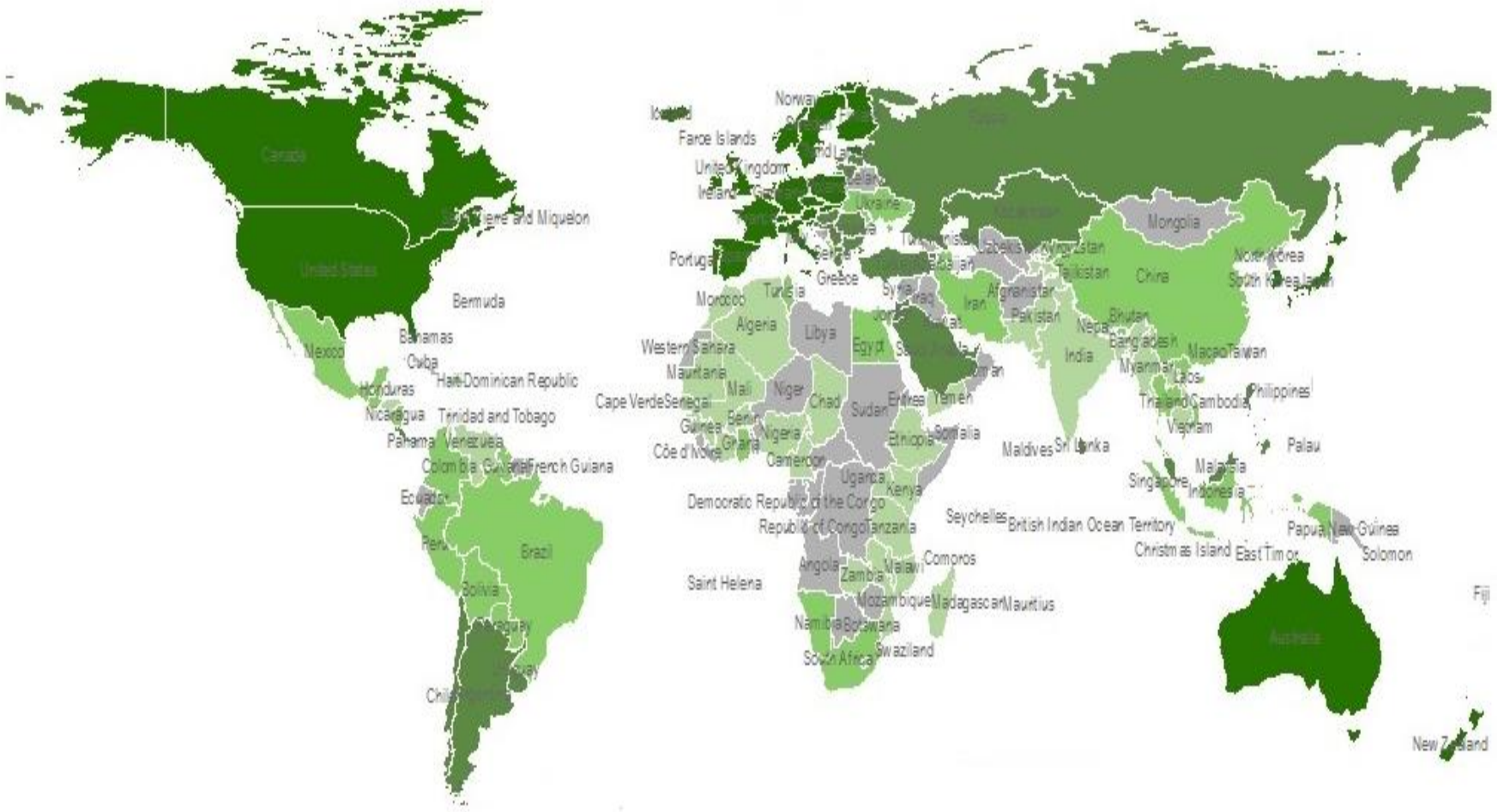
Low Exposure **High Resilience** Cyprus, Estonia, Iceland, Israel, Malta, Singapore, Sweden, UAE	**Medium Exposure** **High Resilience** Australia, Austria, Belgium, Bulgaria, Canada, Croatia, Czech Republic, Denmark, Finland, France, Germany, Ireland, Italy, Korea, Latvia, Lithuania, Luxembourg, New Zealand, Norway, Poland, Portugal, Russia, Slovakia, Slovenia, Spain, Switzerland, UK, USA	**High Exposure** **High Resilience** Chile, Costa Rica, Greece, Hungary, Japan, Netherlands
Low Exposure **Medium Resilience** Barbados, Mongolia, Paraguay, Qatar, Saudi Arabia, Ukraine	**Medium Exposure** **Medium Resilience** Argentina, Armenia, Azerbaijan, Bolivia, Botswana, Brazil, China, Colombia, Ghana, India, Iran, Jordan, Kazakhstan, Kuwait, Malaysia, Mexico, Namibia, Peru, South Africa, Sri Lanka, Tajikistan, Thailand, Tunisia, Turkey, Uruguay, Venezuela, Zambia	**High Exposure** **Medium Resilience** Dominican Rep., El Salvador, Guatemala, Jamaica, Kyrgyzstan, Mauritius Nicaragua, Philippines, Romania, Serbia, Guyana, Trinidad, Vietnam
	Medium Exposure **Low Resilience** Bhutan, Burkina Faso, Burundi, Chad, Cote d'Ivoire, Ethiopia, Guinea, Kenya, Lao PDR, Malawi, Mali, Mauritania, Morocco, Mozambique, Myanmar, Nepal, Nigeria, Pakistan, Rwanda, Tanzania, Uganda, Yemen	**High Exposure** **Low Resilience** Algeria, Bangladesh, Cambodia, Cameroon, Honduras, Indonesia, Madagascar, Senegal

The key findings are as follows:

- This analysis shows that there are eight countries that have high exposure and low resilience: Algeria, Bangladesh, Cambodia, Cameroon, Honduras, Indonesia, Madagascar, and Senegal. These are countries that in need for resilience enhancement. On the contrary, Cyprus, Estonia, Iceland, Israel, Malta, Singapore, Sweden, and UAE are among the most resilient with low hazard exposure. These countries are considered the 'safest' places in terms disasters.
- This analysis helps international organizations identify where the focus of aids and assistance should be.

5.4 GIS-based spatial analysis

The key purpose of this section is to demonstrate the spatial dimensions of global disaster resilience. To attain this goal, a Geographical Information System (GIS) was utilized to show the spatial patterns of national disaster resilience. The evaluation comes in a visual presentation (in Figure 5.3.) of the analysis provided in the section 5.2. Yet, it has taken the results further in that country's scores are mapped. Since the 123 countries are mapped, it is visible for us to capture the patterns of resilience across continents, and the world.



PINE | (-1.49) to (-0.38) | (-0.37) to 0.07 | 0.08 to 0.71 | 0.73 to 1.69 | No data available

Figure 5.3 GIS-based spatial analysis

5.5. Disaster resilience enhancement

In terms of enhancing national disaster resilience, the resiliency is often generated from a sum of a number of actions. The national disaster resiliency is the product of multiple efforts and inputs from (1) the multi-level task (from individual, community, prefecture, region, and up to an international level (Council of Australian Governments, 2011), (2) the systematic and multiplied sector efforts (Rockefeller Foundation, 2014), and (3) "smart" coordination of both soft and hard resilience policies, plans, and strategies (Kenneth et al., 2010). In other words, the multiplex nature of national disaster resilience requires the integration of strategies into a variety of existing activities and institutions. Resilience must be a building block of the plans and operations of existing institutions and systems. Resilience is not simply the result of adding up resilient individuals. It also involves both "soft" strategies which optimize disaster preparedness and response, and "hard" strategies which mitigate natural and human-caused hazards, thereby reducing disaster losses. Both "soft" and "hard" strategies are undertaken during disaster recovery. Kenneth et al. (2010) argue that in many countries "soft" and "hard" resilience approaches coexist as uncoordinated activities, but disaster outcomes are better when "soft" and "hard" strategies are purposely coordinated. Thus, "smart" resilience involves coordination of both "soft" and "hard" resilience strategies.

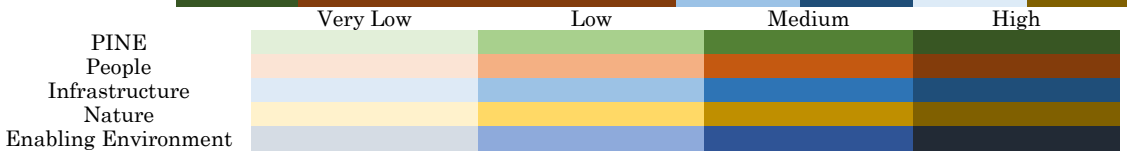
To help increase the level of disaster resilience, the PINE structure for national disaster resilience measurement can be a helpful instrument for international organizations to identify countries in need for assistance. The international organizations can make decision regarding the allocation of resources and fund for disaster risk reduction based on the PINE scores. When compared with other factors e.g. hazard exposure in Section 5.3.2., PINE is evidently useful for that purpose and increases potency to its analysis.

Additionally, for a national analysis, PINE can be further elaborated to help countries improve their levels of resiliency. To the simplest end, the detailed PINE scores shown in Table 5.12 give some implications in term of policy interventions. For example, Argentina is in the group of medium disaster resilience. Judging from the scores, Argentina should focus on the improving enabling environment especially on the legal aspects. The country should also focus on strengthening the ecosystem, and improving workforce and employment as the scores in these categories are among the lowest.

To a more elaborated end, PINE can be developed further to give guidelines for national disaster resiliency. Due to the fact that there are limited number of literature discussing national disaster resilience and its operationalization, this research had no alternative but to look at the sub-national level and studied four resilience-in-application articles from UNISDR (2012), Council of Australian Governments (2011), and Stockholm Resilience Centre (a), and Rockefeller Foundation (2014), with the hope to find a way to enhance disaster resilience. This research has found that the PINE structure can be further developed by interplaying with the seven identified qualities of a resilient country. It can be translated into drivers or essentials bullet-points according to the PINE domains and some of the resilience qualities can be highlight alongside the bullet-points. Though those qualities are supposed to reflect to the whole system, when it comes to each category there are some core qualities that can be embraced.

Table 5.12 Examples of the detailed PINE scores.

Country	PINE	P	Education	Well-being & Health	Workforce & Employment	I	National Infra-structure	Disaster Management	N	Environ-mental Health	Ecological Strength	E	Socio-economics	Governance	Legislation
Argentina	0.084	0.362	0.091	0.362	-0.408	0.459	0.603	0.314	-0.069	86.800	24.720	-0.415	-0.156	-0.098	-0.992
Australia	1.311	1.231	0.988	0.663	0.675	1.148	1.176	1.121	1.926	99.440	71.030	0.939	-0.561	1.479	1.899
Austria	1.153	1.306	0.713	0.886	0.886	0.797	1.050	0.544	1.679	92.150	69.110	0.828	-0.668	1.428	1.724
Bangladesh	-0.718	-0.900	-0.959	-0.606	-0.543	-0.142	-0.851	0.568	-1.523	30.420	22.400	-0.306	0.670	-0.757	-0.831
Bolivia	-0.273	-0.067	-0.409	-0.878	-0.185	-0.714	-0.278	-1.150	-0.012	53.950	48.170	-0.299	0.481	-0.409	-0.969
Botswana	-0.369	-0.600	-0.386	-0.270	-0.416	-1.165	-0.289	-2.041	-0.187	62.040	37.980	0.475	0.142	0.646	0.638
Brazil	-0.163	-0.242	-0.497	0.150	0.078	-0.405	0.446	-1.257	0.139	72.220	40.130	-0.142	-0.314	-0.034	-0.077
Bulgaria	0.491	0.532	0.282	0.333	-0.496	0.597	0.666	0.527	0.809	86.570	48.970	0.027	-0.226	0.057	0.248
Canada	0.932	1.482	1.355	0.548	0.875	-0.045	1.046	-1.136	1.364	97.920	56.610	0.926	-0.630	1.546	1.862
Chile	0.602	0.437	0.250	0.306	0.194	0.149	0.647	-0.349	1.169	89.420	56.940	0.653	-0.551	1.044	1.465
China	-0.005	0.029	0.069	0.010	0.516	0.564	0.174	0.954	-0.467	42.730	43.190	-0.147	0.360	-0.500	-0.300
Colombia	-0.030	0.044	-0.169	-0.116	-0.229	0.080	0.219	-0.058	0.005	66.010	40.620	-0.250	-0.402	-0.430	0.081
Costa Rica	0.513	0.244	0.382	0.445	0.378	1.063	0.605	1.521	0.477	82.620	42.470	0.270	-0.433	0.722	0.520
Czech Republic	0.972	0.984	0.452	0.310	0.210	0.600	0.847	0.354	1.870	90.630	75.350	0.436	-0.607	0.834	1.080
Denmark	1.113	1.443	0.891	0.943	0.932	0.433	1.327	-0.461	1.594	97.610	63.120	0.984	-0.592	1.640	1.905
Dominican Rep.	-0.032	-0.413	-0.732	-0.223	-0.401	0.210	-0.036	0.455	0.155	69.120	42.650	-0.081	0.190	-0.222	-0.209
Finland	1.401	1.755	1.601	0.844	1.250	1.327	1.191	1.464	1.521	99.440	59.900	1.000	-0.774	1.762	2.012
France	0.904	1.224	0.776	0.744	0.520	0.546	1.098	-0.006	1.237	96.480	54.090	0.609	-0.512	1.063	1.276
Germany	0.866	1.073	0.888	0.877	1.149	-0.303	1.108	-1.715	1.809	92.830	72.230	0.886	-0.605	1.488	1.774



5.6. Usage and users of the PINE scores

The main users of the PINE national disaster resilience can be divided into two levels: international and national levels. For **the international level**, key users include international organizations (e.g. UN, WFP, ASEAN, APEC, WHO) as well as donors, countries and other actors including development partners with a resilience agenda. For **the national level**, national policy formulators and emergency managers are among the key users at this level. Thus, it depends on each user to customize how PINE can be of their usage. The following are suggestions:

- The global result of PINE can be utilized to prioritize or group countries by the levels of their national disaster resilience, or any of its domains. This can facilitate decision-making process on benefit distribution.
- The whole set of the PINE results for each particular country are considered country profile, which shows the level of individual elements of national disaster resilience. This can aid decision-making process on which focal areas to pay attention in terms of policy intervention to improve and better national disaster resilience.
- The singular overall PINE results facilitate users to study trend analysis on the level of overall national disaster resilience and its components. Monitoring trends over time in that fashion can facilitate decision-making process on adjustments and allocation of national limited resources, intervention, and distribution in term of policy attentions.

In summary, the measurement that this research proposes is designed to convey answers to the following questions:

- How disaster resilient a country is or what countries are of need in term of help and intervention?
- What countries are likely to suffer from the disasters?
- What can be the underlying elements that a country should address in order to improve its disaster resilience?
- How does a country's disaster resilience change over time?

However, when utilizing composite indicators, literature suggests that measurement and its results should be used with care and cautions because they can be 'misleading' (Freudenberg, 2003; Nardo et al., 2005). Indicators could send misleading, non-robust implication and hidden message in terms of policy formulation they are not well drafted and wrongly interpreted and implied. Also, the end result often deal with a

singular number or “big picture” results, where indicators or an index may mislead users to jump to the narrow or simplistic implications or conclusions. Therefore, an index should be used in parallel with its detailed elements or indicators to be able to reach sophisticated interpretations for policy implication and interventions. In this research, content and construct validations in the form of correlation analysis, and framework for indicator selection can reduce some of those negative effects.

CHAPTER 6 DISCUSSIONS, CONCLUSIONS, AND RECOMMENDATIONS

6.1. Introduction

The value that this research has added to the reservoir of knowledge is the operationalization of the concept of disaster resilience particularly at the global and national levels, by constructing a model for national disaster resilience analysis that is theoretically sound, reality-reflective, consistent with international expectation, and empirically validated. To fulfil the task, several steps were taken to develop this evaluation. This chapter discusses the steps according to research goals outlined in the introductory chapter and conclude the key findings of the research. This Chapter further sum up conclusions, outline discussion points, and give some recommendations for future research. Consequently, limitations of the research is also examined, as well as the research's contributions and practicality.

6.2. Discussions

This research's objectives explained in the first chapter can be summarized into five discussion points according to the steps in developing the framework for national disaster resilience and the PINE structure of national disaster resilience measurment; (1) revisiting disaster resilience definitions, (2) constructing an analytical framework for national disaster resilience, (3) developing an approach for national disaster resilience measurement (PINE structure), (4) aggregating and validating the index, and (5) assessing global disaster resilience.

6.2.1. Revisiting disaster resilience definitions

This was the first step to embark the journey. It included exploration of resilience on its theories, definitions, utilizations, applications, and interpretations. The key objective of the task was to build the theoretical foundation for constructing a framework that has an ability to understand and quantify disaster resilience. The key observed points are as follows:

- Despite the fact that disaster resilience as a concept has increasingly been utilized, the definition of disaster resilience is very inconsistent. There are a large number of disaster resilience definitions in the literature.
- Due to the complex and multidisciplinary nature of the concept, it appears that there is no consensus on how disaster resilience should be defined. Some

scholars have pointed that it is not practical or not even possible to do so (MacAskill and Guthrie, 2014).

- Despite the absence of universally accepted definition, there is a significant amount of similarities among those definitions of which this research took advantage to build the foundation upon.
- Therefore, the working definition of disaster resilience was developed as a basis to further identify the elements of disaster resilience and establish an approach to evaluate it.
- The working definition of disaster resilience was formed based on the system theory, DROP model, and 3D resilience. This definition sees resilience as a process and that resilience and vulnerability are separate but often linked concepts.
- However, it would bring great advantages if a common definition of disaster resilience is formed. This could help advance the comprehension and utilization of the concept, as well as significantly facilitate consensus on resilience evaluation and operationalization.

6.2.2. Constructing an analytical framework for national disaster resilience

Shifted from the resilience definitions discussed in Chapter 2, the focus of Chapter 3 was on an investigation of various theoretical frameworks and analytical models of disaster resilience that can be utilized to serve the purposes of this research. In fact, it was expanded to include the related concept of vulnerability because there are some linkages between the two concepts. In total, four frameworks of disaster and two framework of vulnerability were studies, including (1) Resilience as the system of systems: Panarchy, (2) R4 Framework and TOSE domain, (3) Disaster Resilience of Place (DROP), (4) 3D Resilience Framework, (5) Pressure and Release Model (Vulnerability Progression), and (6) Framework of vulnerability Analysis.

Emerging from the investigation of these frameworks was the principle that it was comprehensive and critical to measure national disaster resilience as a static property, despite its dynamic nature, and focus on the antecedent condition of a country where the three resilience capacities reside. Measuring disaster resilience by capacities are an ideal but it proved impractical in ways that (1) most of the indicators contribute to generate each or all capacities, and (2) there is no criteria to clearly assign indicators to particular capacities. Therefore, an important result of this analysis was to measure

disaster resilience by systems within the system; yet, the following bullet points are the findings regarding identification of systems of the system.

- There is no limit on the number of systems or subsystems that a resilient system should have, because of its panarchic characteristic.
- Systems within a system can be classified by various criteria, e.g. sectors, institutions, capitals, assets, etc.
- A resilient system has distinct qualities or characteristics that separate it from a prosperous system.

The understanding that a domain-centric approach to national disaster resilience provides a logic and basis for considering and selecting indicators addressing depth and width of disaster resilience based on the three resilience capacities. Thus the final working definition of disaster resilience was formed based on the theories (1) 3D resilience framework where it includes an ability of bouncing back from, withstanding and coping with, adjusting to the impact of, and recovering from the effects of disturbances or shocks in a timely and effective manner through shock anticipation, absorption, adaptation, transformation, (2) system theory where it implies maintenance and restoration of essential functions in the time of disturbances, as well as resilience as the product of the country's systems, and (3) DROP framework where it emphasizes on the ability that is inherent within a country. All in all, the working definition of disaster still sees resilience as a dynamic property but suggests a measurement be made as static property. It also broadens the DROP model where it focuses on the social-built-natural systems' interactions to focus on multiple and complex systems.

The PINE structure for national disaster resilience measurement was created in this research based on an argument that disaster resilience is the product of resilience capacities in the four domains of systems: People, Infrastructure, Nature, and Enabling Environment. It is also grounded on the rationale that each domains have elements that play a role in contributing to the resilience.

6.2.3. Developing an approach for national disaster resilience measurement

Conceptually, an essential point in developing the PINE framework for national disaster resilience was to identify and choose relevant indicators to include in the index. In this research, disaster resilience is quantified by using composite indicators method. In Chapter 4, the PINE structure was further interpreted into a framework for indicator selection where a cross-classifying method was utilized. The framework for indicator

selection helped create the initial starting point for index development. After this, ongoing efforts in measuring disaster resilience were studied. At the national level, none of the 6 frameworks truly discusses disaster resilience, except World Economic Forum's Country Resilience Rating where its preliminary list of indicators discusses heavily on economic aspects. The study then extended to include another 10 ongoing efforts at sub-national level. At this level, there are a number of framework that discusses disaster resilience. Some elements of resilience were harvested to include in the PINE framework. This method appeared to be theoretically justified and practical in the sense that each indicators were specifically evaluated and chosen for each cell. It thus yielded the selection of theoretically relevant indicators and ensured content validity of the chosen indicators.

To make the PINE structure reflective to the reality, an investigation of disaster events was introduced. This research studied 99 cases of disaster-related event and project from various sources in order to extract resilience elements and other useful ingredients for the PINE framework. Paralleled to this, a review of Hyogo Framework for Action and the Post-2015 Framework for disaster risk reduction (or Sendai framework) was carried out with the hope to make the PINE framework consistent with the most up-to-date expectation in terms of disaster resilience from international organizations. Last, selected indicators were checked with data availability. It was unfortunate that one of the main hindrances of this research is data availability.

Based on this procedure more than 100 indicators were identified. After being evaluated by data availability, 66 indicators met the selection criteria and were classified according to domains and categories: People domain (30 indicators), Infrastructure domain (16 indicators and 1 high-level indicator), Nature domain (1 indicator and 1 high-level indicator), and Enabling environment domain (11 indicators, and 6 high-level indicators). The high-level indicators are composite indicators that have a number of underlying indicators ranges from 10 to 75 indicators.

6.2.4. Aggregating and validating the index

On the technical aspects of the research, the selected indicators came in different scales from various sources. Before combining the index, scale adjustment was performed. The data was then normalized by using Z-score approach. The crucial part was to decide the weighting scheme. There were two schemes: an average method (AM) and a weight method (WM) according to the number of underlying indicators. The results

from these two methods were similar but not identical. The results of the two methods were compared by using correlation analysis. The results showed that the average method has stronger correlations and thus was chosen to use throughout the research.

For the validation, the logic for this was to study whether the PINE national disaster resilience measurement is theoretically and empirically valid. In general, national disaster resilience is of multifaceted scales that can cover many variables and indicators. Therefore, identifying appropriate variables for statistical validation was a challenge.

This research employed two types of validation: content and construct. The content validation can be proved through the indicator selection process, which was done based on the framework for indicator selection. In fact, indicator selection is a subjective procedure involving personal considerations. The framework for indicator selection created an instrument where only 'hit to the point' indicators were chosen, and restricted the imagination of the author to the correct track, resulting in the reduced level of subjectivity. Also, choosing indicators based on the framework insured that the various dimensions of national disaster resilience were incorporated and thus high content validity and high consistency with the working definition.

The construct validity examines whether the measurement is statistically related to external variables in the close theoretical framework. This exercise in Chapter 4 aimed at validating the PINE national disaster resilience by examining how well it correlates with the external variables in the close theoretical framework. Based on literature, this research employed nine external variables in six topics: (1) Disaster risk, (2) Vulnerability, (3) Lack of coping capacity, (4) Lack of adaptive capacity, (5) Number of Death caused by disasters, and (6) Estimated damage caused by the disasters. The expectation of all the six topics in relation to disaster resilience was negative correlations. The results revealed as expected; yet, differed in strength of the correlations.

6.2.5. Assessing global disaster resilience

Chapter 5 took the framework further into application. The aim was to identify, analyse, and map spatial patterns of global disaster resilience. The logic for this exercise was to additionally evaluate the validity and practicality of the PINE structure by examining the spatial distribution analysis.

6.3. Distinctive features of the framework vs the conventional frameworks

The problem statements points to the need to develop disaster resilience framework that can be applied at the national level because of the following reasons: (1) No consensus exists currently on how to measure resilience. Without a conceptual framework where indicators can both be defined and assessed, resilience will never be meaningful and useful for policies intervention and national development strategies. (2) To date, there has been no framework that directly discusses resilience at national level. The national disaster resilience framework and PINE structure were developed as to fill such voids. With the following features, the framework for national disaster resilience is distinctive to the conventional frameworks.

1. Unlike the conventional frameworks, PINE directly discusses national resilience. Employing the 3D resilience framework, PINE sees resilience as product of the three resilience capacities: absorptive coping, adaptive, and transformative. Its measuring mechanism adequately discusses them all. Most of the conventional frameworks place an emphasis on risk where resilience element is reduced to just coping capacity and/or adaptive capacity.
2. PINE is a balanced framework because it is theoretically sound and reality-reflective. This is proved by the methodology of developing the PINE and the validation of the PINE index.
3. Ultimately, PINE serves two key purposes: (1) to map the global disaster resilience, (2) to track the level of resilience, and (3) to make useful of the resilience concept for policies intervention and development.
4. PINE identifies characteristics and qualities of a resilient country, with the hope to distinguish it from a prosperous country. The quality element of the framework might not be useful for the measurement purposes, but it adds comprehensiveness to the framework which can be further developed for a better interpretations in terms of policy intervention.

6.4. Conclusions

The conclusions of the key findings of this research are summarized as follows:

1. Based on what this research have been gathered, it is fairly convinced that the overall objectives set for this research have been met. The major output was the establishment of national disaster resilience framework and its measurement structure (PINE) for evaluating and quantifying national disaster resilience that is valid, theoretically driven, reality reflective, and operational. The findings of this research gave empirical evidence that PINE framework has an

ability to enhance understanding and operationalization of the concept of disaster resilience.

2. The methodology of developing the PINE structure used in this research was theoretically reasonable and empirically practical. Its salient point is the incorporation of the three resilience capacities and resilience as a system of systems, as well as using 'inherent resilience' as the starting point.
3. In the field of disaster risk management, there is an urgent need for an instrument that can successfully assess disaster resilience and it should be functional and valid. The PINE framework is developed based on those premises. The framework was examined and validated using a mixture of statistical approaches. Considering the findings observed from this research, it is convinced that the PINE framework is functional and valid in both theoretical and empirical terms. It is also potentially promising especially for policymakers and emergency managers because it provides useful information that can be utilized to help formulate development policies. However, additional research should be considered.

6.5. Limitations and recommendations for future research

For the limitations faced while conducting this research, the following points exemplify some of the limitations and some recommendations for future research in response to those limitations.

1. This research made an effort in evaluating a highly multiplex concept of disaster resilience at a broad scale by using a country as the focal unit with the hope to spatially map the global disaster resilience, and efficiently keep track of resilience level. For national policymakers or emergency mangers, this framework might not adequately meet their needs. **A smaller-scaled framework**, preferably at the smallest governmental unit e.g. municipality or village, would probably generate a more contextual result. For future research, an adaptation of the PINE structure to be able to function at smaller scales would be highly useful. With that result, national policymakers will know on which area to place an emphasis.
2. **Data availability** was the key challenge throughout this research. Unlike, other fields, sociology is the concept that is challenging to capture in term of statistics. This research depended to a great extent on secondary data from reliable sources e.g. World Bank, UN, and World Economic Forum. Yet, those data, despite its large numbers, are restricted to the information that has statistic records e.g.

Gross Domestic Products, Child mortality, Employment rate. This limitation was also echoed in the Sendai framework where the UN has commissioned international organizations to develop a number of indicators necessary for the resilience measurement purpose. The research did an investigation on the concept of resilience and it suggests that there is the need for a collection of more specific data. The following issues exemplify some of them:

- Disaster recovery time
- Efficiency of urban planning policy
- Disaster-related household insurance
- Level of disaster awareness
- Social network: mutual support, social trust
- Disaster early warning system
- Construction and maintenance of disaster mitigation structures
- Lifeline infrastructure in time of emergency
- Availability of evacuation areas in time of emergency
- Contingency plan
- Emergency response plan

Additionally, this research utilized a number of indicators collected through a perception survey e.g. quality of education system, corruption perception. These information is very informative to this research but information based on perception often implies the high level of subjectivity. Hence, future research should emphasize on developing a reliable methodology of collecting data and on developing indicators or statistics of the mentioned issues.

3. **Disaster event statistics** are of significance. The validation of such disaster resilience measurement is challenging especially when it needs to correlate with empirical information. This research employed information from EM-DAT, the most reliable source to date. Yet, it reveals the information from EM-DAT is problematic. Some of the problems come from the fact that it is difficult to keep track of the information on hazard events that occur almost on a daily basis and around the world. By EM-DAT database, the loss of life of common dangers amid 1900-1999 is under 0.2% because of volcanic emissions, avalanches and fierce blazes. Then again, the fast onset hazard with a more restricted geographic content hardly fall into the criteria of the EM-DAT database. Starting from the perspective, the vicinity in the database is inadequate and the total loss of life is higher, as one occasion once in a while causes philanthropic emergencies. This confinement is echoed in the UN. The new type

of disaster data collection has recently been discharged and requested that its members to monitor its own particular disaster events. Also, EM-DAT does not have any data on the recovery time which is one of the noteworthy components deciding national disaster resilience.

4. There is a restrictions on the understanding regarding systems or domains used to evaluate disaster resilience. Some even maintain a strategic distance from utilizing system theory and pick to utilize other frameworks. Yet, both face the same issue on the most proficient method to characterize domain and category which indicator fits better in which classification. This research is not an exemption. There is an overlap between domains and category within each domain. For instance, it is pugnacious whether livelihood sub-points fits more in the economics sub-subjects or in the general population area, whether empowering environment space is incorporated as a sub-theme in the framework space, and whether it is important to include a monetary space.
5. Due to the influence of the DROP model over the PINE structure, the disaster resilience measurement created in this research will be a 'snapshot' in time with limited capability to foresee what's to come regarding national disaster resilience. The snapshot also captures a static status, instead of it element property. Despite the fact that the framework facilitates trend analysis, future research might improve the framework by including those spatial and temporal measurements for national disaster resilience. Whether succeed, the model will help policymakers choose proper intervention in the face of hazards before it is too much to handle.

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ANNEX 1
Resilience Conceptualizations and Understandings

Author(s), Year	Conceptualisations
1. Adger, 2000	Socio-ecological resilience as the ability of groups or communities to cope with external stresses and disturbances as a result of social, political and environmental change, while maintaining the sustainability of their livelihoods
2. Adger et al., 2002	All aspects of demographic change, including migration, have impact on the social resilience of individuals and communities, as well as on the sustainability of the underlying resource base.
3. Berkes, 2007	Vulnerability is registered by exposure to hazards, but it also resides in the resilience of the system experiencing the hazard. Resilience is defined as the capacity of a system to absorb disturbance and reorganize while undergoing change yet still retain essentially the same function, structure, identity and feedbacks.
4. Carpenter et al., 2001	Resilience is viewed as the amount of change a system can bear and still retain the same controls on structure and function', the capacity of a system to self-organise and the ability of a system to learn and adapt. Resilience is seen to depend on four main components.
5. Cutter et al., 2008	DROP model of resilience is proposed to give an understanding that social systems, natural systems and the built environment determine the inherent vulnerability and inherent resilience of a system.
6. Folke, 2006	This conceptualisation of resilience treats disturbances in socio ecological systems as an opportunity. Disturbances in a resilient social-ecological system have the potential for doing 'new things, innovations and development.
7. Holling, 1973	Resilience is viewed as the ability of ecological systems to persist in the face of disturbance and maintain relationships between different elements of the system.
8. Manyena, 2006	Resilience is conceptualised as the ability of a system to adapt to environmental shocks and continue functioning without there being a change in its fundamental characteristics. This understanding underlines the importance of viewing resilience as a 'process' rather than only an outcome.
9. Mayunga, 2007	Resilience as 5 Capitals: This understanding of community resilience to disasters springs from the sustainable livelihoods approach where social, economic, human, physical and natural capital are seen as the determinants of resilience.
10. Osbahr, 2007	Resilience is the amount of change a system can undergo while retaining the same controls on structure and function. Resilience is viewed in the context of climate change through an analysis of climate change adaptation interventions/projects in order to identify specific elements of adaptation practice and intervention that might be important in enhancing longer-term resilience to climate change in developing countries
11. Rockefeller Foundation, 2009	Resilience is capacity to dynamically and effectively respond to shifting climate impact circumstances while continuing function at an acceptable level
12. Twigg, 2007	Resilience as an ability to absorb stress, to manage or maintain certain basic functions and structures during disastrous events and bounce-backability after a disaster

1. Adger, W. Neil. (2000)

Adger's article defines social resilience as the ability of groups or communities to cope with external stresses and disturbances as a result of social, political and environmental change. This definition highlights social resilience in relation to the concept of ecological resilience which is a characteristic of ecosystems to maintain themselves in the face of disturbance. There is a clear link between social and ecological resilience, particularly for social groups or communities that are dependent on ecological and environmental resources for their livelihoods. But it is not clear whether resilient ecosystems enable resilient communities in such situations. This article examines whether resilience is a useful characteristic for describing the social and economic situation of social groups and explores potential links between social resilience and ecological resilience.

This article argues that social resilience is defined as the ability of communities to withstand external shocks to their social infrastructure. This is particularly apposite for resource-dependent communities where they are subject to external stresses and shocks, both in the form of environmental variability (such as agricultural pests or the

impacts of climatic extremes), as well as in the form of social, economic and political upheaval (associated with the variability of world markets for primary commodities, or with rapid changes in property laws or state interventions). It is indeterminate whether communities dependent on coastal resources are themselves inherently more resilient, despite the undoubted diversity of these social and economic systems, and the ecological resilience of these areas. The centrality of social resilience to sustainable development remains a critical question.

Given the complex relationship between social resilience and dependency on natural resources, the article developed a set of key parameters for observing social resilience. Social resilience is institutionally determined, in the sense that institutions permeate all social systems and institutions fundamentally determine the economic system in terms of its structure and distribution of assets. Social resilience can therefore be examined through proxy indicators, such as institutional change and economic structure, and through demographic change shown as follows.

1. Economic factors, institutions and resilience indicators

Key factor of the economic aspects of resilience:
• economic growth and the stability and distribution of income among populations • boom and bust nature of markets for the outputs from resource use as well as to technological innovation threatening the sustainability of economic activity • environmental variability • stability, particularly of livelihoods • sustained economic growth • choices in livelihoods and social investments

2. Demographic change and resilience indicators

Mobility and migration are a further set of important indicators of resilience.
• Type of migration: resilience or changes in resilience cannot simply be inferred from the presence or absence of migrants in any area or community; the degree of labour mobility; or an increase or decrease in total population over time. Significant population movement can be evidence of instability, or could be a component of enhanced stability and resilience, depending on the type of migration • The impacts of migration strategies on the use of natural resources, and environment, in both net immigration and net emigration areas • Remittance income

Reference:
Adger, W. N. (2000). 'Social and ecological resilience: are they related?' *Progress in Human Geography.* 24(3):347-364.

2. Adger, et al. (2002)

Their article argues that all aspects of demographic change, including migration, have impact on the social resilience of individuals and communities, as well as on the sustainability of the underlying resource base. Social resilience is the ability to cope with and adapt to environmental and social change mediated through appropriate institutions. They investigated one aspect of the relationship between demographic change, social resilience, and sustainable development in contemporary coastal Vietnam: the effects of migration and remittances on resource-dependent communities in population source areas; and found, using longitudinal data on livelihood sources, that emigration and remittances have offsetting effects on resilience within an evolving social and political context. Emigration is occurring concurrently with, not driving, the expansion of unsustainable coastal aquaculture. Increasing economic inequality also undermines social resilience. At the same time diversification and increasing income levels are beneficial for resilience.

Migration is discussed as a central pillar of social resilience. Migration carries the potential to exert a substantial influence on communities, 'altering economic well-being, changing the structure of the community, and affecting the natural resource base'. If remittances from migration are not controlled by effective institutions they can create severe inequity in society through reduced access to natural resources for some groups and reduced resilience. Similarly, effective and responsive institutions would help in ensuring equitable social and economic trends and more equal access to natural resources; one possible indicator of institutional strength would be the effectiveness of mechanisms to collect taxes and employ this revenue usefully. Also, the manner in which remittance income is employed can increase or decrease social resilience. For example, if in an agricultural economy it is used for investing 'in human or physical capital to enhance household production' in a sustainable manner then the social resilience of individuals within the household is increased. On the other hand, if remittances are used to increase conspicuous consumption or for unsustainable agricultural production, this will have a negative effect on social resilience.

Reference:
Adger, W. N.; Kelly, P. M.; Winkels, A.; Quang H., Luong; Catherine, L. (2002).
'Migration, Remittances, Livelihood Trajectories, and Social Resilience', *Journal of the Human Environment*. 31(4):358-366.

3. Berkes, Fikret. (2007)

Vulnerability is registered not by exposure to hazards alone; it also resides in the resilience of the system experiencing the hazard. Resilience (the capacity of a system to absorb recurrent disturbances, such as natural disasters, so as to retain essential structures, processes and feedbacks) is important for the discussion of vulnerability for three reasons: (1) it helps evaluate hazards holistically in coupled human–environment systems, (2) it puts the emphasis on the ability of a system to deal with a hazard, absorbing the disturbance or adapting to it, and (3) it is forward-looking and helps explore policy options for dealing with uncertainty and future change. Building resilience into human–environment systems is an effective way to cope with change characterized by surprises and unknowable risks. There seem to be four clusters of factors relevant to building resilience (1) learning to live with change and uncertainty, (2) Nurturing various types of ecological, social and political diversity for increasing options and reducing risks, (3) increasing the range of knowledge for learning and problem-solving, and (4) creating opportunities for self-organization, including strengthening of local institutions and building cross-scale linkages and problem-solving networks.

Berkes proposes five components that are important in building the resilience of socioeconomic systems.

1. Resilience thinking requires an acknowledgement of the fact that systems must learn to live with uncertainty and that change is inevitable: ***"Expecting the unexpected"***. These tools and codes can spring from memories held by societies of similar events in the past.
2. ***Diversity is important to building resilience*** as it extends multiple options for dealing with perturbations, reducing risks by spreading them. This diversity can be nurtured ecologically through high biodiversity, both economically through livelihood diversification and through the inclusion of diverse points of view in policymaking processes.
3. Different types of knowledge should be appropriated in any learning process. This can be done through ***the appropriation of local knowledge in policy processes***. The creation of platforms for cross-scale dialogue, allowing each partner to bring

their expertise to the table, is a particularly effective strategy for bridging scales to stimulate learning and innovation.

4. As renewal and reorganisation are essential parts of natural cycles, the ***ability of systems to reorganise*** is a critical determinant of their resilience. This is possible through strengthening community-based management and maintaining the local capacity for social and political organization in the face of disasters. Response by the community itself, through its own institutions, is key to effective response and adaptation. Building linkages across scales of governance is another component of giving communities the ability to self-organise; community organisations need to work with regional and national organisations.
5. A ***dynamic learning component*** is crucial for providing a rapid ability to innovate in terms of the capacity to create new responses or arrangements. Such learning can be improved by adaptive co-management, defined as a process by which institutional arrangements and environmental knowledge are tested and revised in a dynamic, ongoing, self-organized process of learning-by-doing. Learning organizations allow for errors and risk-taking behaviour as part of the learning process.

He also laid out four Strategies that have a high probability of enhancing resilience to future change.

1. Foster ecological, economic and cultural diversity

Diversity provides the seeds for new opportunities and maximizes the options for coping with change. By supporting and protecting ecological, economic and social diversity, countries or regions make themselves less vulnerable to adverse effects of future change.

2. Plan for changes that are likely to occur

By recognizing the directional nature of current changes, and by identifying external drivers of change, countries have the opportunity to design the institutional flexibility necessary to anticipate and adjust to change.

3. Foster learning

Countries, communities, NGOs, and government agencies can learn from one another. By collaborating closely to examine patterns of response to hazards, it is possible to learn which policy options show promise. Particularly effective are learning networks of public, private and civil society actors.

4. Communicate the societal consequences of recent changes

Societal consequences of hazards are felt at multiple levels. The communication of the consequences of perturbations is important in understanding actual local impacts and adaptations. Such communication helps make a convincing case that the global nature of causes warrants global action.

Reference:
Berkes, F. (2007). 'Understanding Uncertainty and Reducing Vulnerability: Lessons from Resilience Thinking' *Natural Hazards*. 41(2):283-95.

4. Carpenter, et al. 2001

Very broadly, This understanding sees resilience as the amount of change a system can bear and still retain the same controls on structure and function', the capacity of a system to self-organise and the ability of a system to learn and adapt. Resilience is seen to depend on four main components: (1) the magnitude of disturbance required to fundamentally disrupt the system causing a dramatic shift to another state of the system, controlled by a different set of processes; (2) the policy, regulatory and governance structures which allow different parts of the system to reorganise; (3) the variety of groups performing different functions in an SES; and (4) the nature of learning processes that exist within a system.

Indicators within such an approach include fundamental variables which maintain a domain of attraction, such as the land tenure systems. Resilience is dependent the degree to which legal and regulatory environment gives control over natural resources to its users, and a number of different species that perform a variety of ecological functions. It also relies on local knowledge being used in any system of managing resources: the users (e.g. fishermen) within this system have a good understanding of how a socio-ecological system works, certain institutions test various methods of building resilience, monitor the results of these tests, update existing data on resilience building and have the capacity to modify policy as new knowledge is gained.

Reference:
Carpenter, S.; Walker, B.; Anderies, J. M.; and Abel, N. (2001). 'From Metaphor to Measurement: Resilience of What to What?' *Ecosystems*. 4:765-781.

5. Cutter et al., 2008

In the Disaster Resilience of Place (DROP) model, existing concepts are analysed to form a dynamic and cyclical understanding of inherent resilience of a system to natural hazards. Essentially, this model begins with an understanding that social systems, natural systems and the built environment determine the inherent vulnerability and inherent resilience of a system. This interacts with the nature of the hazard (i.e. frequency, duration, intensity, etc.) and the effects of the event are then amplified or reduced depending on the coping capacity of the system. If the absorptive capacity is exceeded the community will experience low recovery unless it can improvise and learn.

This model is cyclical, with ***the inherent resilience being determined by ecological, social, economic, infrastructural and institutional components as well as the level of community competence***. Each of these components has indicators such that, for example, high biodiversity and low soil erosion are ecological factors that would lead to high inherent resilience in an ecosystem, while substantial presence of social networks and faith-based organisations are indicators of high inherent resilience in the social sphere.

1. Ecological

Candidate Variables:
• Wetlands acreage and loss Erosion rates • % impervious surface • Biodiversity • # coastal defense structures

2. Social

Candidate Variables:
• Demographics (age, race, class, gender, occupation) • Social networks and social embeddedness • Community values-cohesion • Faith-based organizations

3. Economic

Candidate Variables:
• Employment • Value of property • Wealth generation • Municipal finance/revenues

4. Infrastructure

Candidate Variables:
• Participation in hazard reduction programs (NFIP, Storm Ready) • Hazard mitigation plans

- Emergency services
- Zoning and building standards
- Emergency response plans
- Interoperable communications
- Continuity of operations plans

5. Institutional

Candidate Variables:
- Lifelines and critical infrastructure
- Transportation network
- Residential housing stock and age
- Commercial and manufacturing establishments

6. Community competence

Candidate Variables:
- Local understanding of risk
- Counseling services
- Absence of psychopathologies (alcohol, drug, spousal abuse)
- Health and wellness (low rates mental illness, stress-related outcomes)
- Quality of life (high satisfaction)

Referenece
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 Environment Change*. 18(4):598-606.

6. Folke, Carl. 2006

His article presents the origin of the resilience perspective and provides an overview of its development to date. The resilience approach emphasizes non-linear dynamics, thresholds, uncertainty and surprise, how periods of gradual change interplay with periods of rapid change and how such dynamics interact across temporal and spatial scales. The history was dominated by empirical observations of ecosystem dynamics interpreted in mathematical models, developing into the adaptive management approach for responding to ecosystem change. Serious attempts to integrate the social dimension is currently taking place in resilience work reflected new discoveries of linked social–ecological systems. Recent advances include understanding of social processes like, social learning and social memory, mental models and knowledge–system integration, visioning and scenario building, leadership, agents and actor groups, social networks, institutional and organizational inertia and change, adaptive capacity, transformability and systems of adaptive governance that allow for management of essential ecosystem services.

This conceptualisation of resilience treats disturbances in socio ecological systems as an opportunity. It equates resilience with the ability to use disturbances as occasions for doing 'new things, for innovation and for development'. This understanding encapsulates the idea that surprises in any system are inevitable and resilience will result from learning to live with uncertainty. This is in contrast to 'command and control' perspectives that seek to control the degree of variability and are successful only in the short term. A complex, interacting and dynamic system is therefore seen as a resilient system. In this conception, a resilient system is also reliant on groups performing different functions and responding differently to the same environmental change. Resilient systems have 'far from equilibrium dynamics' meaning that the complexities of systems make it impossible to predict paths of recovery as socio-ecological systems can never be the same after a disturbance. Instead of conceptualising the system as one that has an equilibrium to which it must return after a disturbance, it is therefore more useful

to look at it as having a 'domain of attraction', a dynamic state where different system elements have different equilibriums around which they are organised.

Reference:
Folke, C. (2006). 'Resilience: The Emergence of a Perspective for Social-Ecological Systems Analyses' *Global Environmental Change*. 16:253-267.

7. Holling, C. S. 1973

Holling understood resilience to be a measure of the ability of ecological systems to persist in the face of disturbance and maintain relationships between different elements of the system. Resilience springs from understanding of natural systems as dynamic and being away from an 'equilibrium' or stable state at any point, instead being organised in a domain of attraction in which different elements of a system are organised around different, individual equilibriums. Events in ecological systems are essentially non-linear and the 'randomness' of events within a system will be further exacerbated by human actions. Indeed, Holling argues that a certain degree of fluctuation in a system may actually improve the system's ability to persist in the face of change. Therefore while a disturbance might change the position of particular elements in this system, the system will persist if the nature of the relationships between these elements broadly remains the same.

Holling additionally focused on the significance of embracing a regional perspective on events in a system rather than a narrower, local one as relationships within a system might not be immediately clear at the micro level. He also added that heterogeneity in systems contributes to enhanced resilience and spatially and temporally homogenous environments have a lower versatility.

This conceptualisation has been used in particular in ecosystem management approaches, with resilience based on keeping options open, recognising that perfect knowledge can never be achieved, that future events can never be perfectly anticipated and drawing on complexity theory and systems thinking. Emphasis is also given to flexibility in management approaches, stressing adaptable generic guidelines instead of rigid steps.

Reference:
Holling, C. S. (1973). 'Resilience and Stability of Ecological Systems' *Annual Review of Ecology and Systematics*. 4:1-23.

8. Manyena, S. B. 2006

Resilience is conceptualised as the ability of a system to adapt to environmental shocks and continue functioning without there being a change in its fundamental characteristics. This understanding underlines the importance of viewing resilience as a 'process' rather than only an outcome. Characteristics of a system resilient to natural disasters would therefore include a focus on recovery as opposed to a singular concentration on resisting shocks, effective adaptation to disturbances as opposed to attempts at only risk mitigation, and an attribution of importance to local knowledge and culture.

Reference:
Manyena, S. B. (2006). 'The Concept of Resilience Revisited' *Disasters*. 30.4: 433–50.

9. Mayunga, J. S. 2007

This understanding of community resilience to disasters springs from the sustainable livelihoods approach where social, economic, human, physical and natural capital are seen as the determinants of resilience. Each of these four capitals corresponds to a number of characteristics of resilient systems. For example, a strong base of social capital in the form of trust, norms and networks would lead to a high degree of coordination and cooperation in the community, evidenced by the presence of a large number of non-profit organisations. Similarly, human capital in the form of education, health, skills, knowledge and information will lead to, for instance, a high capacity to develop and implement an effective risk reduction strategy. Indicators of this would include high levels of educational attainment and good health.

1. Social capital

Indicators:

- Participation in voluntary organizations (Volunteerism): using registered non-profit organizations
- Involvement in social groups (Association densities): using recreational centers (bowling centers, and fitness centers), golf clubs, and sport organizations
- Civic and political participation: using three indicators: registered voters, civic and political organizations, and Census response rates for the decennial population and housing survey
- Religious participation
- Community attachment: using owner-occupied housing units
- Connection to working places: using two indicators: professional organizations and business organizations

2. Economic capital

Indicators:

- Income: Income was measured using two indicators: per-capita income and median household income
- Employment: using the percentage of people who are employed
- Property value: using the median value of owner occupied housing units
- Business: using business establishments
- Health insurance: using the percentage of people with health insurance

3. Physical capital

Indicators:

- Construction: using five indicators: building construction establishments, heavy and civil engineering construction establishments, highway, street, and bridge construction establishments, utility systems establishments and architecture and engineering establishments
- Environment: using two indicators: environmental consulting establishments and environmental and conservation establishments
- Land and building regulations: using three indicators: land subdivision establishments, legal services establishments, and building inspection establishments
- Land use planning: using landscape architecture and planning establishments
- Property insurance: using property and causality insurance establishments
- Research: using scientific research and development establishments
- College: using colleges, universities, and professional schools
- Housing: using two indicators: occupied housing units and vacant housing units
- Critical facilities: using eight indicators: hospitals, hospital beds, ambulances, fires stations, schools, licensed child care facilities, nursing homes, and hotels and motels
- Transportation: using three indicators: occupied housing units with a vehicle available, special need transportation services, and school and employee buses
- Communication: using five indicators: occupied housing units with telephone services, newspaper publishers, radio stations, television stations, and internet providers
- Emergency shelter and relief services: using three indicators: temporary shelters, community housing, and community food services' facilities

4. Human capital

Indicators:

1. Education attainment: using percentage of population with more than high school education
2. Health: using two indicators: physicians and health care support workers

3. Labor force (human resources): using the following sub-components
    - Construction: using four indicators: building construction workers, heavy and civil engineering construction workers, architecture and engineering workers, and highway, street, and bridge construction workers
    - Environment: using two indicators: environmental consulting workers and environmental and conservation workers
    - Land and building regulations: using three indicators: land subdivision workers, population employed in legal services, and building inspectors
    - Land use planning: using landscape architects and planners
    - Property insurance: using property and causality insurance workers
    - Mitigation: using five indicators: FEMA community rating system (CRS) score, comprehensive plans, zoning regulations, FEMA approved mitigation plans, and building codes
    - Citizen protection: using the population employed as fire fighters, prevention, and law enforcement workers
    - Research: using the population employed in scientific research and development services
    - College: using population employed in colleges, universities, and professional school
    - Language: using the population that speaks English language very well
    - Transportation: using the population employed in special need transportation services
    - Community and social services: using community and social workers

Reference:
Mayunga, J. S. (2007). 'Understanding and Applying the Concept of Community Disaster Resilience: A Capital-Based Approach' draft working paper prepared for the summer academy, Megacities as Hotspots of Risk: Social Vulnerability and Resilience Building, Munich, Germany, 22–28 July 2007.
Mayunga, J. S. (2013). Measuring the Measure: A Multi-dimensional Scale Model to Measure Community Disaster Resilience in the US Gulf Coast Region. 2013.

10. Osbahr, Henny. 2007

A deeper understanding of resilience in the context of climate change is constructed through an analysis of climate change adaptation interventions/projects. This is in order to identify specific elements of adaptation practice and intervention that might be important in enhancing longer-term resilience to climate change in developing countries. Multiple characteristics of resilience are identified including:

- The need for institutions that effectively translate scientific data into guidance for policymakers;
- Governments that are accountable for the distribution of risks in society;
- Donors engaged in climate change interventions over the long term (possibly through projects that last for more than five years);
- Formal training of communities using new thinking on adaptation: The employment of existing social and economic networks in spreading awareness on climate change adaptation and disaster risk reduction;
- Adaptation being thought of as a financially and commercially viable activity, possibly through the formulation of a business case for adaptation in the national budgets of countries.

Osbahr also highlights some useful policy options that would help to enhance successful adaptation:

1. Climate tools: there is a need for improved tools for climate change data analysis to provide information that is credible. Reinforcing and sustaining climate observation networks is essential if the full potential of climate information is to be realised for individual sectors. However, outputs are most effective for livelihood decision-making when integrated into multidisciplinary frameworks.

2. Reinforce local support networks: informal institutions mediate livelihood stability and it is critical that new initiatives in any sector do not replace or challenge these systems. Although, it is possible to build adaptation options without high levels of community stability, these are unlikely to be resilient in the longer-term.
3. Ensure multi-level institutional involvement in adaptation initiatives: this requires investment in institutional capacity at all scales, but especially at the district-local level and participation by local communities. This helps to generate 'networks of engagement', which are critical to shaping human capacity, by incorporating local knowledge and empowering those most affected by the impacts of climate change.
4. Build communication channels and forums: to support information/skills transfer and social learning. Improved communication offers opportunities for equitable pathways and decision making by poor people. Success depends on structured forums for sharing knowledge, technologies and skills, especially those that improve education and reinforce traditional networks.
5. Acknowledge the importance of heterogeneity of stakeholders: especially at local level where it is essential to capture 'key brokers' or entrepreneurs. This counters traditional aid approaches that target the most vulnerable. Equally, at the district and regional scale, it is important to create decision-making structures that bring together interdisciplinary stakeholders.
6. Develop innovative approaches to financing adaptation and building opportunities for resilient decision-making: For example, access to microcredit options that support local collective adaptation. The funding of relief efforts to support stability and coping are dealt with best through the reform of existing disaster relief funds. Instruments for the disbursement of adaptation funding need not deal solely with climate change aspects, indeed it would difficult to see how these would be defined as separate from development initiatives? However, the move to finance 'specific' adaptation projects in developing countries through the Adaptation Fund is an international priority. It is important to ensure that the private sector is not discouraged from investing in developing countries. The Adaptation Fund will be replenished predominately through the private sector contributions generated in developing countries, and it is aimed at supporting developing countries. However, it is unlikely that the adaptation fund will provide for current demands. Capturing private sector funding may secure funding closer to the figure of US$41bn estimated by the World Bank for adaptation (which does not include retrofitting). Index-based weather insurance and better access to microcredit might help to stimulate local level innovation. Currently these mechanisms still exclude the most vulnerable groups (e.g. pastoralists)

Reference:
Osbahr, H. (2007). 'Building Resilience: Adaptation Mechanisms and Mainstreaming for the Poor' *Human Development Report Occasional Paper*. Oxford: University of Oxford.

11. Rockefeller Foundation, 2009

This understanding of resilience is in specific reference to climate change and it is understood to be the capacity to respond to the impact of a changing climate while continuing to function regularly. Resilience results from the following characteristics.

Characteristics of resilience:
1. Flexibility at an individual, organizational, and systemic level, with each level able to respond and contribute to each situation, and to respond to shifting and unpredictable circumstances.

2. A multi-faceted skill set, including abilities that enable thorough preparation, such as comprehensiveness and detail-orientation; survival, such as quick decision making and resourcefulness; or rapid recovery, such as innovation and diligence.
3. Redundancy of processes, capacities, and response pathways within an institution, community, or system, to allow for partial failure within a system or institution without complete collapse.
4. Collaborative multi-sector approaches to planning, execution, and recovery, since no one sector has a monopoly on a particular impact and thus understanding the overlaps and gaps between sectors is critical.
5. Planning and foresight to prepare for identified impacts and risks. While it is impossible to plan for every possible set of impacts, and in many cases the cumulative effect of impacts is unknown, the process of planning brings learning, builds skills, and helps to create resilience.
6. Diversity and decentralization of planning, response, and recovery activities. A diversity of options has greater potential to match the particular scenario of impacts that occurs, while decentralization allows for parts of the system to continue operations even if other parts of the system are down.
7. Plans for failure so that break-downs happen gracefully, not catastrophically—for example, when flood gates break, they do so in a way that channels floodwaters to uninhabited floods zones, perhaps damaging property, but protecting human lives. Accepting that the unpredictability and uncertainty of climate risks and responses will ultimately lead to failure of some element of the system allows for failure-planning. In some cases returning to a pre-existing state will not be possible or will not be appropriate. Incremental failures and planning for failures will allow for real-time response and revision and will limit social, environmental, and economic costs. Total system failure limits response options and results in greater suffering.

Reference:
Rockefeller Foundation. (2009). 'Building Climate Change Resilience' *Rockefeller Foundation White Paper.*

12. Twigg, John. 2007

Twigg in his guidance note on 'Characteristics of a Disaster-resilient Community' defines resilience to be the ability of a community to absorb stress, capacity to manage, or maintain certain basic functions and structures, during disastrous events and the bounce-backability of a community after a disaster. He takes building blocks provided by the Hyogo Framework for Action (the global framework to guide disaster risk reduction efforts) to define five following thematic areas for action: governance, risk assessment, knowledge and education, risk management and vulnerability reduction, and disaster preparedness and response. He then devises three columns for each thematic area: components of resilience; characteristics of a disaster-resilient community; and characteristics of an enabling environment (dealing with wider institutional, policy and socioeconomic factors in supporting community-level resilience).

1. Governance

Resilience components:
- Policy, planning, priorities and political commitment
- Legal and regulatory systems
- Integration with development policies and planning
- Integration with emergency response and recovery
- Institutional mechanisms, capacities and structures; allocation of responsibilities
- Partnerships
- Accountability and community participation

2. Risk assessment

Resilience components:
- Hazards/risk data and assessment
- Vulnerability/capacity and impact data and assessment
- Scientific and technical capacities and innovation

3. Knowledge and education

Resilience components:
- Public awareness, knowledge and skills
- Information management and sharing
- Education and training
- Cultures, attitudes, motivation
- Learning and research

4. Risk management and vulnerability reduction

Resilience components:
- Environmental and natural resource management
- Health and well-being
- Sustainable livelihoods
- Social protection
- Financial instruments
- Physical protection: structural and technical measures
- Planning regimes

5. Disaster Preparedness and response

Resilience components:
- Organizational capacities and coordination
- Early warning systems
- Preparedness and contingency planning
- Emergency resources and infrastructure
- Emergency response and recovery
- Participation, voluntarism, accountability

Reference:

Twigg, J. (2009). *Characteristics of a Disaster-resilient Community: a guidance note.* London: University College London.

ANNEX 2
Key Features of ongoing efforts in resilience measurement

1. National level

Name (Developer)	Objective(s)	Component(s)
1. AGIR[1] Results Framework (AGIR)	Assessing resilience in terms of food and nutritional vulnerabilities	4 Pillars: strengthen and secure livelihoods & improve social protection/ strengthen nutrition/ sustainably strengthen agricultural and food productivity/ and strengthen the governance for food and nutritional security
2. Global Focus Model (UN/OCHA[2] & Maplecroft)	Assessing Risk and Vulnerability	Commercially available
3. Country Resilience Rating (World Economic Forum)	Assessing resilience of countries to global risks with emphasis on economic terms	4 components: robustness, redundancy, resourcefulness, response and recovery
4. Index for Risk Management (INFORM) (Inter-Agency Standing Committee Task Team for Preparedness and Resilience and the European Commission)	Assessing risk for humanitarian crisis and disasters	3 dimensions: hazard & exposure, vulnerability, and lack of coping capacity
5. Indicators of Disaster Risk and Risk Management (Inter-American Development Bank)	Assessing disaster risk and risk management (Program for Latin America and the Caribbean)	4 composite indicators: Disaster Deficit Index, Local Disaster Risk Index, Prevalent Vulnerability Index, and Risk Management Index
6. World Risk Index (WRI) (UNU-EHS[3])	Measuring disaster risk value for 173 countries	4 components: exposure, susceptibility, coping capacities, and adaptation

1.1. AGIR Results Framework (Global Alliance for Resilience)

AGIR is a global alliance to foster improved synergy, coherence and effectiveness of resilience initiatives in the region. Launched in December 2012, AGIRs roadmap includes a set of key performance and impact indicators.

The objectives of AGIR and the related indicator framework focus on food and nutritional vulnerability and resilience. It aims to structurally reduce, in a sustainable manner, food and nutritional vulnerability by supporting the implementation of Sahel and West African policies"- Zero Hunger in 20 years.

The following 4 pillars have been laid out in this framework. Three out of four outcomes and the related indicators refer to food and nutrition, while one refers to social protection. The indicators are mostly drawn from the region's existing policies and programmes, as well as from regional and international initiatives in which many countries in the region participate, such as the Scaling-Up Nutrition movement.

1. To restore, strengthen and secure livelihoods & improve social protection for the most vulnerable communities and household

Indicators:
• Formulation and implementation of programmes & appropriate safety nets mechanisms (number of countries that have formulated and implemented coherent social safety programmes of nets for Food and Nutrition)

[1] Global Alliance for Resilience
[2] United Nations Office for the Coordination of Humanitarian Affairs
[3] Institute for Environment and Human Security (EHS) of the United Nations University (UNU)

- Effective establishment and functionality of the regional food security reserve
- Number of rural municipalities or local structures with functional local mechanisms of solidarity to address food crises

2. To strengthen nutrition of vulnerable households

Indicators:

- Formulation and implementation of structural programmes for the: (i) access to nutrition and health services, (ii) prevention and treatment of diseases with high morbidity, mortality, (iii) reproductive health
- Formulation and implementation of specific programmes focused on infant and young child feeding
- Integration of nutrition issues in other sectoral development policies: (i) the objectives and nutritional outcomes clearly formulated in sectoral policies, (ii) an institutional position of 'Nutrition' adequately established.
- Establishing legal and financial frameworks for the implementation of nutrition priority actions in the countries

3. To sustainably strengthen agricultural and food productivity and incomes of vulnerable households and improve their access to food

Indicators:

- Significant increase in the volume of investments (in particular States' own resources) for the implementation of NAIP (especially the priorities 'Resilience') and in particular the development of agriculture ecologically intensive and sustainable
- Formulation and effective implementation of economic diversification programmes, especially for women in structurally vulnerable areas
- Strengthening institutional mechanisms of governance of natural resources at local, national and regional levels
- Implementation of local, national and regional land security mechanisms in favour of family farms, agro-pastoralists and pastoralists, particularly women and youth.
- Implementation of policy and financial frameworks to strengthen countries' land governance
- Formulation and adoption of the regional land Charter
- Establishment of operational mechanisms of agricultural risk management (functionality / effective reactivity of the platform for agricultural risk management) and Climate-Smart Agriculture
- Adoption and implementation of legislation and financial frameworks to support local industry and trade: (i) fertilizer, (ii) processed food and nutritional products (fortified foods) from local agricultural commodities
- Appropriate Financing systems tailored to the needs and specificities of family agriculturalists, agro-pastoralists, pastoralists (microcredit, insurance)
- Formulation and adoption of regional instruments (in support of production and trade) to support strategic food chains for food and nutrition security (RAIP)
- Appropriate Systems / Institution of Research and Extension for enhanced access of family agriculturalists, agro-pastoralists, pastoralists agricultural to agricultural services, in particular: (i) environmentally and economically sustainable agriculture with a focus on the sustainable management of soil fertility and natural resources, (ii) the resilience of production systems to climate risks and other disasters
- Policy and financial frameworks to strengthen the capacity of States to the implement community rules on free trade of agricultural and food products

4. To strengthen the governance for food and nutritional security

Indicators:

- A functional 'PREGEC' and a Framework for food and nutrition vulnerability (CH) applied in accordance with the Charter for food crises prevention and management
- Formulation and implementation of programmes to strengthen community-based food security early warning and the prevention of disasters risks mechanisms (SCAP)
- Operational Mechanisms- frameworks at local / community, national and regional levels for prevention, adaptation to climate change and disaster risk reduction (DRR)
- Policy, legal and financial frameworks for the consideration of the role of women in strategies and programmes for food security and nutrition
- Operational framework for external review of the Charter for food crisis prevention and management
- Establishment of an international platform for exchange and coordination (under the political leadership of the regional organizations) within the RPCA
- Policy alignment with the results framework of the 'Resilience' at national, regional and international levels

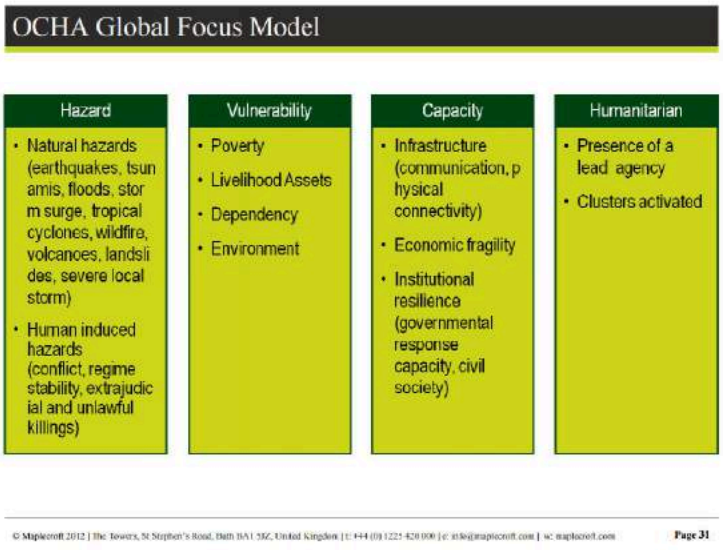
- Operational frameworks to capitalize good practices and to support innovation & anticipation

Key source:
Global Alliance for Resilience. (2013). *Regional Roadmap (draft)*. Available at http://www.oecd.org/swac/publications/AGIR%20draft%20roadmap_ENG_29%20March.pdf
Global Alliance for Resilience. (2013). *Regional Roadmap (adopted on 9 April 2013)*. http://www.oecd.org/swac/publications/AGIR%20roadmap_EN_FINAL.pdf

1.2. **Global Focus Model** (UN/OCHA & Maplecroft)

OCHA developed a risk model in 2007 to analyze natural and human-induced hazards, vulnerabilities and response capacity at the country-level using a range of quantitative indicators. Since then, the model has been adopted as a corporate risk model and updated each year as part of OCHA's annual work planning cycle. The 2012 Global Focus Model (GFM) has been rebuilt in conjunction with Maplecroft.

The Global Focus Model is designed to answer several core questions: Which populations are most exposed to hazards that could trigger a humanitarian emergency? What factors influence a hazard's impact on a population? What factors influence the ability of a community and society to cope with the impact of a hazard? To what extent is OCHA likely to have a role in a country, given the organisation's mandate, tools and services?



The model seeks to answer these questions through analysis of data in four areas: hazards, vulnerability, capacity and the demand for humanitarian coordination support. These categories follow international standards for the calculation of risk, while allowing flexibility to account for factors specific to OCHA's humanitarian mandate. The sub-index on capacity directly relates to resilience. The sub-index reflects capacity of government and civil society, comprising economic health, institutional resilience and infrastructure at equal weights.

1. Infrastructure (33.3%)

Indicators:
- communication (comprised of indicators on adult literacy rates, household electrification, rates of internet usage, mobile phone subscriptions and fixed telephone lines),

- physical connectivity (comprised of indicators reflecting both the absolute and relative numbers of people living distant from cities and the density of road and rail lines)

2. Economic Fragility (33.3%)

Indicators:
- per capita GDP using Purchasing Power Parity (PPP)
- total GDP

3. Institutional Resilience (33.3%)

Indicators:
- government effectiveness score from the World Bank's governance indicators reflect the ability of a government to organise an effective response,
- size of the military is used as a proxy for logistical response capacity
- civil society capacity considers the extent of non-governmental organisations and the ability of civil society to function without hindrance from the state

Key source:
Hodge, H. (2012). *Maple Croft and Global Focus Model: Risk, Responsibility, and Reputation.* Available at https://interagencystandingcommittee.org/system/files/legacy_files/Maplecroft_GFM_050412.pdf

1.3. **Country Resilience Rating** (World Economic Forum)

Country Resilience Rating believes that resilience applies to different entities, ranging from communities to countries, but the critical point is to avoid examining any of them in isolation. It views country as a system that is comprised of smaller systems and a part of larger systems. A country's resilience is affected by the resilience of those smaller and larger systems. Systems thinking provide a foundation to assess resilience through considering such components as the system's robustness, redundancy, resourcefulness, response and/or recovery.

World Economic Forum (WEF) developed this diagnostic tool intended to measure the resilience of a country to global risks by treating it as a system composed of subsystems. Several methods already exist to measure the resilience of such subsystems, mostly as they relate to the economy or ecosystem. But what makes an economic system resilient is different from what makes an ecological system resilient (not only are the threats and risks different, but so are the interconnections with other systems). Therefore, WEF presents a prototype framework to measure a country's overall resilience via a five-part initial framework. This framework considers the country as comprised of five core subsystems:

1. Economic subsystem: includes aspects such as the macroeconomic environment, goods and services market, financial market, labour market, sustainability and productivity.
2. Environmental subsystem: includes aspects such as natural resources, urbanization and the ecological system.
3. Governance subsystem: includes aspects such as institutions, government, leadership, policies and the rule of law.
4. Infrastructure subsystem: includes aspects such as critical infrastructure (namely communications, energy, transport, water and health).
5. Social subsystem: includes aspects such as human capital, health, the community and the individual.

Each of the five subsystems is assessed further using five components of resilience: 1) robustness, 2) redundancy, 3) resourcefulness, 4) response and 5) recovery. These five components can be categorized further into two types: resilience characteristics (robustness, redundancy and resourcefulness) and resilience performance (response and recovery). Each component of resilience is further defined by key attributes, and for each of these attributes, potential qualitative and quantitative indicators have been identified. The proposal is to combine for each component quantitative data from secondary sources (mostly from already existing aggregated indices) with primary data on perceptions from the World Economic Forum's well-established Executive Opinion surveys. The World Economic Forum defined such a framework in a special report on national resilience of its Global Risks Report 2013.

Resilience Components	Component Attributes	Potential Executive Opinion Survey Indicators	Potential Quantitative Indicators
Robustness	Monitoring system health	Quality of natural environment Quality of healthcare system Quality of overall infrastructure Quality of education system	Logistics Performance Index from the World Bank
	Modularity	State cluster development	Economic Freedom of the World Index from Gwartney, J., Lawson, R., & Clark, J. R. *Economic Freedom of the world, 2012.*
	Adaptive decision-making models	Willingness to delegate authority	Index of Economic Freedom from *2012 Index of Economic Freedom*, the Heritage Foundation.
Redundancy	Redundancy of critical infrastruc-ture	Quantity of local suppliers	Reserves Renewable freshwater resources Density of physicians from *World Health Statistics*, World Health Organization.
	Diversity of solutions and strategy	Value chain breadth	Environmental Performance Index (Ecosystem Vitality) from *Environmental Performance Index*, Yale University.
Resourcefulness	Capacity for self-organization	Accessibility of digital content Extent to which virtual social networks are used	Education Index from *International Human Development Indicators*, United Nations Development Programme.
	Creativity and innovation	Latest technologies	Research and development expenditure as a percentage of gross domestic production from *World Development Indicators*, the World Bank.
Response	Communi-cation	Public trust in politicians	Media Sustainability Index from IREX.
	Inclusive participation	Business-government relations	Business regulatory environment Structural policies cluster from *Country Policy and Institutional Assessment*, the World Bank.
Recovery	Responsive regulatory feedback mechanisms	Reform implementation efficiency	Actionable Governance Indicators from *Actionable Governance Indicators Data Portal*, the World Bank.
	Active "horizon scanning"	Collaboration within clusters	Some studies have suggested potential quantitative data for this attribute including developing public-private partnerships for Research and Development and Innovation and promoting centres and networks of excellence, regional research driven clusters and innovation poles (Manjón, J. & Vicente J. A Proposal of Indicators and Policy Framework for Innovation Benchmark in Europe. In *Journal of Technology Management and Innovation*, 2010, 5:13-23.)

Reference

World Economic Forum. (2013). *Global Risks 2013 Eighth Edition: An Initiative of the Risk Response Network.* Available at http://www3.weforum.org/docs/WEF_GlobalRisks_Report_2013.pdf

1.4. Index for Risk Management (INFORM) (Inter-Agency Standing Committee Task Team for Preparedness and Resilience and the European Commission

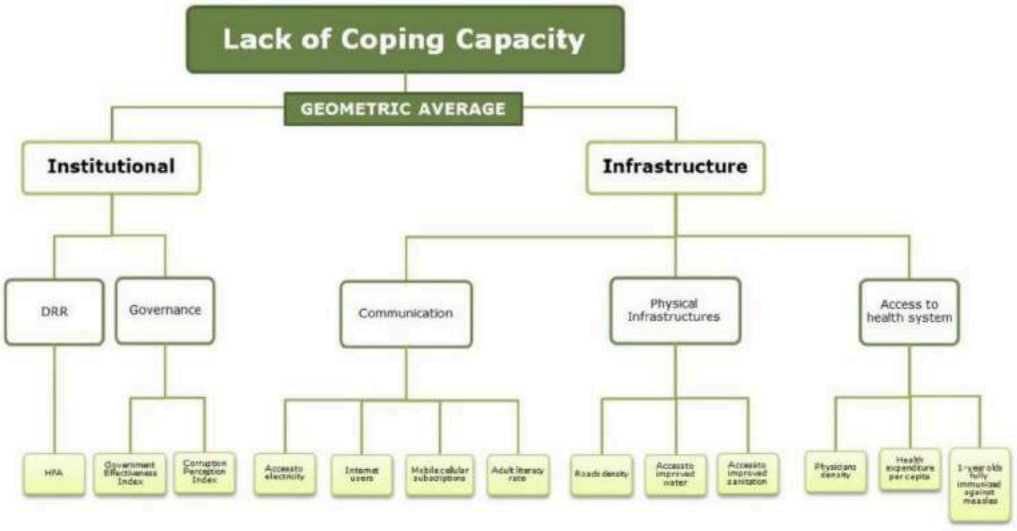
The INFORM model is based on risk concepts published in scientific literature and envisages three dimensions of risk: hazards & exposure, vulnerability and lack of coping capacity dimensions. They are conceptualized in a counterbalancing relationship: the risk of what (natural and human hazard), and the risk to what (population). The model balances two major forces: the hazard & exposure dimension on one side, and the vulnerability and the lack of coping capacity dimensions on the other side. Hazard dependent factors are treated in the hazard & exposure dimension, while hazard independent factors are divided into two dimensions: the vulnerability dimension that considers the strength of the individuals and households relative to a crisis situation, and the lack of coping capacity dimension that considers factors of institutional strength.

The model adopts the three aspects of vulnerability reflected in the UNISDR definition. The aspects of physical exposure and physical vulnerability are integrated in the hazard & exposure dimension, the aspect of fragility of the socio-economic system becomes INFORM's vulnerability dimension while lack of resilience to cope and recover is treated under the lack of coping capacity dimension. The split of vulnerability in three components is particularly useful for tracking the results of disaster reduction strategies over time. Disaster risk reduction activities are often localized and address particular community-level vulnerabilities and capacities. In order to accommodate the INFORM methodology, where the vulnerability variable is split among three dimensions, the equation is updated to:

$$Risk = Hazard\&Exposure^{1/3} \times Vulnerability^{1/3} \times Lack\ of\ coping\ capacity^{1/3}$$

It is a multiplicative equation. The risk equals zero if one of the three dimensions above is zero. Theoretically, in case of tropical cyclones there is no risk if there is no likelihood of a tropical cyclone to occur or/and the hazard zone is not populated or/and if the population is not vulnerable (e.g., all people have high level of education and live in high level of health and livelihood condition as well as they can afford houses built to a high level of wind security) or/and if the resilience of the country to cope and recover is ideal.

For the coping capacity dimension, the question is which issues the government has addressed to increase the resilience of the society and how successful their implementation is. The coping capacity dimension measures the ability of a country to cope with disasters in terms of formal, organized activities and the effort of the country's government as well as the existing infrastructure which contribute to the reduction of disaster risk. It is aggregated by a geometric mean of two categories: institutional and infrastructure. The difference between the categories is in the stages of the disaster management cycle that they are focusing on. If the institutional category covers the existence of DRR programmes which address mostly mitigation and preparedness/early warning phase, then the infrastructure category measures the capacity for emergency response and recovery.



Reference
INFORM website at http://www.inform-index.org/

1.5. Indicators of Disaster Risk and Risk Management (Inter-American Development Bank)

The framework proposed has four components or composite indicators designed to represent the main elements of vulnerability and show each country's progress in managing risk. The four indicators are the Disaster Deficit Index (DDI), the Local Disaster Index (LDI), the Prevalent Vulnerability Index (PVI), and the Risk Management Index (RMI).

1. The Disaster Deficit Index (DDI) measures country risk from a macroeconomic and financial perspective according to possible catastrophic events. It requires the estimation of critical impacts during a given period of exposure, as well as the country's financial ability to cope with the situation. DDI relates assumed (deductive) indicators and depends on the simple modeling of physical risk as a function of the occurrence of a potentially extreme hazard (scientific prediction).
2. The Local Disaster Index (LDI) identifies the social and environmental risks resulting from more recurrent lower level events (which are often chronic at the local and subnational levels). These events have a disproportionate impact on more socially and economically vulnerable populations, and have highly damaging impacts on national development. LDI relies on indicators of past events with different impact levels (history).
3. The Prevalent Vulnerability Index (PVI) is made up of a series of indicators that characterize prevalent vulnerability conditions reflected in exposure in prone areas, socioeconomic weaknesses and lack of social resilience in general. PVI is composites derived by aggregating quantitative and qualitative indicators.
4. The Risk Management Index (RMI) brings together a group of indicators that measure a country's risk management performance. These indicators reflect the organizational, development, capacity and institutional actions taken to reduce vulnerability and losses, to prepare for crisis and to recover efficiently from disasters. RMI is composites derived by aggregating quantitative and qualitative indicators.

The system of indicators covers different areas of the risk problem, taking into account issues such as: potential damages and losses resulting from extreme events; recurrent disasters or losses; social and environmental conditions that make particular countries or regions more disaster prone; the capacity of the economy to recover; the operation of key services; institutional capacity and the effectiveness of basic risk management instruments (such as risk identification, prevention and mitigation measures, financial mechanisms and risk transfer); emergency response levels; and preparedness and recovery capacity.

The indices were constructed using a multi-attribute technique and the indicators were carefully related and weighted. The indicators and the variables used in their construction were chosen through an extensive review of the risk management literature, assessment of available data, and broad-based consultation and analysis.

Details	Objectives	Meaning
1. Disaster Deficit Index (DDI) = $\frac{Maximum\ Considered\ Event\ (MCE)\ Loss}{Economic\ Resilience}$		
1.1. MCE Loss ● Calculated in probabilistic form ● Analytical and predictive model based on the intensity of the phenomena (not on historical measures of losses) ● Defined with an arbitrary return period **1.2. Economic Resilience** (Resources Potentially Available to the Government) ● Representing internal and external resources available to the government ● 7 constrains are taken into consideration	● Measuring the economic loss that a country suffer when a catastrophic event takes place and the implications in terms of resources needed to address the situation ● Capturing the relationship between the demand for contingent resources to cover the losses caused by the Maximum Considered Events (MCE) and the public sector's economic resilience (availability funds for restoring affected inventories) ● Measuring a country's fiscal exposure and potential deficit in case of an extreme disaster	**High** DDI means : - inability to cope with extreme disasters - greater gap between losses and the country's ability to face them - government responsibility was restricted to the sum of loss associated with public sector buildings and housing for the lowest income population
2. Local Disaster Index (LDI) = $LDI_{Deaths} + LDI_{Affected} + LDI_{Losses}$		
● Using data & information from **DesInventar** of 6 phenomena (1&2) external and internal geodynamic (3) hydrological (4) atmospheric (5) technological and (6) biological ● The database takes into account 3 variables (1) The number of deaths (2) The number of people affected by the events (3) Direct losses (the economic value of housing and crops lost or damaged)	● Representing the propensity of a country to experience small-scale disasters and their cumulative impact on local development and the country as a whole	**Low** LDI = high concentration of small disasters in few municipalities and a low spatial distribution of their effects between municipalities where they had taken place **Medium** LDI = small disasters concentration and distribution of their effects are intermediate **High** LDI = the majority of municipalities suffer small disasters and their effects are similar
3. Prevalent Vulnerability Index (PVI) = $\frac{PVI\ Exposure + PVI\ Fragility + PVI\ Lack\ of\ Resilience}{3}$		
● Based on relationship between risk and development that is vulnerability, therefore risk, are the result of inadequate economic growth and deficiencies that may be corrected by means of adequate development processes ● Weighted using the Analytic Hierarchy Process (AHP)	● Depicting predominant vulnerability conditions ● Reflecting susceptibility due to the level of physical exposition of goods and people, which favor the direct impact. ● Reflecting conditions of social and economic fragilities which favor the indirect and intangible impact.	**PVI varies from 0-100** **PVI>80** = very high vulnerability **40<PVI<80** = high vulnerability **20<PVI<40** = medium vulnerability **20>PVI** = Low vulnerability

Details	Objectives	Meaning
	• Reflecting the lack of capacity to absorb the consequences, efficiently respond and recover	
PVI has 3 following sub-indicators. **3.1. PVI Exposure & Susceptibility** • reflecting the nation's susceptibility to dangerous events • consisting of 8 indicators including (1) Population growth, avg. annual rate (2) Urban growth, avg. annual rate (3) Population density (4) Poverty (5) Capital stock in millions USD per 1,000 km² (6) Imports and exports of goods and services (% of GDP (7) Gross domestic fixed investment (% of GDP) and (8) Arable land & permanent crops (% of land area) **3.2. PVI Socioeconomic Fragility** • showing that there is an intrinsic predisposition for adverse social impacts in the face of dangerous phenomena • consisting of 8 indicators including (1) Human Poverty Index (2) Dependants as a proportion of the working age population (3) Inequality as measured by the GINI coefficient (4) Unemployment (% of total labour force) (5) Annual increase in food prices (6) Share of Agricultural in total GDP growth (7) Debt service burden (% of GDP), and (8) Soil degradation resulting from human activities **3.3. PVI Lack of Resilience** • Capturing the capacity to recover from or absorb the impact of dangerous phenomena • consisting of 8 indicators including (1) Human Development Index (2) Gender-related Development Index (3) Social expenditures on pensions, health, and education (% of GDP) (4) Governance Index (5) Infrastructure and Housing insurance (% of GDP) (6) TV sets per 1,000 people (7) Hospital beds per 1,000 people and (8) Environmental Sustainability Index		
4. Risk Management Index (RMI) = $\frac{RMI\ Risk\ Identification+RMI\ Risk\ Reduction+RMI\ Disaster\ Management+RMI\ Governance}{4}$		
• RMI is constructed by quantifying 4 public policies including the identification of risk, risk reduction, disaster management, and governance and financial protection.	• assessing risk management performance based on predefined targets or benchmarks that risk management efforts should aim to achieve	**High RMI** = High performance of risk management in the country
RMI consists of 4 following sub-indicators. **4.1. RMI Risk Identification** • Measuring individual perceptions, how those perceptions are understood by society as a whole, and the objectives of risk • consisting of 6 indicators (1) Systematic inventory of disasters and losses (2) Hazard monitoring and forecasting (3) Hazard evaluation and mapping (4) Vulnerability and risk assessment (5) Public information &communication participation, and (6) Risk Management training and education **4.2. RMI Risk Reduction** • Involving prevention and mitigation measures • consisting of 6 indicators (1) The extent to which risk is taken into account in land use and urban planning (2) Management of river basins and environment protection (3) Implementation of control and protection techniques prior to hazard events (4) Relocation of persons living in disaster prone areas and improvements to housing in those areas (5) Updating and enforcement of safety standards and construction codes, and (6) Reinforcing and retrofitting of public and private assets **4.3. RMI Disaster Management** • Involving measures of response and recovery • consisting of 6 indicators (1) Organization and coordination of emergency operations (2) Emergency response planning and implementation of warning systems (3) Supply of equipment, tools and infrastructure (4) Simulation, updating and testing of inter-institutional response capability (5) Community preparedness and training, and (6) Rehabilitation and reconstruction planning **4.4. RMI Governance and Financial Protection** • Measuring the degree of institutionalization and risk transfer • consisting of 6 indicators (1) Decentralized organizational units, inter-institutional and multi-sector coordination (2) Availability of resources for institutional strengthening (3) Budget allocation and mobilization (4) Existence of social safety nets and funds (5) Insurance coverage and loss transfer strategies for public assets, and (6) Housing and private sector insurance and reinsurance coverage		

Referene
Cardona, O. D. (2003). 'The Need for Rethinking the Concepts of Vulnerability and Risk from a Holistic Perspective: A Necessary Review and Criticism for Effective Risk Management'. in G. Frerks, G. Bankoff, & D. Hilhorst (Eds.), *Mapping Vulnerability: Disasters, development, and people*. London:Earthscan.
Cardona, O.D. (2005). *Indicators of Disaster Risk and Risk Management: Summary Report*. Washington D.C.: Inter-American Development Bank.

1.6. World Risk Index (WRI) (UNU-EHS)

The World Risk Index identifies and ranks regions and countries that face a high disaster risk. The index uses 28 indicators to calculate and compare risk values for 173 countries. The index is designed and tracked by the Institute for Environment and Human Security (EHS) of the United Nations University (UNU). The index is reported in the World Risk Report.

The composite index consists of a set of indicators that track natural hazards (the natural hazard sphere) and vulnerabilities (the societal sphere):

Countries are ranked based on four key components that take both natural hazards and social factors into account.

1. exposure to natural hazards and potential risks

Natural Hazards:	Indicators:
• Earthquake • Storms • Floods • Droughts • Sea level rise	• Number of people in a country who are exposed to the natural hazards earthquakes (A), cyclones (B) and/or flooding (C) • Number of people in this country who are threatened by drought (D) and/or sea level rise (E) (each weighted half owing to the uncertainty of the data base) • Number of total population in country

2. susceptibility as the likeliness of suffering harm, susceptibility as a function of public infrastructure, housing conditions, nutrition, poverty and dependencies, and economic capacity and income distribution

Indicators:
1. Public infrastructure
   - Share of the population without access to improved sanitation
   - Share of the population without access to an improved water source
2. Nutrition
   - Share of population undernourished
3. Poverty and dependencies
   - Dependency ratio (share of under 15- and over 65-year-olds in relation to the working population)
   - Extreme poverty population living with USD 1.25 per day or less (purchasing power parity)
4. Economic capacity and income distribution
   - Gross domestic product per capita (purchasing power parity)
   - Gini index

3. coping capacities related to governance and authorities, disaster preparedness and early warning, medical services, social networks and material coverage

Indicators:
1. Government and authorities
   - Corruption Perceptions Index
   - Good governance (Failed States Index)
2. Medical services

- Number of physicians per 10,000 inhabitants
- Number of hospital beds per 10,000 inhabitants

3. Material coverages
   - Insurances (life insurances excluded)

4. adaptive capacities related to education and research, gender equity, environmental status and ecosystem protection, adaptation strategies and investments

Indicators:

1. Education and research
   - Adult literacy rate
   - Combined gross school enrolment
2. Gender equity
   - Gender parity in education
   - Share of female representatives in the National Parliament
3. Environmental status / Ecosystem protection
   - Water resources
   - Biodiversity and habitat protection
   - Forest management
   - Agricultural management
4. Investment
   - Public health expenditure
   - Life expectancy at birth
   - Private health expenditure

The third and fourth component - coping capacities and adaptive capacities - directly relate to resilience capacities. The index makes use of existing composite indicators such as the Corruption Perception Index and the Failed States Index as well as standard high-level development measurements like the adult literacy rate or the share of female representatives in parliament.

Reference

World Risk Report website at http://worldriskreport.entwicklung-hilft.de/WorldRiskReport,435,0.html

2. Sub-national level

Name (Developer)	Objective(s)	Component(s)
1. Baseline Resilience Indicators for Communities (BRIC) (University of South Carolina)	Measuring baseline resilience of a community	4 sets of metrics: social vulnerability, Built Environment and Infrastructure, Natural Systems and Exposure, and Hazards Mitigation and Planning for Resilience
2. Community Based Resilience Analysis (CoBRA) (UNDP Drylands Development Centre)	Developing community-based resilience analysis and assessing resilience based on food and basic needs	5 categories: Physical, Human, Financial, Natural, and Social
3. DRLA/UEH Evaluation Resilience Framework for Haiti (Tulane University / University of Haiti)	Measuring the relationship between a shock, humanitarian assistance and resilience	7 components: wealth/ debt and credit/ coping behaviours/ human capital/ protection and security/ community networks/ and psychosocial status
4. FAO Resilience Tool (FAO[4])	Understanding the most effective combination of short and long term strategies for lifting families out of cycles of poverty and hunger and measuring households resilient to food security shocks	6 components: assets, income and food access, access to basic services, social safety, adaptive capacity, and stability
5. Livelihoods Change Over Time (LCOT) (Tufts University, Mekelle University)	Assessing ability to "bounce back" from major regional food security crises in Northern Ethiopia	3 types of analysis: a) household welfare over time, b) food security dynamics, c) poverty traps
6. PEOPLES Resilience Framework (Multidisciplinary Center for Earthquake Engineering Research: MCEER)	Comprehensive measurement framework building upon MEERC R4 resilience framework and TOSE domain to assess resilience in a community	7 components: population & demographics/ environmental & ecosystem/ Organized governmental services/ Physical infrastructure/ Lifestyle and community competence/ Economic development/ and social-cultural capital
7. Resilience Capacity Index (RCI) (Network on Building Resilient Regions (BRR))	Gauging of a region's foundation for responding effectively to a future stress Assessing regional strengths and weaknesses in the US, and comparing their region's capacity profile to that of other metropolitan areas	3 components: regional economic capacity, socio-demographic capacity, and community connectivity capacity
8. ResilUS (Western Washington University)	Prototyping simulation model of community resilience in U.S. in terms of disaster recovery from disasters based on the measurable aspects of community capital: and operationalizing community resilience across multiple, hierarchical scales – household/business, neighbourhood, and community – in relation to a range of policy and decision variables associated with each scale	5 components according to 5 elements of community capitals: Physical, Economic, Socio-cultural, Personal, and Ecological capitals.
9. Risk Reduction Index (RRI) (DARA)	Measuring local perception on risk drivers (For Latin America and Western Africa)	4 components of risk drivers: environment and natural resources, socio-economic conditions, land use and the built environment, and governance
10. USAID resilience domain framework (USAID)	Developing matrix with a set of indicators for 3 objectives and the goal of increased resilience of chronically	6 domains: income & food access, assets, adaptive capacity, social capital and safety nets, governance, nutrition and health

[4] Food and Agriculture Organization of the United Nations

	vulnerable populations and measuring community resilience	

2.1. Baseline Resilience Indicators for Communities (BRIC) (University of South Carolina)

The Baseline Resilience Indicators for Communities (BRIC) are based on the Disaster Resilience of Place (DROP) model that provides a conceptualization for understanding and measuring community-level resilience to natural hazards. Developed at the Department of Geography and Hazards & Vulnerability Research Institute at the University of South Carolina, USA, in 2008, the model proposes to measure inherent community resilience through the use of a limited set of indicators for the ecological, social, economic, institutional dimension, for infrastructure and for community competence.

The inherent resilience potion of the DROP model was operationalized and refined in 2010 in a Baseline Resilience Indicators for Communities metric (BRIC) together with the Community and Regional Resilience Institute (CARRI). The BRIC proposes a methodology and a set of indicators for measuring baseline characteristics of communities that foster resilience. Baseline characteristics are the antecedent conditions within communities before the implementation of any programs, policies, and interventions that foster resilience.

There are four following key sets of metrics needed to build a profile or baseline of community resilience. Each of these components is briefly described and list of candidate variables is provided.

1. Social Vulnerability: The most often used metric for social vulnerability is the Social Vulnerability Index (SoVI), which uses a broad set of indicators to explore differences in social vulnerability among places using census geography (counties, census tracts, census block groups). SoVI graphically illustrates the uneven capacity for preparedness and response and highlights areas where differences in underlying social vulnerabilities are the greatest.

Indicators:
• Race and ethnicity: % African American; % Native American; % Asian or Pacific Islanders; % Hispanic • Age: % population under 5 years old; % population 65 or older; median age • Socioeconomic status: Per capita income; % families earning more than $100,000; median dollar value of owner-occupied housing • Gender: % female; % females in civilian labor force • Employment: % of the civilian labor force unemployed; % civilian labor force participation • Education: % population over 25 with less than high school education • Household structure: Average number of people per household; % families living in poverty; % female-headed households, no spouse present • Access to services: Number of physicians per 100,000 population; % rural farm population; % urban population • Occupation: % employed in fishing, farming, forestry; % employed in transportation, communications, public utilities; % employed in service occupations • Housing: % housing units that are mobile homes; % renter-occupied housing units; median gross rent ($) for renters • Special needs: Nursing home residents per capita; % Social Security recipients; % migrate to the United States from abroad in last 5 years

2. Built Environment and Infrastructure: Measures of the built environment and infrastructure provide an overall assessment of the amount of public and private property that could be damaged by disasters, and the likely economic losses. It also provides an indicator of the community response capacity (e.g., public safety structures, shelters, health care facilities), as well as the identification of critical

infrastructure such as pipelines, roads and bridges, water treatment and storage, communications, and power transmission.

Indicators:

- Residential: Median age of housing units, Housing units built before 1960, Density of housing units, Density of mobile homes, Number of building permits for new housing units, Daily water usage, Value of all residential property
- Commercial and industrial development: # commercial establishments, # manufacturing establishments, Value of sales for all businesses ($), value of all sales for all farms, Industrial earnings ($), Banking offices, Private non-farm business establishments, Hazardous materials facilities, # Small businesses, # marinas
- Lifelines: Hospitals, Schools, Electric power facilities, Potable water facilities, Wastewater facilities, Dams, Police stations, Fire stations, Oil and natural gas facilities, Nuclear facilities, Emergency centers, Number of hospital beds, Communications towers/antennae
- Transportation infrastructure: Airports, Bus terminals, Ferry facilities, Interstate miles, Other principal arterial miles, Fixed transit and ferry network miles, Rail miles, Highway and rail bridges, Ports
- Monuments and icons: Churches, Landmark and Historic registry buildings, parks, social organizations

3. Natural Systems and Exposure: There is more research on natural systems indicators of sustainability and resilience than on any other component. In coastal areas, for example, wetlands and dunes offer a buffer against impending storm surges, while biodiversity enables the system to recover more quickly after a disturbance. Species at risk from over-harvesting, pollution, or habitat degradation influence the economic vitality of communities dependent upon them for their livelihoods and thus incur an economic loss when nature's services are diminished.

Indicators:

- Area of dunes
- Average dune height
- Average beach width
- Erosion rates
- Acreage of wetlands
- Wetland/habitat loss (% change from previous decade)
- Acreage of undisturbed habitat
- Coastal subsidence (rate per year)
- Sediment supply (estimated berms and offshore bars)
- # and location of coastal defenses (groins, jetties, seawalls, revetments)
- # and size of storm water detention basins
- Water contamination (surface and ground)
- 100-year and 500-year flood zones delineations
- Storm surge inundation zones
- Land cover classification
- Amount of impervious surfaces
- Projected Sea Level rise from Intergovernmental Panel on Climate Change reports IPCC

4. Hazards Mitigation and Planning for Resilience: There is considerable evidence in the literature that risk reduction and hazards mitigation planning offer the best path towards enhancing community. As communities consist of physical infrastructure, emotional ties, and cultural institutions, it is difficult to adequately measure many of these less tangible components that foster resilience. These include elements such as local leadership, social capital and networks, the role of faith-based institutions within the community, non-governmental organizations, and most importantly, the values, ethics, and collective responsibility toward disaster reduction within the community.

Indicators:

- Disasters/emergency response plans (household and community)
- Building standards, codes and enforcement
- Hazard mitigation plans and hazard vulnerability assessments (required by the Disaster Mitigation Act of 2000)
- Comprehensive plans (land use and growth management)

- Zoning ordinances prohibiting development of high hazard areas
- Continuity of operations plans for local governments
- Interoperable communications among police, fire, and emergency responders
- Disaster recovery plans
- Participation in the National Flood Insurance Program (NFIP)
- Coastal setbacks for development
- Dune management districts
- Transfer of development rights to discourage development in sensitive areas
- Fiscal policies to shift public infrastructure costs (water, sewer, roads) to developers
- Provision of risk/hazard information to the public
- Tabletop and mock exercises and drills for disaster response

Reference:
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 Environment Change*. 18(4):598-606.
Cutter, S. L.; Barnes L.; Berry, M.; Burton, C.; Evans, E.; Tate, E.; and Webb, J. (2008) *Community and Regional Resilience: Perspectives from Hazards, Disasters, and Emergency Management* (CARRI Research Report 1). Oakridge.

2.2. Community Based Resilience Analysis (CoBRA) (UNDP Drylands Development Centre)

The Community Based Resilience Analysis (CoBRA) is a conceptual framework and methodology to measure resilience. It was commissioned by UNDP's Drylands Development Centre in mid-2013. The measurement framework foresees both universal as well as contextual indicators of resilience. To define a universal threshold for resilience based on food and basic needs, the approach uses the Household Economy Approach (HEA) Response Thresholds. To measure factors that build resilience, the analysis distinguished between five following categories:

1. Physical: The basic infrastructure (roads, railways, telecommunications) that people use to function more productively.

Indicators:
- Access to all weather roads
- % households with electricity supply
- % households with year round access to clean water
- Water storage / reserve capabilities
- Crop storage / reserve capacity

2. Human: The sum of skills, knowledge, labour and good health that together enable people to pursue different livelihood strategies and achieve their livelihood outcomes.

Indicators:
- % households requiring formal food/cash assistance
- % global and severe acute malnutrition rates
- Gross / net enrolment rates
- # Households members with secondary education or higher
- # Household members economically active

3. Financial: The cash that enables people to adopt different livelihood strategies. This can be in the form of savings, or a regular source of income such as a pension or remittance. The inputs that support livelihoods, as well as the producer goods (tools, equipment, services) that contribute to the ability to increase financial capital.

Indicators:
- Income level
- % of households with secure access to land for livelihood purposes
- Livestock numbers and value
- Crop production / value
- # household sources of earned income
- Access to functioning markets
- Access to saving and credit facilities

- Access to agriculture / livestock extension services

4. Natural: The natural resources (land, forests, water) and associated services (e.g. erosion protection, storm protection) upon which resource-based activities (e.g. farming, fishing etc.) depend.

Indicators:
- Extent of natural tree cover
- Households undertaking reforestation activities
- # functional NRM/ rangeland management committees
- % time quality pasture available
- Quality of rangeland management
- Rate of deforestation

5. Social: Access to and participation in networks, groups, formal and informal institutions. Peace and security.

Indicators:
- # functioning local structures / committees
- % of households with woman and marginalized groups involved in local planning processes
- Quality of leaders /institutions (fair, responsive, non-corrupt)
- % population living in peace and security
- % year there are no incidences of conflict / insecurity
- Community resources raised to build resilience

Reference
UNDP Drylands Development Centre. (2013). Community Based Resilience Analysis (CoBRA): Conceptual Framework and Methodology, version May 17, 2013.

2.3. DRLA/UEH Evaluation Resilience Framework for Haiti (Tulane University / University of Haiti)

The DRLA/UEH Evaluation Resilience Framework measures the relationship between a shock, humanitarian assistance and resilience. It was designed for a large scale evaluation of humanitarian assistance in the wake of the Haiti earthquake in 2010. The framework was put together by the Disaster Resilience Leadership Academy (DRLA) of Tulane University and the State University of Haiti (UEH). The framework is based on three components: the resilience characteristics of a community, household or individual; the scope and nature of the shock; and the presence and type of humanitarian response. The framework also demonstrates how communities, households and individuals who experience a shock can adapt, absorb, erode or fail.

The model involves measuring seven resilience dimensions: wealth, debt and credit, coping behaviours, human capital, protection and security, community networks, and psychosocial status. A quantitative composite score was calculated for each dimension in the framework, using principle component analysis (PCA), to combine multiple relevant indicators to the particular dimension. This analysis was applied to the entire household sample, creating standardized dimension scores. All scores had an average of zero at the national level. Each dimension score was scaled such that a higher score signified higher household resilience. The scores measured household resilience at a specific point in time (a "snap-shot") and can be further described and validated with change-over-time and additional complementary data.

1. Wealth: Financial and physical capital, income expenditures and food security/ consumption are reflected in the wealth dimension.

For the wealth dimension, the DRLA/UEH team calculated a composite score using the following indicators from the household survey:
- Food consumption

- Asset wealth
- Percent of expenditure on food
- Household expenditure per capita
- Household savings

2. Debt and Credit: This dimension includes information on the use of credit to access food and non-food items necessary for survival. Analysis of the variety of debt and credit behaviors of households indicated that debt and credit behavior was not necessarily associated with wealth and therefore, required its own dimension. Although access to credit could be considered a way to increase resilience, use of credit (accumulation of debt) for survival is an indication of vulnerability.

For the credit and debt dimension, the DRLA/UEH team calculated a composite score by combining the following indicators from the household data:
- Household solicited credit in the past 12 months
- Household accumulated debt in the past 12 months
- Household purchased food using credit in the past month
- Household purchased non-food items/services using credit in the past 12 months
- Percent of total cited food consumed that was purchased on credit

3. Coping Behaviors: This dimension includes behaviors used to respond to recent shocks, as well as behaviors that households might employ should their situation become more difficult. This dimension focuses not on the ability of households to respond, but rather on the negative aspects of coping that can lead to the exhaustion of household resources.

A composite coping behavior score was created to capture coping strategy severity using the following measures:
- Reduced Coping Strategies Index (CSI)
- Number of coping strategies used in the past year (a module asked what households did to deal with shocks in the past year, with codes for 34 possible answers)
- Number of coping strategies that might be used in the future (a module asked what households could envision doing in the future if their situation became more difficult, and allowed for the same 34 possible coping codes)

4. Human Capital involves the skills and abilities that enable households/individuals to generate income and have access to food and goods and services. While there are many indicators of human capital, it is represented here by education level and workforce capacity within the household.

For this evaluation, a composite indicator for human capital was created using the following indicators:
- Dependency percent
- Household head's level of education
- Presence of one or more household members incapable of working regularly

5. Protection and Security were measured in terms of self-reported experiences, perceptions and opinions of household members related to their personal sense of security and their reported exposure to personal and property crime.

For the protection and security dimension, the team created a composite security indicator from the survey data by combining three indicators related to security:
- Prevalence of households that reported having a security problem since the earthquake
- Prevalence of households that reported that the security situation had improved, remained stable, gotten worse but returned to normal, or gotten worse and remained that way since the earthquake
- Shock of "insecurity" in the past year had negatively impacted their livelihood, their capacity to produce or buy food or has led to the depletion of savings and assets

6. Community Networks reflects the connectedness of households to groups—particularly those related to livelihoods, income or decision-making within the community— and community decision processes (this is related to the concept of social capital).

A composite community networks score was calculated using the following:

- Awareness of the existence of community networks (associations/ organizations)
- Members of household who participated in community networks (associations/organizations)

7. Psycho-social Status is not typically measured and monitored in Haiti. Psychological status and well-being of household heads is a dimension of resilience often adversely affected in the short term, and potentially long-term, depending, in part, upon the nature and effectiveness of humanitarian assistance.

The composite psychosocial score was created using two composite scales based on the household survey data. These questions were primarily directed at heads of households (the target subjects of the data collection) and the indicators were measured at an individual level, not a household level:
- General Health Questionnaire
- Well-Being Index

Reference
Tulane University. (2011). *Haiti Humanitarian Assistance Evaluation from a Resilience Perspective.* Disaster Resilience Leadership Academy.

2.4. FAO Resilience Tool (FAO)

The FAO resilience framework looks at the root causes of household vulnerability instead of trying to predict how well households will cope with future crises or disasters. It also considers how household food security links to the entire food system.

Factors that make households resilient to food security shocks and stresses include:

1. Income and access to food

Indicators:
- Average per person daily income (local currency/person/day)
- Average per person daily expenditure (local currency / person/day)
- Household food insecurity access score
- Dietary diversity and food frequency score
- Dietary energy consumption (kcal/person/day)

2. Access to basic services

Indicators:
- Physical access to health services (ordinal, 1 to 3)
- Quality score of health services
- Quality of educational system (ordinal, 1 to 6)
- Perception of security (ordinal, 1 to 4)
- Mobility and transport constraints (ordinal, 1 to 3)
- Water, electricity and phone networks (count)

3. Social safety nets

Indicators:
- Amount of cash and in-kind assistance (local currency/ person/day)
- Quality evaluation of assistance (ordinal, 1 to 4)
- Job assistance (binary yes/no response)
- Frequency of assistance (number of times assistance was received in the last six months)
- Overall opinion of targeting (assistance targeted to the needy; to some who are not needy; or without distinction)

4. Assets

Indicators:
- Housing (number of rooms owned)
- Durable index (Principal Component Analysis on list of items: TV, Car, etc...)
- Tropical Livestock Unit (TLU) equivalent to 250 KG;
- Land owned (in hectares)

5. Adaptive capacity

Indicators:
• Diversity of income sources (count, 0 to 6)
• Educational level (household average)
• Employment ratio (ratio, number of employed divided by household size)
• Available coping strategies (count, 0 to 18)
• Food consumption ratio (Share of food expenditure divided by total expenditure)

6. Stability

Indicators:
• Number of household members that have lost their job (count)
• Income change (ordinal: increased, the same, decreased)
• Expenditure change (ordinal: increased, the same, decreased)
• Capacity to maintain stability in the future (ordinal, 1 to 5)
• Safety net dependency (share of transfers on the total income)
• Education system stability (ordinal: quality increased, the same, decreased)

These factors are combined into an index which gives an overall quantitative 'resilience score'. The score shows where investments need to be made to further build resilience. By using this quantitative approach, decision makers can objectively target their actions and measure their results over time. The resilience tool uses data available in national household budget surveys such as the Living Standard Measurement Surveys or Household Income and Expenditure Surveys.

Reference:
FAO/EU, no date, *Measuring Resilience: A Concept Note on the Resilience Tool*. Available at http://www.fao.org/docrep/013/al920e/al920e00.pdf
Alinovi, L.; Mane, E.; Romano, D. (2009). Measuring household resilience to food insecurity: application to Palestinian households, working paper, January 2009.

2.5. Livelihoods Change Over Time (LCOT) (Tufts University, Mekelle University)

The Livelihoods Change Over Time (LCOT) survey is the basis of this resilience measurement. The survey collects panel data twice a year, in the postharvest period and during the peak of the hunger season, from a sample of 300 households in two locations. Since 2009, a team from Tufts University has been studying livelihoods change over time in Northern Ethiopia, focusing specifically on Eastern and Southeastern Tigray. The research objective is to understand the determinants of food security in a relatively risk-prone context.

The LCOT approach captures both static livelihood outcomes (e.g. food security, health status, education level) and more complex outcomes based on dynamic interactions between livelihood strategies, policies and programmes.

The LCOT performs three types of analysis. First, describe how household welfare evolves over time, using a broad set of indicators. Second, look at the determinants of food security dynamics between the postharvest and the hunger season, examining the underlying changes in livelihoods that affect food security. Third, employ the "poverty traps" framework to test for the presence of multiple asset equilibria. For purposes of measurement, the focus is on change over time of eight indicators of food security outcomes and household well-being.

1. Coping Strategies Index (CSI) and Reduced Coping Strategies Index (rCSI). The Coping Strategies Index, developed by Maxwell in 1996, looks at the behaviors exercised by households in order to cope with a food deficit. The index combines the frequency and severity of coping strategies, so the higher the index score, the

more food insecure the household is. In addition to the standard Coping Strategies Index, the reduced Coping Strategies Index (rCSI) is also utilized, which measures less severe coping behaviors.

2. Household Food Insecurity and Access Scale (HFIAS) and Household Hunger Scale (HHS). The HFIAS, developed by Coates et al. in 2007, focuses on three dimensions of food access: anxiety about not being able to procure sufficient food, the inability to secure adequate quality of food, and the experience of insufficient quantity of food intake. The related Household Hunger Scale is also utilized.
3. Food Consumption Score (FCS) and Household Dietary Diversity Scale (HDDS). The Food Consumption Score is a measure of dietary diversity developed by the World Food Programme. It asks about frequency of consumption over the past month for cereals and tubers, pulses, vegetables, fruit, meat and fish, milk, sugar, and oil. The HDDS asks the same questions as the FCS, but does not weight the food categories, as does the FCS.
4. Self-reported welfare measures. The LCOT also asks households to self-assess their food security and livelihood security over the six months preceding the survey on a simple Likert scale.
5. Illness Score. The illness score is a measure of the number of days in the past six months that all household members have been unable to perform normal activities due to illness and injury.
6. Value of productive assets: land, livestock, and tools. This indicator is the summed value of all productive assets owned by the household, defined as land, livestock, and tools. Land "ownership" values are imputed from rental rates, as technically all land in Ethiopia is owned by the government, and there is no land market from which actual exchange value can be measured. Yet land is clearly the major productive asset in the livelihood system, so "value" is inferred from existing land rental rates. Productive asset value is our preferred measure of physical and natural capital.
7. Net debt. This is a measure of the household's outstanding debt obligations, minus any existing savings. The reason for including this measure is that onerous debt is the one of the chief obstacles to households rebuilding after the experience of a shock, and thus low debt load is a key indicator of resilience.
8. Income (with per-capita daily expenditure as the best measureable proxy for income). This variable takes into account all expenses reported by the household for the six month period preceding the survey, divided by household size.

Reference:
Maxwell, D.; Vaitla, B.; Tesfay, G.; Abadi N. (2013). *Resilience, Food Security Dynamics, and Poverty Traps in Northern Ethiopia: Analysis of a Biannual Panel Dataset*, 2011–2013, Feinstein International Centre, October 2013, http://reliefweb.int/sites/reliefweb.int/files/resources/Ethiopia%20Resilience-Food-Security-Dynamics.pdf

2.6. PEOPLES Resilience Framework (Multidisciplinary Center for Earthquake Engineering Research: MCEER)

The PEOPLES resilience framework aims at defining and measuring disaster resilience for a community at various scales. The framework attempts to address simultaneously the assets of the community and their functionality at various geographic and temporal scales. The framework builds upon and extends the MCEER R4 framework. This resilience framework identifies seven dimensions that characterize community functionality (represented by the acronym PEOPLES):

1. POPULATION AND DEMOGRAPHICS

Indicators:

a) Distribution/Density: i) Urban ii) Suburban iii) Rural iv) Wildland
b) Composition: i) Age ii) Gender iii) Immigrant Status iv) Race/Ethnicity
c) Socio-Economic Status: i) Educational Attainment ii) Income iii) Poverty iv) Home Ownership v) Housing Vacancies vi) Occupation

2. ENVIRONMENTAL/ECOSYSTEM

Indicators:
a) Water Quality/Quantity
b) Air Quality
c) Soil Quality
d) Biodiversity
e) Biomass (Vegetation)
f) Other Natural Resources

3. ORGANIZED GOVERNMENTAL SERVICES

Indicators:
a) Executive/Administrative i) Emergency Response and Rescue ii) Health and Hygiene
b) Judicial
c) Legal/Security

4. PHYSICAL INFRASTRUCTURE

Indicators:
a) Facilities
i) Residential (1) Housing Units (2) Shelters
ii) Commercial (1) Distribution Facilities (2) Hotels - Accommodations (3) Manufacturing Facilities (4) Office Buildings
iii) Cultural (1) Entertainment Venues (2) Museums (3) Religious Institutions (4) Schools (5) Sports/Recreation Venues
b) Lifelines
i) Communications (1) Internet (2) Phones (3) TV (4) Radio (5) Postal
ii) Health Care (1) Acute Care (2) Long-Term Acute Care (3) Primary Care (4) Psychiatric (5) Specialty
iii) Food Supply iv) Utilities (1) Electrical (2) Fuel/Gas/Energy (3) Waste (4) Water
v) Transportation (1) Aviation (2) Bridges (3) Highways (4) Railways (5) Transit (6) Vehicles (7) Waterways

5. LIFESTYLE AND COMMUNITY COMPETENCE

Indicators:
a) Collective Action and Decision Making i) Conflict Resolution ii) Self-Organization
b.) Collective Efficacy and Empowerment
c.) Quality of Life

6. ECONOMIC DEVELOPMENT

Indicators:
a) Financial Services i) Asset Base of Financial Institutions ii) Checking Account Balances (Personal and Commercial) iii) Consumer Price Index iv) Insurance v) Number and Average Amount of Loans vi) Number of Bank and Credit Union Members vii) Number of Banks and Credit Unions viii) Savings Account Balances (Personal and Commercial) ix) Stock Market
b) Industry – Employment - Services i) Agriculture ii) Construction iii) Education and Health Services iv) Finance, Insurance and Real Estate v) Fortune 1000 vi) Fortune 500 vii) Information, Professional Business, Other viii) Leisure and Hospitality ix) Manufacturing x) Number of Corporate Headquarters xi) Other Business Services xii) Professional and Business Services (1) Employment Services (Flexibilities/ Opportunities/ Placement) (2) Transport and Utilities (3) Wholesale and Retail
c) Industry – Production i) Food Supply ii) Manufacturing

7. SOCIAL/CULTURAL CAPITAL

Indicators:
a) Child and Elderly Services
b) Commercial Centers
c) Community Participation
d) Cultural and Heritage Services
e) Education Services
f) Non-Profit Organizations
g) Place Attachment

The PEOPLES Resilience Framework is built on, and expands, previous research at MCEER linking several previously identified resilience dimensions (i.e., technical, organizational, societal, and economic) and resilience properties (i.e., R4 : robustness, redundancy, resourcefulness, and rapidity). PEOPLES incorporates MCEER's widely accepted definitions of service functionality, its components (assets, services, demographics) and the parameters influencing their integrity and resilience. While the components have different weights and values, the order of these dimensions in the acronym is not indicative to their importance.

Reference:
Renschler, Frazer, Arendt, Cimellaro, Reinhorn, Bruneau. (2010). *Framework for Defining and Measuring Resilience at the Community Scale: The PEOPLES Resilience Framework, Technical Report MCEER-10-0006*, October 8, 2010.
Available at http://mceer.buffalo.edu/pdf/report/10-0006.pdf

2.7. Resilience Capacity Index (RCI) (Network on Building Resilient Regions (BRR)

Developed by Kathryn A. Foster, member of the BRR research network and director of the University at Buffalo Regional Institute, the Resilience Capacity Index is a single statistic summarizing a region's score on 12 equally weighted indicators—four indicators in each of three dimensions encompassing Regional Economic, Socio-Demographic, and Community Connectivity attributes. As a gauge of a region's foundation for responding effectively to a future stress, the RCI reveals regional strengths and weaknesses, and allows regional leaders to compare their region's capacity profile to that of other metropolitan areas.

The Resilience Capacity Index is calculated and accessible through the website Network on Building Resilient Regions (BRR), affiliated with the Institute of Governmental Studies at the University of California, Berkeley. The composite index uses secondary data (like the GINI coefficient for income equality) and existing indices (like the Innovation Index from Indiana Business Center)

1. Regional economic capacity

   Indicators:
   - Income Equality
   - Economic Diversification
   - Regional Affordability
   - Business Environment

2. Socio-demographic capacity

   Indicators:
   - Education Attainment
   - Without Disability
   - Out of Poverty
   - Health-insured

3. Community connectivity capacity

   Indicators:
   - Civic Infrastructure
   - Metropolitan Stability
   - Homeownership
   - Voter Participation

Reference: Resilience Capacity Index website: http://brr.berkeley.edu/rci/

2.8. ResilUS (Western Washington University)

ResilUS – "Resilience United States" – is a prototype simulation model of community resilience. Based on the measurable aspects of community capital, the model operationalizes community resilience across multiple, hierarchical scales – household/business, neighbourhood, and community – in relation to a range of policy and decision variables associated with each scale. It simulates the loss and recovery dynamics of households, businesses, neighbourhoods, and communities before, during, and after a hazard event. ResilUS is unique in its emphasis on recovery time paths, spatial disparities, and linkages between different sectors of a community.

ResilUS simulates community loss and recovery. Currently the model focuses primarily on indicators associated with household and business well-being, such as health, employment, productivity, and product demand. It represents the relationship between these indicators of well-being and restoration of the built environment, such as building, road network, electrical network, etc.

ResilUS has been under development for almost a decade and in the prototyping process has been applied to three study areas. A prototype model was applied to the case of the catastrophic 1995 Kobe (Japan) earthquake, and a series of validation exercises were conducted. A list of the important variables represented in ResilUS have been developed. The variables are listed with respect to their association to the five elements of community capital. The organization of variables by community capital is not intended to be rigidly precise, as it is possible that variable might be related to multiple elements. The point of organizing ResilUS variables by community capital is to illustrate the breadth of the conceptual model, as well as elements of community capital that potential require further development in ResilUS.

1. Physical capital

Indicators:

- BYR = Year building or lifeline component built.
- BL = Ratio of resources (materials, labor etc.) expended in reconstruction to building replacement value. Alternatively, percent to which reconstruction is complete. 0 to 1, with 1 being reconstructed.
- CRIT = Probability that critical facilities network component service is fully restored.
- CYR = year seismic (or other building) code effective.
- DMG = Damage of building or lifeline component expressed as ratio of building replacement value.
- ELEC = Probability that electrical network component service is fully restored.
- FACILITY = Service level of a business's facility. 0 to 1, with 1 indicating operation at pre-event service level.
- MAINT = Probability that component has been well-maintained.
- MIT = Pre-event structural mitigation of building or lifeline component. Currently 1 (maximum) indicates a 25% increase is fragility curve median.
- SHEL = Probability that household has adequate shelter and associated services.
- STH = Probability that short-term housing is available, Y/N.
- TRNS = Probability transportation network component service is fully restored.
- TYPE = Type of building or lifeline component—a proxy for size and/or complexity for reconstruction. 0 to 1, with 1 indicating largest or most complex building/component type.
- WAT = Probability that water network component service is fully restored.
- WAT_ALT = Provision for alternate water sources (water trucks) for neighborhood. 0 to 1, with 1 being equivalent to maximum total water service in neighborhood (WATn = 1)

2. Economic capital

Indicators:

- AID = Normalized post-event grant amount.
- DEBT = Normailzied level of debt. The inverse of LOAN.

- DEMAND = Post-event demand for product. 0 to 1, with 1 indicating pre-event demand level.
- EMPL = Probability that employment is available.
- FAIL = Occurrence of business failure (Y(1)/N(0))
- INC = Normalized annual income.
- INS = Whether or not an agent has insurance.
- LOAN = Normalized amount of reconstruction loan taken out. Implicitly related with DMG (ratio of building replacement value).
- LOAN_MAX = Limit on post-event loan amount. MARG = Pre-event financial marginality.
- OUTLAY = Whether or not an agent has received an insurance payment. 1 is implicitly defined as the replacement value of their building.
- PROD = Probability that business is at pre-event production level.
- SAVINGS = Normalized savings or assets.
- SECT = Type of business sector (0:local or 1:export).
- SIZE = Normalized number of employees.

3. Socio-cultural capital

Indicators:
- CAP = Recovery capacity of community (proxy for integration and consensus). 0 to 1, with 1 being highest capacity.
- CONSTR = Probability that necessary construction resources available for restoration.
- INSP = Time in weeks after event that safety inspections are completed.
- MUT = Provision for mutual aid in lifeline restoration. 0 to 1, with 1 equal to maximum construction resources without mutual aid (i.,e., MUT can at most double construction resources)
- PLAN = Probability of an effective restoration plan.
- PRTY = An absolute score given at the neighborhood level, indicating priority. The score can range from NBRHD (number of neighborhoods) to 1, with higher numbers indicating higher priority.

4. Personal capital

Indicators:
- HEALTH = Probability that household is healthy
- INJURY = Probability that household health or business demand has been injured.
- LEAVE = Whether or not household has left region.

5. Ecological capital

Indicators:
- HAZ = Severity of earthquake's (or hazard event) physical effects. 0 to 10, Conceptually equivalent to ShakeMap intensiy/MMI

Reference:

S.B. Miles; and S.E. Chang. (2008). *ResilUS -- MODELING COMMUNITY CAPITAL LOSS AND RECOVERY.* The 14 th World Conference on Earthquake Engineering October 12-17, 2008, Beijing, China. Available at http://www.iitk.ac.in/nicee/wcee/article/14_09-01-0095.PDF

2.9. Risk Reduction Index (RRI) (DARA)

The Risk Reduction Index (RRI) measures local perceptions about underlying risk. The index is based on surveys conducted with key informants using a questionnaire in a selected number of 'Representative Territorial Units' and validated through national workshops. The index has been designed and is used by DARA international (daraint.org), a humanitarian organization based in Madrid/Spain. The Risk Reduction Index tracks existing conditions and capacities for disaster risk reduction and climate change adaptation that either prevent or enable local and national actors to carry out effective risk management. Capacities are understood as human resources available to manage risks, while conditions are the frameworks (including norms, laws, legislations, codes and agreements) within which actors perform.

The index uses four following components namely 'risk drivers':

1. Environment and natural resources

Indicators:

1. Air pollution: PM10, country level (micrograms per cubic meter)
2. Deforestation: Forest area (sq. km)
3. Water scarcity: Annual freshwater withdrawals, total (% of internal resources)
4. Capacity: (i) CPIA policy and institutions for environmental sustainability rating (ii) Terrestrial and marine protected areas (% of total territorial area)

2. Socio-economic conditions

Indicators:

1. HEALTH
   - Prevalence of HIV, total (% of population ages 15-49)
   - Antiretroviral therapy coverage (% of people with advanced HIV infection)
   - Notified cases of malaria (per 100,000 people)
   - Tuberculosis treatment success rate (% of registered cases)
   - Incidence of tuberculosis (per 100,000 people)
   - Life expectancy at birth, total (years)
   - Prevalence of undernourishment (% of population)
   - Vitamin A supplementation coverage rate (% of children ages 6-59 months)
   - Hospital beds (per 1,000 people)
   - Physicians (per 1,000 people)
   - Health expenditure per capita, PPP (constant 2005 international $)
2. EDUCATION
   - Literacy rate, adult total (% of people ages 15 and above)
   - School enrollment, primary (% net)
   - School enrollment, secondary (% net)
   - School enrollment, tertiary (% gross)
   - Public spending on education, total (% of government expenditure)
   - CPIA building human resources rating
3. SOCIAL CONDITIONS
   - Poverty headcount ratio at national poverty line (% of population)
   - GINI index
   - Food - Production Index Numbers
   - Net migration (absolute value, % of total population)
   - Ratio of girls to boys in primary and secondary education (%)
   - Share of female teachers in primary, secondary and tertiary education
   - Unemployment (% of total labor force)
   - Vulnerable employment (% of total employment)
   - GDP per capita growth (annual %)
   - CPIA equity of public resource use rating
   - CPIA gender equality rating
   - CPIA social protection and labour

3. Land use and the built environment

Indicators:

1. Rural
   - Rural population growth (annual %)
   - Improved water source, rural (% of rural population with access)
   - Improved sanitation facilities, rural (% of rural population with access)
2. Urban
   - Urban population growth (annual %)
   - Improved water source, urban (% of urban population with access)
   - Improved sanitation facilities, urban (% of urban population with access)
   - Proportion of urban population living in slums
3. Rural and Urban
   - Population density (people per sq. km of land area)
   - Population living in areas where elevation is below 5 meters (% of total population)
   - Roads, paved (% of total roads)
   - Power outages in firms in a typical month (number)

4. Governance

Indicators:

1. Democracy
   - Firms with female participation in ownership (% of firms)
   - Proportion of seats held by women in national parliaments (%)

- Voice and Accountability

2. Government effectiveness
   - Government Effectiveness - Regulatory Quality
   - CPIA transparency, accountability, and corruption in the public sector rating
   - Regulatory Quality
   - CPIA debt policy rating
3. Rule of law
   - Rule of Law
   - Political Stability
   - Control of Corruption

The methodology adopted to analyse the risk drivers is fundamentally qualitative, although it also uses quantitative methods. On the one hand, a mixed-method approach with strong qualitative focus is employed to capture and measure perceptions of risk-related conditions and capacities at a local level. On the other hand, a quantitative approach is applied to analyse data collected from public databases. DARA carried out an analysis of seven countries in Central America and the Caribbean in 2009-2010 and a second analysis for West Africa in 2013.

A questionnaire is the main tool used to collect information on local level perceptions on the conditions and capacities for DRR and CCA. The structure of the questionnaire is as follows:

- A short section on key informants' personal information.
- A section containing preliminary questions on natural hazards and climatic conditions.
- The main section divided into four risk drivers

The questionnaire contains open-ended questions, polar questions (i.e. yes/no) and closed questions requiring a response based on a likert scale of one to five, where five is the maximum, one is the minimum, and three represents the midpoint. Key informants can also select the "Not applicable (NA)" and "Do not know (DK)" options. The questionnaire is available at: http://daraint.org/rri/west-africa/survey. A preliminary data analysis of the responses follows the data collection (survey) in order to measure perceptions on the severity of conditions and the effectiveness of capacities. These measurements are based on key informants' score responses, and presented and discussed in-depth in workshops at RTU level.

Reference:
DARA website at http://daraint.org/risk-reduction-index/
DARA. (2013). *RRI Risk Reduction Index in West Africa: Analysis of the conditions and capacities for Disaster Risk Reduction*. Available at http://resources.daraint.org/rri/rri_eng.pdf

2.10. USAID resilience domain framework (USAID)

USAID has adapted a FAO resilience domain framework and identified a number of potential indicators under 6 following domains from 3 key objectives: (1) increased and sustainable economic well-being, (2) strengthened institutions and governance, and (3) improved health and nutrition status.

1. Income & food access

Indicators:
- Per capita expenditure (income proxy)
- Poverty prevalence
- Stability of income (seasonal and trend)
- of individual receiving training
- of jobs created

2. Assets

Indicators:
- Asset ownership
- Change in HH asset ownership
- Number of communal assets created/ rehabilitated by type

3. Adaptive capacity

Indicators:
- Income/livelihood diversity
- Self-perceived coping/adaptive capacity
- Access to credit
- Woman's empowerment in Ag index
- Adopting and applying new technologies/ management practices

4. Social capital & safety nets

Indicators:
- Community and local organization/ groups participation and leadership
- Ability to rely on others in times of stress (retrospective & prospective)
- % of households with access to positive coping strategies

5. Governance

Indicators:
- Government capacity for coordination: local and national (capacity assessment)
- Of effective laws governing natural resources (land tenure/rural code)
- Of effective local governance structures in place by type (natural resource management, conflict mitigation management, disaster risk management)

6. Nutrition and health

Indicators:
- Prevalence of stunted/underweighted children under 5 years of age
- Prevalence of diarrhea among children under 5 years of age
- Women's dietary diversity
- % of children 8 to 23 months that received a minimum acceptable diet
- % of HH with access to potable water
- % of mothers practicing appropriate care/feeding practices
- % of individuals/HH practicing appropriate WASH practices
- % of men/women with positive knowledge and attitudes about: birth spacing/ family planning/ child caring/feeding practice/ WASH practices/ use of health services

This framework makes use of existing indicators and data already collected in standard FFP/FTF baseline surveys, adding in a limited set of additional measures. As part of this framework, USAID is piloting a resilience module in Kenya and Ethiopia that focuses on measuring resilience capacities. The module uses a survey on self-perception and includes retrospective as well as prospective questions. Retrospective questions in relation to past (reference) shocks are included, as are prospective questions about a household's capacity to absorb and manage through future shocks and stresses. These survey methods will also be complemented by qualitative inquiry to better understand how people themselves conceive of (and bolster) their own mitigative, adaptive and recover capacities.

Reference:
USAID (no date), *The Resilience Agenda: Measuring Resilience in USAID*, Available at https://www.usaid.gov/sites/default/files/documents/1866/Technical%20Note_Measuring%20Resilience%20in%20USAID_June%202013.pdf

ANNEX 3

The Study of Disaster-related Events

AFGHANISTAN	1.	Baghlan Earthquake, 2002/2012
	2.	Hindu Kush Earthquake, 2004
	3.	Raising Awareness of Risk through Radio Drama Broadcast (BBC Afghanistan)
ARMENIA	4.	Spitak Earthquake, 1988
	5.	Empowering children with Earthquake Awareness through Theatrical Performance
	6.	Cooperation with Asian Disaster Reduction Centre in Empowering Students and Teachers in Community-based Earthquake Disaster Risk Reduction
BANGLADESH	7.	Chittagong Mudslide, 2007
	8.	Voluntary Formation of Community-Based Organizations to Implement DRR Activities in Communities
	9.	The Comprehensive Disaster Management Programme: Empowering local governments
CANADA	10.	The Ontario Provincial Hazard Identification and Risk Assessment
	11.	Flood history (1879-2013)
CHINA	12.	Wuzhou city flood, 2005
	13.	Sichuan Earthquake, 2008
COLUMBIA	14.	Galeras Volcano Eruption, 2002, 2006, 2008, 2009, 2010
DOMINICAN REP.	15.	Flood, 2003
CONGO	16.	Nyiragongo Volcano Eruption, 2002
CZECH REPUBLIC	17.	Prague flood, 2002
ECUADOR	18.	Critical Video Analysis" of Communities Affected by Tungurahua Volcanic Eruption to Mitigate the Risks of Living Near an Active Volcano
EL SALVADOR	19.	San Miguel Earthquake & Landslide, 2001
	20.	Integrating children and youth in disaster management
FIJI	21.	Cyclone Thomas, 2010
	22.	Beyond Early Warning and Response
FRANCE	23.	South-eastern flood, 2003
	24.	Mission Risques Naturels (MRN): Private participation in the formulation of disaster prevention policies and provision of a technical interface between insurance association and public authorities at the national, European and territorial level. (PPP)
	25.	Memo'Risks: Students survey community risk knowledge (the Loire River catchment)
HAITI	26.	Haiti flood, 2004, 2014, 2015
	27.	Port-au-prince Earthquake 2010
	28.	Community Members Design & Implement Information Campaigns
INDIA	29.	Gujarat Earthquake, 2001, Chobari, Bhachau Taluka
	30.	Varunawat Hills Landslide, 2003, Uttarkashi, Uttarakhand State
	31.	Masons trained in earthquake-resistant construction
	32.	"Afat Vimo" Disaster Micro-Insurance Scheme for Low-Income Groups
	33.	Human resource development programme in disaster risk management in India
INDONESIA	34.	Kelud Volcano Crisis, 2007, Blitar and Kediri, East Java
	35.	Merapi Volcanic Activity 2001, Central Java
	36.	Combining Science and Indigenous Knowledge to Build a Community Early Warning System to Prevent Drought-Induced Food Shortage, Nusa Tenggara, Southeastern Indonesia
	37.	An integrated Flood Early Warning System (FEWS) for Jakarta
	38.	'Tsunami Ready Toolkit' : Private Toolkit Provision
	39.	Indonesia, Nias island landslide, 2001
	40.	Indonesia, Sumatra flashflood, 2006
IRAN	41.	Bam Earthquake, 2003
	42.	Northern Iran Earthquake, 2004
ITALY	43.	Stromboli Volcano Eruption, 2001-2002
JAPAN	44.	Kobe Earthquake, 1995
	45.	Typhoon Talas, 2011
	46.	Tohoku Earthquake and Tsunami, 2011
	47.	Building Public-Private Partnerships to Ensure Safe Gas Use: Tokyo Gas
	48.	Private-led Initiatives and Public Support in activities for widespread use of disaster resistant glass: Asahi Glass Co., Ltd.
	49.	'Women's Net Kobe' : Disaster & Women Information Network in Japan
	50.	Children and communities study mountain and urban risks (Saijo city)
	51.	Puppet show project "Inamura no Hi" Sompo Japan's efforts to raise disaster awareness through puppet shows (Sompo Japan Insurance Inc.)
KAZAKHSTAN	52.	Local Risk Management in Earthquake Zones : Strengthening the capacity of local communities in disaster preparedness and early warning through the development of knowledge and skills required for effective disaster mitigation
KOREA	53.	One-Stop Service for Rapid and Easy Recovery Support
KYRGYZSTAN	54.	UNDP projects since 2005, disaster risk mitigation through local community participation & Establishment of Volunteer 'Rural Rescue Teams' in vulnerable communities
	55.	Utilization of Satellite Surveillance System
MALAWI	56.	Multi-Stakeholder Flood Management: Small, Medium-Scale Initiatives to Control River Flow

MONGOLIA	57. Establishment of the National Emergency Management Agency of Mongolia (NEMA)
MOROCCO	58. Earthquake, 2004
	59. West & central Morocco flood, 2002
MYANMAR	60. Nargis Cyclone & flood, 2008
	61. Using local wisdom as prevention measures
NAMIBIA	62. Supporting Local Decision Making with Inter-Community Platform and Local-Level Monitoring
NEPAL	63. Gorkha flood and landslide, 2003
NEW ZEALAND	64. Christchurch earthquake, 2011
PAKISTAN	65. Balochistan flood, 2005
PERU	66. Disaster Prevention among Native and Mestizo Communities
	67. Empowering local government as leaders in disaster reduction and recovery
PHILIPPINES	68. Mainstreaming Community-Based Mitigation in City Governance : Community-Based Disaster Risk Management & Local Governance (Dagupan, north of Manila on Luzon Island in northern Philippines)
	69. A permanent provincial coordinating office for disaster risk reduction
	70. Leyte island landslide, 2006
	71. Typhoon Haiyan, 2013
RUSSIA	72. North Ossetia Landslide, 2002
	73. Stavropol flood, 2002
	74. Southern Russia flood, 2002
	75. The Amur river flood, 2013
	76. Kalka glacier-slide, 2002
	77. Yukutsk flood, 2001
SLOVENIA	78. Bovec landslide, 2000
SURINAME	79. Flood, 2013
SWITZERLAND	80. Flood and landslide, 2005
TAIWAN	81. Earthquake, 2010, 2016
TAJIKISTAN	82. REACT
	83. Disaster Preparedness action plan (DIPECHO)
	84. International Involvement in rehabilitating the seismic monitoring network
	85. Children in Emergencies Training
THAILAND	86. 'Mister Warning', a village-based disaster warning volunteer
	87. Central Thailand flood, 2011
TURKEY	88. Bingol Earthquake, 2013
USA	89. Hurricane Katrina, New Orleans, 2005
	90. Hurricane Gustav, New Orleans, 2008
	91. Hurricane Sandy, 2012
VIETNAM	92. Planting Mangroves to Mitigate Sea Dyke Erosion
	93. Flood and Typhoon-Resilient Homes through Cost-Effective Retrofitting
	94. Building local capacity and creating a local government network for cyclone risk
MULTINATIONAL LEVEL	95. SUMA
	96. Linking the private and public sectors on hazard mitigation projects that benefited communities by reducing disaster vulnerability to the community and to participating businesses (hurricanes Georges and Mitch 1998, Haiti, Dominican Republic, Guatemala, El Salvador, Honduras, and Nicaragua)
	97. Knowledge Network in Central Asia (Tajikistan, Kazakhstan, Kyrgyzstan)
	98. Indian Ocean Earthquake and Tsunami, 2004
	99. Hurricane Jeanne, 2004

Case Lessons Learnt and Good Practices from Past Experiences

Case Details	Resilience Identified/implied	Problems/Vulnerabilities	Lessons Learnt & Good Practices
AFGHANISTAN			
CASE 1 Baghlan Province **Hazard(s):** Earthquake → Landslide **Year(s) of event:** March 2002, November 2012 **Source(s):** http://www.afghanistannewscenter.com/news/2002/march/mar272002.html http://earthquake-report.com/2012/06/11/afghanistan-strong-earthquake-hits-populated-area/	• Security of lifeline facilities: roads • Emergency response/preparedness: Shelters for the affected, food, water • Government effectiveness • Disaster financial reserves and contingency mechanisms • Seismic building design code • Learning from the past experiences • Political instability: prolonged armed conflicts	• Two of the three roads into the immediate area blocked by landslides triggered by quakes • Mud-brick buildings collapsed. • The tens of thousands who have fled their homes have settled in deserts and hills in the open air without food, shelter or water. • Some 1,500 homes were destroyed and 20,000 people left without shelter. • It is beyond the interim government to deal with this tragedy • Earthquakes are relatively frequent in this area.	• Similar earthquakes in the past have also been devastating and caused a lot of fatalities; yet, no lessons learnt. • This has been chiefly because of the political situation in the area. • Traditional construction, mud houses, has low tolerance to earthquakes. • The level of emergency response and preparedness was very low, especially shelters for the affected and provision of food, water and sanitation during emergency.
CASE 2 Badakhshan province **Hazard(s):** Earthquake **Year(s) of event:** 2004 **Source(s):** http://www.afghanistannewscenter.com/news/2004/april/apr72004.html	• Security of lifeline facilities: roads • Seismic building design code • Emergency response/preparedness : disaster drill, response plan	• Officials struggled for details from the isolated communities of flimsy mud houses that dot the inaccessible valleys of Badakhshan, an impoverished region which also borders Tajikistan and China • Several houses were damaged and a student of Kabul University broke his leg jumping from a second-floor window of his campus lodgings. • 'The whole region is earthquake-prone,' said presidential spokesman Jawed Ludin. Emergency response has been very challenging in the past because a lot of areas are difficult to access.	• Some with past experience learnt to survive the quake; 'People here grabbed their children and ran for their lives. They remember what happened in Takhar.'
CASE 3 Raising awareness through radio **Hazard(s):** Various types **Year(s) of event:** - **Project Organizer:** Tearfund, BBC World Service **Source(s):**	• Adequate basic infrastructure: road • DRR education	• Partly because of its mountain ranges, the country is also hindered by lack of transport; hence the existence of perhaps the most isolated villages in the world. These isolated villages happen to be extremely prone to disasters. • In the light of this, and as 80 per cent of Afghans have radio sets in their homes and between 60 to 68 per cent of them listen to BBC world service.	• The messages need to be integrated effectively into a drama that is entertaining. In-depth analyses of issues are needed but they are not always possible. • The opportunity to get community social networks or mobilizing structures to discuss the messages needs to be nurtured. It is hoped that the above-mentioned separate stand-alone audio stories will help trigger local debates. • There is a need to work closely with the BBC to ensure that its staff members have an understanding of the basic concepts of DRR. This would help script writers

Case Details	Resilience Identified/implied	Problems/Vulnerabilities	Lessons Learnt & Good Practices
http://www.tearfund.org/~/media/Files/TILZ/Topics/DRR/Raising%20Awareness%20of%20Risk%20Through%20Radio%20in%20Afghanistan.pdf			communicate the messages effectively in a culturally relevant way.
ARMENIA			
CASE 4 Spitak, Leninakan, and Kirovakan **Hazard(s)**: Earthquake **Year(s) of event**: 1988 **Source(s)**: https://en.wikipedia.org/wiki/1988_Armenian_earthquake	• Security of lifeline facilities: hospital, roads • Seismic building design code • Government effectiveness (red tape) • International aids	• Many buildings did not hold up to the shaking of the earthquake and those that did collapse often lacked any survival space, but lack of effective medical care and poor planning also contributed to the substantial scope of the disaster. • Most bridges and tunnels and other public infrastructure withstood the earthquake but hospitals did not fare well. Most collapsed, killing two-thirds of the doctors, destroying equipment and medicine, and reducing the capacity to handle the critical medical needs in the region. • The highway's embankment failed, and though the site was repaired immediately, the resulting damage to the highway caused considerable delay in getting people and supplies into and out of the area following the disaster. • Red tape inevitably held up some of the rescue efforts and criticism of the perceived flawed processes soon followed.	• One hundred and thirteen countries sent substantial amounts of humanitarian aid to the Soviet Union in the form of rescue equipment, search teams and medical supplies, but private donations and assistance from NGOs also had a large part of the international effort. • For the rebuilding, the new buildings would be no taller than four stories and would be located away from areas with the highest seismic risk.
CASE 5 Empowering children with Earthquake Awareness through Theatrical Performance **Hazard(s)**: Earthquake **Source(s)**:	• Disaster-related education • Educating Disaster-related knowledge through training between authorities and parties concerned	• Low consciousness of the residents • Inadequate available teaching materials • Inadequate interaction & understanding among related parties & authorities	• As part of its seismic risk reduction activities, Armenian National Survey for Seismic Protection, with the Ministry of Science and Education, and the city of Yerevan have developed and staged a theatrical performance entitled 'Terra non Firma', where children learn the basics of seismic behaviour and protection techniques through interactive educational play. The play was filmed and given to the local authorities of the 12 Yerevan city districts to distribute to local schools • The performance is targeted at kindergarten and primary school children. • The goal is to provide the film 'Terra non Firma' throughout the country. • Also, training between authorities at all levels and related parties (emergency workers and response

Case Details	Resilience Identified/implied	Problems/Vulnerabilities	Lessons Learnt & Good Practices
			specialists, as well as dam panel engineers and technicians, along with the active participation of active rural residents.) • Education and training of active community members
CASE 6 Cooperation with Asian Disaster Reduction Centre in Empowering Students and Teachers in Community-based Earthquake Disaster Risk Reduction **Hazard(s):** Earthquake **Source(s):**	• Cooperation with International Organizations • The importance of international aids	• Armenia is one of the most earthquake-prone countries in the world. • The earthquake in December 1988, struck Armenia where over 6,000 children died	• Integrating of earthquake disaster risk reduction in school curricula and promoting the safe construction and retrofitting of school buildings to withstand seismic hazards.
BANGLADESH			
CASE 7 Chittagong **Hazard(s):** Heavy rainfall → Mudslide & Flood **Year(s) of event:** 2007 **Source(s):** http://archive.thedailystar.net/2007/06/12/d7061201033.htm https://en.wikipedia.org/wiki/2007_Chittagong_mudslides http://www.iol.co.za/news/world/landslides-kill-30-in-bangladesh-1.356964#.ViX3Zn4rLcs	• Security of lifeline facilities: telephone line • Land use planning • Hazard map • Environmental reservation (deforestation)	• Communication infrastructure was badly affected with telephone links with the rest of the country and within the city inoperable. • "The only reason for Monday's mud slide in the cantonment area is cutting hills indiscriminately... We were warning about this risk for decades, and this event our fears real." Architect Jerina Hossain said, "Cutting hills made the soil slippery and loose. As a result, it came down with the rain." • "We warned several times that the places where landslide occurred had become vulnerable due to hill cutting. But proper measures were never taken to stop the practice," Dr Shahidul Islam, Geography professor of Chittagong University. • People also build houses on the hill top and on the slope cutting the trees and it blocks rill or gully of the hills.	• Efficient land use planning should be implemented with disaster-expert recommendations.
CASE 8 Voluntary Formation of Community Organizations to Implement DRR **Hazard(s):** Various Types **Source(s):** UNDP. (2007). **Building Disaster Resilience Communities**. Retrieved at http://www.unisdr.org/files/596_10307.pdf	•	Project Details: • This is a community-based participatory project that is part of an ongoing larger project entitled "Mainstreaming Livelihood-Centered Approaches to Disaster Management." It is about forming voluntary community-based organizations and strengthening them to assume a leading role in the formulation and implementation of Disaster Risk Reduction (DRR) or disaster resiliencerelated projects initiated by the community	• The good practice lies in the fact that the project is based on a participatory approach whereby facilitation techniques are used to empower communities to assess their vulnerabilities and capacities in the face of identified hazards. Their involvement in identifying their problems, solutions and the implementation of their own strategies empowers them. Appropriate technologies are introduced to increase their capacity. The key to success is the involvement of the community and the CBO in all stages of the process. Technologies which both strengthen

Case Details	Resilience Identified/implied	Problems/Vulnerabilities	Lessons Learnt & Good Practices
		• The project was launched in January 2006, lasting five years. It is being implemented in Northwestern Bangladesh in the following unions (lowest tiers of local government): Kamargani Union in Gaibanda District; Sariakandi and Norsi unions in Bogra District; and Kazipur and Maizbari unions in Siraigani District. The three districts are located on the Western bank of Jamuna River in Northwestern Bangladesh.	local coping strategies and diversify livelihood strategies are offered on demand. • Communities always try to adapt to changing situations. Initially, they use their indigenous knowledge to cope with the situation. Coping strategies are often inadequate and need to be reinforced through training to enhance skills in alternative livelihood options. • Technological support is commonly needed both during and after flooding.
CASE 9 The Comprehensive Disaster Management Programme: Empowering local governments **Hazard(s):** Various Types **Source(s):** UNDP. (2010). **Local Governments and Disaster Risk Reduction**. Retrieved at http://www.memorisks.org/docs/ISDR_2010_LocalGovernmentsandDisasterRiskReduction.pdf		**Project Details**: The Comprehensive Disaster Management Programme (CDMP) is a whole-of-government strategy led by the Bangladesh Government's Ministry of Food and Disaster Management, and implemented by a range of government and private organizations. The community intervention part of the programme aims to increase community resilience and strengthen local government capacity to manage risk reduction as part of their development responsibilities. The programme has developed and implemented a standardized community risk assessment, and helped develop local action plans for mainstreaming disaster risk reduction into the work of government authorities. Most importantly, the programme provides a local funding structure to implement priority actions, motivating local authorities and communities to take part. The CDMP has been successfully piloted and designed for national roll-out.	• A standardised risk assessment is applied to all risk environments and delivers consistent outcomes. This enables separate community risk assessments to be readily compared or consolidated, and has facilitated replication of the project across Bangladesh. • The presence of the Local Disaster Risk Reduction Fund provides a practical, concrete demonstration to local authorities of the viability of a comprehensive disaster risk reduction approach. Funding the implementation of priority disaster risk reduction interventions gives local authorities a concrete reason to engage in the process. • All stakeholders, especially the local authorities and marginalised groups, are involved in the policy planning and decision making process. This encourages local authorities to take ownership of disaster risk reduction issues and activities, and increases community participation. • Local authorities get practical experience in assessing their risk environment, determining the vulnerabilities of their local communities, and taking the appropriate actions to mitigate them. • In considering all hazards and all sectors, the methodology can readily be adapted to an extremely wide variety of sociocultural and disaster risk environments, with minor adjustment. The World Bank's Local Government Support Programme for example is training local officials to use this risk assessment guideline to assess vulnerabilities across all sectors, devise strategies

Case Details	Resilience Identified/implied	Problems/Vulnerabilities	Lessons Learnt & Good Practices
			to mitigate risk, and facilitate local mainstreaming of disaster risk reduction. • The action plans developed as an outcome of the risk assessment process can be readily used to guide development in the region as a whole.
CANADA			
CASE 10 The Ontario Provincial Hazard Identification and Risk Assessment **Hazard(s):** Various Types **Source(s):** UNDP. (2010). **Local Governments and Disaster Risk Reduction**. Retrieved at http://www.memorisks.org/docs/ISDR_2010_LocalGovernmentsandDisasterRiskReduction.pdf		**Project Details**: The Ontario Provincial Hazard Identification and Risk Assessment (HIRA) process provides a ranked risk assessment of the frequency and potential impact of different hazards on the province, including natural, technological and man-made hazards. The 2003 assessment provided a baseline for Ministry-level assessments to be conducted throughout the provincial government, and meant that preparedness planning could be improved. The initial Provincial HIRA is being revised with an updated assessment, including a methodology for prioritizing hazards, due for completion at the end of 2009. The process has been led by Emergency Management Ontario, part of the Ministry of Community Safety and Correctional Services.	• A standardized methodology can provide a clear baseline for Ministries and municipalities to create their own HIRAs. If the same methodology is used, results can then be compared to identify and analyze trends and vulnerabilities. • A methodology based on scientific information and data can minimize perceived risk and provide a more realistic view of hazards and their potential effects. • The Provincial HIRA must be updated, as hazards are not static. • Clear guidelines and an explanation of the methodology used for the Provincial HIRA can be adapted by ministries and municipalities for their own risk assessments. • Information from a variety of sources and experts is crucial, as obtaining reliable scientific data can be a challenge. • A HIRA can assist in the allocation of money and resources • The Provincial HIRA provides a rigorous, baseline assessment that: (1) enables disaster prevention, mitigation, preparedness, response and recovery practices to be as effective as possible by highlighting the hazards of greatest concern, (2) uses a methodology that combines qualitative and quantitative data to assess risk through examining the frequency and potential magnitude of each hazard. This makes the process as accurate as possible, (3) gives emergency management professionals at all levels of government a practical and easy-to-use tool to assess the magnitude and frequency of each hazard. This then highlights which hazards should be a priority for preparedness programmes, (4) offers a

Case Details	Resilience Identified/implied	Problems/Vulnerabilities	Lessons Learnt & Good Practices
			dynamic and scientifically based method of assessing evolving hazards and risk, (5) identifies the most likely hazards to which the Government of Ontario may have to respond, including priorities for training and exercises.
CASE 11 Flood history in Canada **Hazard(s):** Flood **Year(s) of event:** 1879-2013 **Source(s):** https://en.wikipedia.org/wiki/History_of_flooding_in_Canada#1997_Red_River_flood.2C_.27flood_of_the_century.27:_a_return_interval_ranging_from_100_to_500_years http://ec.gc.ca/meteo-weather/default.asp?lang=En&n=47EF1277-1 http://www.cbc.ca/news/canada/newfoundland-floods-cause-state-of-emergency-evacuation-1.564206	• Learning from past experience • Effective urban planning and land use • Preparedness: Early warning system • Flood water management: waterway constructions, dikes, and comprehensive mitigation plans • Government effectiveness • Lifeline infrastructure: roads, railways • Timely evacuation • Efficient emergency response • Disaster financial reserves and contingency mechanisms • Active participation of local government in disaster mitigation • Infrastructure maintenance: water system	• In 1929, a tsunami stuck Burin Peninsula, Newfoundland, after a large-scale Grand Banks earthquake. In most places, the sea level swelled three to seven metres above normal. The tsunami destroyed many south coastal communities on the Burin Peninsula, killing 27 or 28 people, sweeping away homes, businesses, wharves, and fishing boats, and leaving 10,000 more homeless. • In 1948, the second largest Fraser River flood of record occurred. The flood of 1948 caused greater damage than the 1894 flood because of "intensive development" on the flood plain. By this time, the Lower Fraser Valley was a highly developed agricultural area, with commercial and industrial development and the beginnings of residential development. Thousands of people were displaced and infrastructure, including bridges and roads, was significantly damaged. • During the 1950 Red River Flood the Red River reached its highest level since 1861 resulting in "most catastrophic flood ever seen in Canada" from April to June. Winnipeg was ill prepared for such a huge swell of water. Eight dikes gave way and flooded much of the city. Four of eleven bridges were destroyed. • In 1954, Hurricane Hazel submerged low-lying land from Etobicoke to the Holland Marsh, left 81 people dead, and over 4,000 families homeless. As a result of an intense flash flood, Toronto's infrastructure took a heavy hit. Not built to withstand serious flooding, as it is in a climate area that does not see exceptionally prolonged or heavy rainfall, over 50 bridges, many part of important highways, were heavily damaged. • Most of the damage to homes and businesses in Canada during severe weather events like floods is linked to infrastructure failure with a large part of that resulting from water damage due to sewer backup. In many parts	• After the 1950 Red River Flood, the province of Manitoba completed the Red River Floodway in 1968 after six years of excavation, put up permanent dikes in eight towns south of Winnepeg, and built clay dikes and diversion dams in the Winnipeg area. Other flood control structures completed later were the Portage Diversion and the Shellmouth Dam on the Assiniboine. • After the 1954 Hurricane Hazel and flashflood, a regional approach to flood control and water management was adopted in Ontario and by 1959 the Metropolitan Toronto and Region Conservation Authority (MTRCA) finalized a comprehensive Plan for Flood Control and Water Conservation which included the proposed development of large dams and major flood control channels, with future plans for an erosion control program and the acquisition of 7,300 acres of land. In 1977, the Red River Floodway, known as "Duff's Ditch" saved Winnipeg from flooding. The CA$60 million Red River Floodway was built to mitigate flood damage on the Red River. Since its completion, it has saved an estimated CA$30 billion in damages in 20 flooding events (1960-2010). • In 2012, widespread June rains and violent thunderstorms enhanced the snowmelt, escalating the flood risk in the Kootenays, Okanagan, along the Fraser River and elsewhere. Floods were being fought on several fronts across the province. Emergency Management BC and municipalities opened 19 local emergency centres and the River Forecast Centre issued high water advisories for at least a dozen rivers from one end of the province to the other. • The 2013 Calgary and Southern Alberta Flood started on June 20, 2013 and was focused in communities in and around Calgary. Waters rose quickly and 100,000 had been evacuated. Government official co-ordinated information on social media, and the City of Calgary's

Case Details	Resilience Identified/implied	Problems/Vulnerabilities	Lessons Learnt & Good Practices
		of Canada water systems are vulnerable, as ageing storm and sanitary sewer infrastructure, stemming from a "significant long-term deficit in infrastructure improvement" often results in infrastructure incapacities to handle the "new, higher levels of precipitation.	official website was replaced with its blog with up-to-the-minute information on the emergency. • Canada, the provincial and federal government via the Canadian taxpayer, cover the cost of large-scale floods, as private insurers will not cover the cost of home owners' overland flooding damage. Private insurers cover sewage backup, but won't offer flood protection because the small population base of Canada means it's difficult for the companies to cover the cost of their risk. • All levels of government have a role to play in a provincial flood mitigation strategy. For a large flood event, the federal government pays up to 90% of the disaster assistance funds and, therefore, should have an interest in a strategy to reduce economic losses. The province has responsibility for managing natural resources that includes regulating activities in the waterways, flood risk identification and flood forecasting. As well the province is responsible for a portion of disaster assistance funding.
CHINA			
CASE 12 Wuzhou City Flood **Hazard(s):** Flash flood **Year(s) of event:** July 2005 **Source(s):** http://edition.cnn.com/2005/WORLD/asiapcf/06/23/china.floods/ http://earthobservatory.nasa.gov/NaturalHazards/view.php?id=15231	• Effective early warning • Timely evacuation announcement • Frequent monitoring of t hazards	• China has evacuated 100,000 residents of a southern city to escape a swollen river in one of three provinces where heavy rains have triggered landslides and floods killing more than 20 people. Floodwaters forced the mass evacuation overnight of residents in low-lying areas of the industrial city of Wuzhou, where the Xijiang river had reached 24.42 metres by Tuesday night, more than seven metres higher than the warning level. • Notices on the mass evacuation were posted on walls, warning sirens blared in the dark of night and Wuzhou residents began to load up cars, trucks and carts with valuables and flee the area for higher ground. • A flash flood swept through a low-lying primary school in northeastern Heilongjiang province, killing 117 people, 105 of them children.	

Case Details	Resilience Identified/implied	Problems/Vulnerabilities	Lessons Learnt & Good Practices
CASE 13 Sichuan Earthquake **Hazard(s):** Earthquake **Year(s) of event:** May 2008 **Source(s):** https://en.wikipedia.org/wiki/2008_Sichuan_earthquake http://www.britannica.com/event/Sichuan-earthquake-of-2008	• Quick response of disaster • Government effectiveness • Seismic design code • Evacuation site provision	• It is also known as the Wenchuan earthquake, massive and enormously devastating earthquake that occurred in the mountainous central region of Sichuan province in southwestern China on May 12, 2008. The epicenter of the magnitude-7.9 quake (measured as magnitude 8.0 by the Chinese) was located near the city of Dujiangyan, about 50 miles (80 km) west-northwest of Chengdu, the provincial capital, at a depth of 11.8 miles (19 km) below the surface • According to Chinese state officials, the quake caused 69,180 known deaths including 68,636 in Sichuan province; 18,498 people are listed as missing, and 374,176 injured.	• General Secretary and President Hu Jintao announced that the disaster response would be rapid. Just 90 minutes after the earthquake, Premier Wen Jiabao, who has an academic background in geomechanics, flew to the earthquake area to oversee the rescue work soon afterward, the Ministry of Health said that it had sent ten emergency medical teams to Wenchuan County. On the same day, the Chengdu Military Region Command dispatched 50,000 troops and armed police to help with disaster relief work in Wenchuan County. However, due to the rough terrain and close proximity of the quake's epicenter, the soldiers found it very difficult to get help to the rural regions of the province. • Because of the magnitude of the quake, and the media attention on China, foreign nations and organizations immediately responded to the disaster by offering condolences and assistance. On May 14, UNICEF reported that China formally requested the support of the international community to respond to the needs of affected families.
COLUMBIA			
CASE 14 Galeras Volcano Eruption **Hazard(s):** Volcanic activities **Year(s) of event:** frequently active **Source(s):** https://en.wikipedia.org/wiki/Galeras http://www.volcanodiscovery.com/galeras.html http://www.vulkaner.no/v/volcan/galeras-e.html	• Preparedness: early warning • Awareness raising: normalization bias adjustment • Timely evacuation • Disaster financial reserves and contingency mechanisms	• An eruption in November 2005 forced an evacuation of the dangerous area surrounding the volcano, and about 9,400 people from nearby villages (most of them farmers) were ordered to leave. • In 2006, the Colombian government has repeatedly ordered evacuations to temporary shelters, of more than 8500 people residing in the highest risk areas surrounding the volcano, with hopes of eventual assistance toward permanent relocation. • The inhabitants in the area surrounding the volcano have for a long time used mask to prevent themselves breathing particles of ash. Incandescent material has been flowing down the slopes of the volcano and set fire to the vegetation and the crops, and domestic and wild animal suffers.	• In 2004, the Colombian government on Tuesday ordered the evacuation of 9,000 people living on the slopes of the Galeras volcano near the border with Ecuador. The government will pay evacuees about $40 a month to help with renting temporary accommodations.

Case Details	Resilience Identified/implied	Problems/Vulnerabilities	Lessons Learnt & Good Practices
		• The authorities request not to believe in rumors and to rely solely on the official notices that come through the local radio stations. • In 2004, the Colombian government on Tuesday ordered the evacuation of 9,000 people living on the slopes of the Galeras volcano near the border with Ecuador. The government will pay evacuees about $40 a month to help with renting temporary accommodation. But some peasants have told local television they do not believe the warnings and will refuse to leave their smallholdings. • In 2004, after eruption, there was a collapse in the media, all radio channels were blocked, there was no contact by phone. More seriously, in times like these, is that the population had only one thing in mind "I do not believe that anything will happen". That was why everyone with few exceptions, refused to leave their homes, farms or plots to go to the shelters built for their safety.	
DOMINICAN REPUBLIC			
CASE 15 Northern Dominican **Hazard(s):** Heavy rains → Flood **Year(s) of event:** November 2003 **Source(s):** http://reliefweb.int/report/dominican-republic/american-red-cross-responds-flooding-dominican-republic http://www.caribbeannewsnow.com/caribnet/2003/11/27/flooding.htm http://www.ifrc.org/ar/news-and-media/news-stories/americas/dominican-republic/heavy-rains-and-floods-hit-dominican-republic/	• Food and livestock security • Preparedness: early warning • Lifeline facilities: water, food, shelter, sanitation • Effective emergency response	• Towns have been completely flooded-literally sitting in the middle of a river-for four or five days. Communities are cut off entirely. • Water systems have been contaminated, and the area is experiencing a flood-related swell in the disease-carrying mosquito population. • An increase in mosquitoes in addition to inadequate treatment of sewage and limited supplies of potable drinking water bring an increase in exposure to communicable diseases such as malaria and cholera. • Further devastating long-term effects are expected from sizeable crop and livestock losses, which could contribute to economic losses for the country in the millions of dollars. It is estimated that 195,000 "tareas" of crops are lost. According to the Agricultural Ministry, is estimated that at least 600,000 quintals of rice, equivalent to one month's national supply, have been	

Case Details	Resilience Identified/implied	Problems/Vulnerabilities	Lessons Learnt & Good Practices
		lost. Hundreds of heads of livestock are also reported missing. • Evacuees currently number 47,270 and 2,159 persons are currently in shelters.	
CONGO, DEMOCRATIC REPUBLIC			
CASE 16 Nyiragongo Volcano, Goma **Hazard(s):** Nyiragongo Volcanic Eruption **Year(s) of event:** February 2002 **Source(s):** http://nyiragongo.com/2002.html https://en.wikipedia.org/wiki/Mount_Nyiragongo#2002_eruption	• Preparedness: early warning system • Government effectiveness • Timely evacuation • Effective land use and urban planning	• The 2002 eruption of Nyiragongo volcano lasted for one day, destroyed 15% of Goma, including part of the international airport and the business centre. Tens of thousands of people were made homeless and 400,000 people evacuated. • The eruption was preceded months beforehand by increased fracturing and fumarolic activity on the upper southern slopes of the volcano and an increasing level of seismicity. • In 1994, five monitoring units were donated by the US Geological Survey's Volcano Disaster Assistance Program (VDAP) to form the Goma Volcano Observatory. But fighting in the area and looting of equipment by armed militia camped on the volcano itself regularly forced volcanologists to flee. According to the VDAP, only two monitoring stations were working properly before the eruption. • VDAP scientists nevertheless received a warning on 12 January - five days before the first eruption. Efforts were made to raise the alarm, but the lack of governance in Goma makes it unlikely that any plan to evacuate the city could have been implemented. • One volcanologist said he would advise against rebuilding Goma at its present location, due to the danger of further eruptions.	
CZECH REPUBLIC			
CASE 17 Praque **Hazard(s):** Flood **Year(s) of event:** July-September 2002	• Lifeline facilities: railways • Disaster financial reserves and contingency mechanisms • International aids	• The Dyje River in south Moravia and other rivers also burst their banks. The flood wave culminated in Prague on August 14 when the water level in the Vltava River reached its peak. On August 17 the flood wave moved further on to Germany.	

Case Details	Resilience Identified/implied	Problems/Vulnerabilities	Lessons Learnt & Good Practices
Source(s): http://m.ceskenoviny.cz/archiv/zpravy/czech-republic-in-2002-july-september/20504		• In all, 753 municipalities were affected and about 220,000 people were evacuated. The death toll reached 17. More than one thousand houses were destroyed by the floods with the most tragic consequences being in the villages of Metly, south Bohemia, and Zalezlice, central Bohemia, where most of houses were destroyed or damaged. • The Spolana chemical plant in Neratovice, central Bohemia, was the most severely hit company as 90 percent of it was inundated. The Prague metro was heavily hit - 25 stations or one half stopped functioning, of which 17 were either flooded or damaged, mostly on the B line. • The government allots 1.15 billion crowns from the state budget to finance flood relief work. Another 500 million crowns are at the disposal in the extra-budgetary Transport Fund designed for the repair of motorways, railways and water transport. European Commission president Romano Prodi confirms in Prague that the European Union will provide almost 58 million euros in immediate relief to finance the removal of the flood damage.	
ECUADOR			
CASE 18 "Critical Video Analysis" of Volcanic Eruption Mitigation Project **Hazard(s):** Volcanic Activities **Source(s):** UNDP. (2007). **Building Disaster Resilience Communities**. Retrieved at http://www.unisdr.org/files/596_10307.pdf		Project Details: • Tungurahua is one of the most active volcanoes in Ecuador. After its eruptive period from 1916 to 1918, it entered a new phase of activity that intensified in 1999, culminating in new eruptions in 2003 and 2006. The new eruptions produced mud flows and volcanic ash that are affecting the country's central provinces, with the greatest impact in Tungurahua province. Across the area, the volcano has caused serious damage to the economy and health of the affected populations. • In 2003, as new eruptions intensified and the risks persisted, the roman catholic diocese of Ambato and Catholic Relief Services (CRS) developed a project entitled "Communities Affected by Tungurahua: Mitigating the Risks of Living Near an Active Volcano".	• This Critical Video Analysis initiative is considered a good practice not only because the knowledge gained allows for project and programme improvement, but also the exercise was more critical and objective than a traditional "lessons learned" review. Indeed, contracting outside the organization brought fresh perspectives and objective critical assessments, and eventually broadened the project understanding within the field of international development. • The initiative is innovative as it contains a strong artistic element which makes the delivery of the analyses more "user friendly" and therefore accessible to both specialists (donors, professionals, etc.) and the public at large in a quick, enjoyable medium rather than a verbose document full of technical jargons.

Case Details	Resilience Identified/implied	Problems/Vulnerabilities	Lessons Learnt & Good Practices
		The project was financed by the European Commission Humanitarian aid Office (ECHO) through its disaster preparedness programme called DIPECHO (Disaster Preparedness, European Commission Humanitarian aid Office), with support from the Catholic Agency for Overseas Development (CAFOD). The project's objective was to strengthen the capacity of the communities and institutions affected by Tungurahua with the goal of reducing the impacts of current/future disasters through preparation, mitigation and prevention. It benefited 35 high-risk communities in Tungurahua province.	• The initiative was implemented through the two videos that were produced, involving 20 interviews with project donors, partners, promoters/implementers and beneficiaries. The interviews include commentaries from the leadership of CRS, ECHO, the National Civil Defence, the National Geophysical Institute and local partners, as well as thoughts and recommendations on the project from civilians affected by the recent volcanic eruptions. The initiative was initiated by CRS and facilitated by a CRS staff member in collaboration with two HASGA Productions staff members. • Strategies and methods that were implemented included participatory processes such as interviews and collaborative meetings, and contracting project implementation outside the organization for the sake of greater objectivity. • The key success/failure factors include: (1) Logistical challenges posed by timely completion of interviews in two different cities and five different rural communities located in difficult-to-reach regions near the volcano; (2) Extracting, re-phrasing and editing contents that were appropriate but not "video friendly".
EL SALVADOR			
CASE 19 San Miguel **Hazard(s):** Earthquake → Landslide **Year(s) of event:** January-February 2001 **Source(s):** https://en.wikipedia.org/wiki/January_2001_El_Salvador_earthquake	• Security of lifeline facilities: water, sanitation • Preparedness: evacuation sites • Seismic design code	• At least 944 people were killed, 5,565 injured, 108,261 houses destroyed - with another 169,692 houses damaged - and more than 150,000 buildings were damaged. • Clean water and sanitation became a matter of grave concern in many areas due to the earthquake's destruction of some $7 million to municipal drinking water systems. • In the countryside they had been housed in temporary huts under the supervision of the armed forces, or with relatives	
CASE 20 Integrating Children and Youth in Disaster Management **Hazard(s):** Various Types		Project Details: • Children represent more than a third of disaster victims, yet the humanitarian sector generally restricts their role in disasters to that of passive victims. Yet,	• This project is a good practice because of its emphasis on integrating children and youth in disaster management. In particular, it proves the need for inclusion of their voice and agency in ensuring a holistic approach to

Case Details	Resilience Identified/implied	Problems/Vulnerabilities	Lessons Learnt & Good Practices
Source(s): UNDP. (2007). **Building Disaster Resilience Communities**. Retrieved at http://www.unisdr.org/files/596_10307.pdf		involving children directly in Disaster Risk Reduction (DRR) activities enables them to develop skills to be prepared for any threat. Furthermore, the emphasis on rights-based approaches to humanitarian work brings forward the right of children and youth to be protected from hazards and vulnerabilities through their participation in disaster-related decisions and efforts. • In the light of all the above, Plan International has mobilized children and youth in El Salvador, Central America, to play a significant role in environmental resources management and disaster risk reduction. The children and youth have worked with their communities in developing risk maps, designing community emergency plans, setting up early warning systems, and implementing response, mitigation and risk reduction plans, among other activities. Plan International's experience in El Salvador has already been replicated in other Central American countries.	disaster management (including preparedness and mitigation), and supports the value of a rights-based approach to childcentred DRR. • The innovative elements of the Project include the targeting of children as actors and agents of change - whereby childfocused risk reduction can tangibly help reduce disaster threats and impacts. In particular, the Project offers implications for conceptual approaches to risk communication and how this might influence the design of early warning systems and community mitigation planning. • Success has been observed, with noted added-value in supporting the children's and youth's roles in risk communication, education/awareness raising, advocacy and practical risk reduction activities. The key success factors of this project are: (1) The communities' trust in an outside agent helping support the organisation of youth groups; (2) The communities' strong sense of social cohesion; and (3) The communities' support for the establishment of an environment that is conducive to child participation.
FIJI			
CASE 21 Cyclone Tomas **Hazard(s):** Cyclone **Year(s) of event:** March 2010 **Source(s):** http://www.nasa.gov/mission_pages/hurricanes/archives/2010/h2010_Tomas.html https://en.wikipedia.org/wiki/Cyclone_Tomas	• Preparedness: early warning • Timely evacuation • Emergency response • International aids	• Areas of north and east Fiji encountered winds near 109 mph (175 km/hour) and storm surges. About 17,000 people had gone to the evacuation centers before the storm hit. • Watches and Warnings are in effect for the Fiji Islands. In Fiji a Cyclone Warning is in effect for eastern quarter of Ono-I-Lau, Vatoa and nearby islands. • Houses were damaged, electricity, water and sewage systems were affected, and flooding was reported.	• After the storm, the governments of New Zealand and Australia each sent $1 million in their respective currencies to Fiji. The New Zealand Air Force sent relief supplies, including tarps and water purifying equipment.
CASE 22 Beyond Early Warning and Response **Hazard(s):** Flood **Source(s):**		Project Details: Flooding in Navua, Fiji, has caused extensive damage to crops, livestock, houses, roads and bridges, and has been exacerbated by poor development planning. In the floods of 2003 and 2004, hundreds of people lost their homes and belongings. Taking a long-term approach to strengthening	• The initiative promotes the investment of national and provincial funds in disaster risk reduction. • Different institutionalized processes of central and traditional government are being respected. • Communities are analyzing their own risks, vulnerabilities and development priorities, and

Case Details	Resilience Identified/implied	Problems/Vulnerabilities	Lessons Learnt & Good Practices
UNDP. (2010). **Local Governments and Disaster Risk Reduction**. Retrieved at http://www.memorisks.org/docs/ISDR_2010_LocalGovernmentsandDisasterRiskReduction.pdf		local level disaster risk reduction, the UNDP Pacific Centre has been working with multiple partners and stakeholders on this comprehensive, locally-implemented project. The initiative has raised awareness of the links between development and flooding within the planning process, helped develop early warning systems, supported communities to assess their vulnerabilities, drawn up plans of action and put those plans into practice.	addressing them from within instead of relying on external forces. This has been achieved by using participatory methods. • Gender-sensitive participatory methods are ensuring women's participation and that their voices are heard. • Local government representatives with planning and disaster risk management responsibilities are being trained in disaster risk reduction. • An advocacy and awareness strategy on disaster risk is being developed for local level use. • Community action plans are aligned with the capacities and resources of the communities. • There is now better communication and interaction between local and national government representatives through joint workshops, training, meetings and participation in a Steering Committee. • Traditional local leadership mobilized communities
FRANCE			
CASE 23 South-eastern France **Hazard(s):** Heavy rainfall → Flash flood **Year(s) of event:** December 2003 **Source(s):** http://news.bbc.co.uk/2/hi/europe/3291867.stm	• Urban planning: consistent with hazard map • Evacuation sites • Lifeline facilities: roads, railways, sanitation • Government effectiveness • Efficient emergency response: prompt evacuation time	• Police were forced to evacuate 190 high-risk prisoners from the town of Arles on Friday after a dyke gave way. • Thousands of people remain without clean water or electricity. • Buildings there are under more than a metre of water and authorities said up to 800 people were evacuated from northern neighbourhoods overnight on Thursday. • Roads and railways were out of use.	• Mayor said he was pleased with the response to the floods, saying local mayors had been well prepared and executed rescue operations swiftly.
CASE 24 Mission Risques Naturels (MRN) **Hazard(s):** Various Types **Source(s):**	• PPP initiatives with state and territorial authorities, on information sharing, public awareness raising and modelling improved analysis of socio-economic and financial costs of risk scenarios.	• MRN was created in 2000 by French insurance companies, just after experiencing the huge losses caused by storms Lothar and Martin, as well as large floods and subsidence during the decade. • It is dedicated to developing general interest services for the market as a whole and for its insurance companies on knowledge and prevention management. • This includes PPP initiatives with state and territorial authorities, on information sharing, public awareness raising and modelling improved analysis of socio-economic and financial costs of risk scenarios.	• Active participation of user clubs, where the different categories of skills with the companies staff members are expressed; • Integration into the different spheres of stakeholders through active networking; and • • The importance of monitoring and sharing of good practice.

Case Details	Resilience Identified/implied	Problems/Vulnerabilities	Lessons Learnt & Good Practices
CASE 25 Memo'Risks: Students survey community risk knowledge **Hazard(s):** Various Types **Source(s):** UNDP. (2010). **Local Governments and Disaster Risk Reduction**. Retrieved at http://www.memorisks.org/docs/ISDR_2010_LocalGovernmentsandDisasterRiskReduction.pdf		Project Details: The Memo'Risks initiative has been operating in the Loire River catchment area of France since 2004, and brings together local governments and schools to survey local disaster risk awareness. Students are rallied by city Mayors to investigate the possible hazard impacts on their town, to map risks, and to survey the preparedness and risk knowledge of the local population. The survey results become a valuable data resource on perceptions of risk and the level of risk knowledge in the local population. Importantly, the process of collecting, presenting and publicising the results is used by the local government to raise disaster awareness through the media, to increase community participation in disaster risk reduction, and to form the basis of targeted disaster risk information campaigns.	• Memo'Risks carries out risk education for students and for the community at large at the same time. • It is based on a true partnership between local governments and schools, both being grassroots institutions able to lead and reach the community effectively • It uses a participatory and capacity-building approach, encouraging students to engage with civic processes and generate publicity with their risk mapping survey. Students, the direct participants, end up leading and informing their community as a whole. • It uses a bottom-up approach by basing information campaigns on the findings of the survey of public perceptions and knowledge. • It has made disaster risk reduction accessible and more relevant to people by emphasizing their personal, everyday experiences. It promotes a media-friendly subject that can form part of an overall risk communication strategy at the local government level.
Haiti			
CASE 26 Haiti flood **Hazard(s):** Tropical storm → Floods & Mudslide **Year(s) of event:** 2004, 2014, 2015 **Source(s):** 2004 http://www.heatisonline.org/contentserver/objecthandlers/index.cfm?id=4677&method=full http://edition.cnn.com/2004/WORLD/americas/05/28/caribbean.storm/index.html?_s=PM:WORLD http://noosphere.princeton.edu/haiti.flood.html http://news.bbc.co.uk/2/hi/americas/3697086.stm 2014	• Lifeline facilities: water, sanitation, medicine, food • Emergency management • Preparedness: early warning • Environmental preservation: forest preservation • Disaster financial reserves and contingency mechanisms • Preparedness: early warning • Waste management • Learning from past experience	• Relief workers say food is still not getting to people quickly enough, amid problems with security and logistical problems caused by the storm. • The UN troops have been mobilised to stop people fighting at food distribution points. • The city was without electricity or running water, and lacks basic medicines such as antibiotics. • Gen. Jose Maria Jimenez of the Dominican Republic Army said the total damage has not yet been realized. 'Even though the press has done a good job of informing the public about the tragedy, I believe the people don't have a good idea of the magnitude of this tragedy'. • The rising waters from the Jimaní River swept away homes, cut utility lines and prevented rescuers from reaching the hardest-hit regions. • In 2014, heavy rainfall starting at the beginning of November 2014 caused flooding and landslides in Northern Haiti, killing 17 people. More than 15,000	

Case Details	Resilience Identified/implied	Problems/Vulnerabilities	Lessons Learnt & Good Practices
http://reliefweb.int/disaster/fl-2014-000155-hti 2015 http://reliefweb.int/disaster/fl-2015-000037-hti http://www.caribbean360.com/news/six-dead-in-haiti-following-heavy-rains-and-severe-flooding		houses were flooded, 90 were destroyed and 800 were severely damaged. Over 6,500 people were temporarily housed in emergency shelters. The floods also affected over 2,200 hectares of crops in one of the country's most fertile areas. • In 2015, the main reasons for the damage caused by flood are the lack of cleaning of drainage canals and unplanned construction in the ravines.	
CASE 27 Port-au-prince **Hazard(s):** Earthquake **Year(s) of event:** January 2010 **Source(s):** https://en.wikipedia.org/wiki/2010_Haiti_earthquake http://reliefweb.int/disaster/eq-2010-000009-hti	• Poverty Reduction and Wealth distribution • Government effectiveness • Lifelines facilities: hospitals, airports, roads, communication systems • Disaster Management • Economic Resilience • International aids • Disaster financial reserves and contingency mechanisms • Land tenure: land ownership • Effective urban planning	• The government of Haiti estimated that 250,000 residences and 30,000 commercial buildings collapsed or were severely damaged. • There has been a history of national debt, prejudicial trade policies by other countries, and foreign intervention into national affairs that contributed to the pre-existing poverty and poor housing conditions that exacerbated the death toll. • Communication systems, air, land, and sea transport facilities, hospitals, and electrical networks had been damaged by the earthquake, which hampered rescue and aid efforts; confusion over who was in charge, air traffic congestion, and problems with prioritization of flights further complicated early relief work. • Amongst the widespread devastation and damage throughout Port-au-Prince and elsewhere, vital infrastructure necessary to respond to the disaster was severely damaged or destroyed. This included all hospitals in the capital; air, sea, and land transport facilities; and communication systems. • The Australian government's travel advisory site had previously expressed concerns that Haitian emergency services would be unable to cope in the event of a major disaster, and the country is considered "economically vulnerable" by the FAO. • Slow distribution of resources in the days after the earthquake resulted in sporadic violence, with looting reported.	• International aids have played in a significant part in Haiti recovery. Here, the 26-member international Interim Haiti Reconstruction Commission, headed by Bill Clinton and Haitian Prime Minister Jean-Max Bellerive, was formed to oversee the US$5.3 billion pledged internationally for the first two years of Haiti's reconstruction. • Local civil society should be included in every process of recovery and rehabilitation. For Haiti, the commission was critiqued by Haitian groups for lacking Haitian civil society representation and accountability mechanisms. Half the representation on the commission was given to foreigners who effectively bought their seats by pledging certain amounts of money.

Case Details	Resilience Identified/implied	Problems/Vulnerabilities	Lessons Learnt & Good Practices
		• One year after the quake, relief and recovery were at a standstill due to government inaction and indecision on the part of the donor countries. • Land ownership posed a particular problem for rebuilding because so many pre-quake homes were not officially registered. Even before the national registry fell under the rubble, land tenure was always a complex and contentious issue in Haiti. Many areas of Port-au-Prince were settled either by tonton makout – Duvalier's death squads – given land for their service or by squatters. In many cases land ownership was never officially registered. Even if this logistical logjam were to be cleared, the vast majority of Port-au-Prince residents, up to 85 percent, did not own their homes before the earthquake.	
CASE 28 Community Members Design and Implement Information Campaigns for Their Communities **Hazard(s):** Various Types **Source(s):** UNDP. (2007). **Building Disaster Resilience Communities**. Retrieved at http://www.unisdr.org/files/596_10307.pdf	•	Project Details: • Haiti is known for its extreme vulnerability to natural hazards. In 2004, innovative community-based information campaigns were developed in the Northern Haiti town of Cap-Haitian, as part of a "Community Based Disaster Preparedness Project". The approach to communication and public awareness allowed 22 newly created Local Civil Protection Committees (LCPCs) to design and implement their own information campaigns for their communities. Each of the 22 local committees was given technical support and project funding to design and implement its own disaster risk reduction campaign. • Because the local actors were asked to develop their own campaigns, the communication methods used were genuinely adapted and "acceptable" and proved to be effective. Final evaluations of the project showed that the approach to risk communication contributed significantly to developing a "culture of safety" among the 22 communities targeted. It modified the riskrelated attitude and behaviour of the people at risk and stimulated community participation in disaster mitigation.	• This was a good practice because it served successfully two purposes - public awareness and capacity building - and it effectively helped enhance the safety of the population at risk. • An innovative aspect was real optimization of local knowledge and local resources by local stakeholders, as well as significant mobilization of the creative and innovative energies of local actors (including local artists - Haiti is well known for its paintings - and local traditions to facilitate community assemblies - where local voodoo groups presented traditional dances, etc.). These resulted in genuine ownership by and empowerment of local actors and groups. • At the end of the project, two types of evaluation were carried out: (1) A traditional evaluation; (2) A Knowledge, Attitude and Practice (KAP) survey. Both showed similar findings: In terms of social vulnerability/capacity, the larger project facilitated and encouraged the creation of a new social dynamics where people shared values and behaviours towards cooperation amongst themselves but also a proactive responsibility towards the community. Regarding individual attitudes and behaviours, a more responsible and proactive conduct was observed as the population was keener to evacuate preventively. Indeed,

Case Details	Resilience Identified/implied	Problems/Vulnerabilities	Lessons Learnt & Good Practices
			it was the first time that people in Cap Haitian evacuated willingly, with their belongings, before it started raining heavily. The presence of about 430 families (2,550 people) from the most high-risk areas was recorded in LCPCmanaged evacuation centres the night before Hurricane Jeanne struck. • A key success factor of this initiative was the combination of two main communication modes: (1) A permanent one - the billboard (most of the billboards were still standing and visible two years after the end of the project); (2) A one-off one - the festive event/assembly.
INDIA			
CASE 29 Chobari Village, Bhachau Taluka, Gujarat **Hazard(s):** Earthquake **Year(s) of event:** January 2001 **Source(s):** https://en.wikipedia.org/wiki/2001_Gujarat_earthquake http://news.bbc.co.uk/onthisday/hi/dates/stories/january/26/newsid_4666000/4666568.stm http://www.ibtimes.co.in/2001-gujarat-earthquake-when-india-faced-one-its-worst-disasters-14-years-ago-photos-621365	• Seismic design code • International aids (The Red Cross – Medical support) • Food and water Supplies after disaster • Hospitals • Lifeline facilities • Shelter and evacuation sites • Effective relief distribution • Fact recovery	• The earthquake of 26 January 2001 (magnitude 7.7) devastated Gujarat State with an unprecedented and widespread loss of life and property. More than 13,000 people lost their lives, and thousands were injured. The earthquake affected an area stretching over more than 400 km. • After the earthquake, the Sustainable Environment and Ecological Development Society (SEEDS), NGOs Kobe, the United Nations Centre for Regional Development (UNCRD), and the Earthquake Disaster Mitigation Research Center (EDM) started a joint reconstruction and recovery program in a village called Patanka in the Patan district of Gujarat. • A project called PNY (Patanka Navjivan Yojna) was formulated. It sought to empower the affected community to such an extent that it would become sufficiently resilient against any future disasters. It attempted to link immediate response in the form of relief to mainstream development/ establish a framework of mutual cooperation among different stakeholders in the post-disaster scenario/ and aim at successively reducing the role of external agencies in local rehabilitation action until the point at which the local community completely took over the functions so far performed only by the external agency. In Kutch, the earthquake destroyed about 60% of food and water	**Post-Disaster Reconstruction and Recovery Model** • The Process of Rehabilitation had three major stages. • **Stage I: Principles and Planning** The first task was setting up the basic principles for planning the rehabilitation intervention. The intervention had to be participatory, with a gradual increase in the involvement of the community. A well-planned rehabilitation exercise could significantly increase the capacity of the community for a more effective response. This plan had three parts: the Strategy Plan, the Community Action Plan and the Implementation Plan. The role of the Project Team was to facilitate the reconstruction process. • **Stage II: Implementation** This Implementation Stage of the project consisted of three steps: (1) Need Assessment, (2) Capacity Building, and (3) Implementation. **Stage III: Ensuing Sustainability** The effort initiated by the Project Team needed to be sustainable long after the interventions were over. In effect, intervention should be designed to ensure that the community was able to take care of its development needs and was resilient against future disasters. For this, strengthening local institutions was necessary.

Case Details	Resilience Identified/implied	Problems/Vulnerabilities	Lessons Learnt & Good Practices
		supplies and around 258,000 houses – 90% of the district's housing stock. The biggest setback was the total demolition of the Bhuj Civil hospital. • Medical facilities are in crisis, with many hospitals damaged by the quake and others overwhelmed by the demand for treatment. • A year later many were still living in tents and shelters in primitive conditions with little sign of damaged houses being redeveloped.	
CASE 30 Varunawat Hills, Uttarkashi, Uttarakhand State **Hazard(s):** Earthquake or Prolonged Rainfall or Intense Rainfall → **Landslide** **Year(s) of event:** September 2003 **Source(s):** http://link.springer.com/article/10.1007%2Fs00254-007-1032-z http://www.adrc.asia/publications/TDRM2005/TDRM_Good_Practices/PDF/PDF-2009e/2.India.pdf	• Pre-emptive mapping of zones • Timely action by all these stakeholders	• A disastrous landslide took place on 24 September 2003 in the Varunawat Hills in Uttarkashi. It engulfed three 4-story hotels and damaged several buildings, roads and other infrastructure. The estimated damage were to the tune of about 50 million dollars. • However, there was no loss of life despite the fact that about 400 buildings were declared at risk after this landslide. The landslide generated debris of more than half a million cubic meters. The height of the landslide was more than 500m and the affected area was approximately 2 sq. km. The landslide remained continuously active for a period of about one month, up to 20 October 2003.	• Pre-emptive mapping of zones susceptible to landslides and their monitoring with field observations to alert the community at risk & suggest preparedness/response actions to the local administration • Appropriate timely action by all these stakeholders (scientists, administration, community and others) • The administration alerts the potentially affected community and disseminates the information through the media for evacuation and response. • Efforts are also made to keep the panic level low. • Local administration helps in providing temporary shelters and other support.
CASE 31 **Masons trained in earthquake-resistant construction** **Hazard(s):** Earthquake **Source(s):** UNDP. (2007). **Building Disaster Resilience Communities**. Retrieved at http://www.unisdr.org/files/596_10307.pdf		Project Details: • Following the devastating 2001 earthquake in Gujarat State, Western India, rehabilitation programmes incorporated several Disaster Risk Reduction (DRR) features. Among them was an initiative by the Sustainable Environment and Ecological Development Society (SEEDS) to create a pool of masons trained in earthquake-resistant construction. The cadre of trained masons was expected to address the immediate need for reconstruction and a long-term need for a culture of safe buildings. • Over the years, the SEEDS Mason Association (SMA) has expanded to an 800-member organization, of which 200 have been certified by the Government for having reached internationally accepted standards in	• This initiative is considered a good practice because: (1) It has been mainstreamed into development from the very beginning; (2) It addresses an important need for safe buildings; (3) It has a grassroots reach; (4) It is very accessible to the poor and to vulnerable households. • It is also innovative as it promotes peer learning as well as a single-point access for disseminating information related to safe buildings. A key success factor of this initiative is that the Association is supported by SEEDS, an NGO with a focus on DRR. SEEDS ensures that the Association is partnered with in every related initiative. • Overall, such a grassroots movement has tremendous potential as over 57 per cent of India's national territory is prone to earthquakes, and vulnerabilities to other disasters put India's one billion people at risk.

Case Details	Resilience Identified/implied	Problems/Vulnerabilities	Lessons Learnt & Good Practices
		construction skills. The masons are now serving their local communities, educating fellow masons in other regions at similar risk, as well as responding in disasterhit areas for shelter reconstruction and capacity building. • The SMA initiative is an effort in consolidating training and research on good quality safe construction practice at grassroots level. The Association also acts as an information centre for dissemination of modern technologies in construction through newsletters and public meetings.	• The key lessons learned from this initiative are: • Disasters are opportunities for bringing in change such as disaster-resistant construction as part of reconstruction; • Peer-level exchange and learning at grassroots level has proved to be effective in building capacity; and • Institutionalization of efforts is important for promoting building safety. • The major challenges of this initiative are: • Difficulty to overcome the inertia among existing construction workers to absorb new technologies; • High demand from the building industry and limited supply has led to poor quality that characterizes the building sector - which has increased disaster risk; and • Recognition and acceptance by communities that have not been affected by disasters yet, has been sluggish.
CASE 32 'Afat Vimo' Disaster Micro-insurance scheme for low-income groups **Hazard(s):** Various Types **Source(s):** UNDP. (2007). **Building Disaster Resilience Communities**. Retrieved at http://www.unisdr.org/files/596_10307.pdf		Project Details: • In 2002, the majority of the 2001 Gujarat earthquake relief beneficiaries were still exposed to disaster-induced financial losses. Various studies - including the Gujarat Community Survey of 2002 by the Gujarat-based All India Disaster Mitigation Institute (AIDMI) and ProVention Consortium - revealed that access to risk transfer was correlated with sustainable economic recovery among victims5 , yet only two per cent of those surveyed had insurance. A micro-insurance scheme was designed to augment AIDMI's ongoing Livelihood Relief Fund6 activities. The resultant scheme, called "Afat Vimo", was the result of extensive discussions and negotiations with insurance providers who could be interested in supplying low-premium insurance policies to poor clients. • Afat Vimo policyholders are covered for damage or loss up to the value of 1,744 US dollars for non-life assets and 465 US dollars for loss of life, which gives a total damage and loss coverage of 2,209 US dollars. Current Afat Vimo clients include 5,054 individuals from lowincome households with an annual income of 280 US dollars. These households are mainly involved in small enterprises in the informal sector and have assets	• The good practice in Afat Vimo lies in the fact that risk is transferred from the individual level to the community or inter-community levels, which include groups based in different geographic locations and which are not equally disaster prone. • The Afat Vimo scheme represents an innovative approach to risk identification, pooling and transfer, which recognizes the fact that the majority of poor disaster victims have little or no access to risk transfer schemes. According to a recent study of micro insurance policies in India by the International Labour Organization, 45 per cent of micro-insurance schemes researched cover only a single risk and only 16 per cent cover three risks. As Afat Vimo covers 19 disaster risks, it is one of the most comprehensive products in India. This not only makes the policy more attractive to clients, but also makes investment in the policy more efficient in economic terms. Another aspect of Afat Vimo that sets it apart from other micro-insurance policies is the extensive range of eventualities covered under the policy. • Last but not least, Afat Vimo policyholders are also supported with micro-mitigation measures such as fire-safety training, seismic-safe construction practices and business development services. The policy is available for

Case Details	Resilience Identified/implied	Problems/Vulnerabilities	Lessons Learnt & Good Practices
		worth approximately 209 US dollars. It is striking that 94 per cent of the clients did not have any other insurance prior to Afat Vimo, and 98 per cent today have no other insurance besides Afat Vimo. • The scheme covers 19 disasters including fires, explosions, riots, malicious damage, aircraft damage, cyclones, tempests, floods, inundation, earthquakes, lightening, implosions, strikes, impact damage, storms, typhoons, hurricanes, tornados and landslides. Afat Vimo policyholders are also supported with micro-mitigation measures such as fire-safety training, seismic-safe construction practices and business development services. The policy is available for an annual premium of less than 5 US dollars (about a four-day wage). Damage to policyholders' houses, household assets, trade-stock and losses of wages due to accidents are covered. The earning household member's life is also covered	an annual premium of less than 5 US dollars (about a four-day wage). Damage to policyholders' houses, household assets, tradestock and losses of wages due to accidents are covered. The earning household member's life is also covered. • The Afat Vimo case study also shows that micro-insurance cannot be used as stand-alone measure for disaster risk reduction. To ensure the viability of such products from a commercial point of view, they should be backed up by other micro-finance services and risk mitigation measures. To succeed, both poverty and risk must be reduced - not merely transferred. In this connection, as mentioned earlier, damage to Afat Vimo policyholders' houses, household assets, trade-stock and losses of wages due to accidents are covered, as well as the life of the earning household member. Afat Vimo policyholders are also supported with micro-mitigation measures such as seismicsafe construction practices and business development services. • Similarly, macro-level challenges such as creating incentives for risk reduction, balancing public-private roles and responsibilities, and making up-to-date data available to decision-makers have been identified as key barriers in enhancing benefits of micro-insurance to the poor. To address these key challenges and achieve higher penetration levels, a greater need for learning across disaster events and stakeholders - including governments, insurance companies and civil society organizations - is envisaged as a way forward.
CASE 33 Human resource development programme in disaster risk management in India **Hazard(s):** Various Types **Source(s):** UNISDR. (2008). **Private Sector Activities in Disaster Risk Reduction: Good Practices and Lessons Learned**. Retrieved at	• Capacity building • Proactive strategy	• Most of India is a highly disaster prone region with natural disasters ranging from earthquakes, landslides, flooding and cyclones to droughts. A total of around 1,700 Major Accident Hazard (MAH) units define the dimensions of the capacity building tasks. • Capacity building is the basis for a proactive strategy that requires a collaborative effort when it comes to both on-site and offsite emergency plans for civil society, regulators, planners and local civil administrators.	• The main objective of the project is the development and implementation of a system for human resource development that provides tools for training needs-analysis, a custom tailored training standard, awareness-building capacities, quality control systems combined with accreditation procedures for training providers, training impact evaluation, and mock drills. • An internet-based documentation and dissemination system is also vital. Train-the-trainers programmes have to be developed to cope with the need to upscale and

Case Details	Resilience Identified/implied	Problems/Vulnerabilities	Lessons Learnt & Good Practices
http://www.unisdr.org/2006/ppew/PPP-bestpractices.pdf http://www.hrdp-idrm.in/e5785/e5801/e11541/ISDRDMIGoodPracticesPPP-DMI-InWEnt-published.pdf		• The necessary tools and platforms have been decided for an operation plan focused primarily on professional skills training for management involving training providers, awareness-raising campaigns, and field testing through mock drills. • The Disaster Management Institute (Bhopal) is a nodal training provider working in co-operation with InWEnt Capacity Building International and the GTZ-ASEM under the Indo-German Bilateral Cooperation programme.	reach the whole country. • An ongoing dialogue between the private and public sector breaks down preconceptions, and allows people to concentrate on solving existing and emerging problems. • Joint capacity building systems in DRM and training providers work as a catalyst in the discussion process, and can reduce emotional communication through managerial and professional skills training as well as through raising awareness.
INDONESIA			
CASE 34 Kelud Volcano, Blitar and Kediri, East Java **Hazard(s):** Volcanic Activities **Year(s) of event:** October 2007 **Source(s):** ADRC. (2009) **Total Disaster Risk Management: Good Practices 2009**. Retrieved at http://www.adrc.asia/publications/TDRM2005/TDRM_Good_Practices/PDF/PDF-2009e/3.Indonesia.pdf	• Integrated Monitoring System to Enable Good Early Warning	• On October 16 2007, a swarm of 306 B-type events occurred within 7 hours causing a rise in the alert level to the highest one, Level IV. On November 4, 2007, a lava dome emerged in the middle of the Kelud crater lake. *However, this phenomenon was not followed by an eruption.* • (Past Eruptions: 1901, 1919, 1951, 1966, 1990)	• Integrated Monitoring System to Enable Good Early Warning
CASE 35 Merapi Volcano, Central Java **Hazard(s):** Volcanic Activities **Year(s) of event:** February 2001 **Source(s):** ADRC. (2006) **Total Disaster Risk Management: Good Practices 2006 Supplement**. Retrieved at http://www.preventionweb.net/files/9054_9054TDRM06.pdf	• Community Training • Capacity building	• On February 10, 2001, Java was in a state of chaos because Merapi Volcano "exhaled a breath" that reached 5.5 km in Sat River, with ash falling in Dukun, Srumbung, Salam, Ngluwar and Muntilan sub-districts. • When Merapi erupted, the inhabitants of Kaliurang, Srumbung and Magelang were able to carry out an orderly evacuation. • Inhabitants of the two most at-risk sub-villages, Kaliurang Utara and Sumber Rejo had evacuated to temporary barracks, long before the appropriate authorities took action.	**Community Training** • To build community capacity in conducting evacuations, the community had undertaken preparedness training. This was really a proactive action, which was produced by the community after the experience of series of disaster management trainings conducted by Disaster Research, Education & Management (DREaM) Working Group of National Development University Yogyakarta and KAPPALA Indonesia Foundation. • This was done by more than 30 communities in the Merapi area, in eight sub-districts, in four regencies and two provinces. The aim of disaster management is to build a common perception. The source of threat is studied in order to determine an early warning system. Mapping is carried out to determine risk and assess

Case Details	Resilience Identified/implied	Problems/Vulnerabilities	Lessons Learnt & Good Practices
			capacity. Emergency relief skills and several methods of evaluation are studied in order to build preparedness capacity
CASE 36 **Combining Science and Indigenous Knowledge to Build a Community Early Warning System** **Hazard(s):** Various Types **Source(s):** UNDP. (2007). **Building Disaster Resilience Communities**. Retrieved at http://www.unisdr.org/files/596_10307.pdf		Project Details: The eastern part of Nusa Tenggara (Southeastern Indonesian islands) has a three-month rainy season and a nine-month drought season. Over the last 100 years or so, food shortage has characterized its drought season as lack of climate-related knowledge and information within the local population often leads to crop failure. A Community-Based Disaster Risk Management (CBDRM) initiative was launched in 2005 to address the issue in a highly vulnerable community of rural farmers. The initiative seeks to build a monitoring system for food security and livelihood with the aim of preventing the food shortage. With help from a local NGO and the Community Association for Disaster Management, the community has developed its own food early warning system.	• This initiative is a good practice because: • It was initiated by the community itself to address crop failures that were also brought about by agricultural approaches from Java Island which were not suitable to drought-prone East Nusa Tenggara. It incorporates indigenous knowledge and develops mechanisms that help prevent food shortage and build community resilience to prolonged drought. • One of the innovative elements of this initiative is the fact that the locally developed early warning system has been developed using a combination of both modern science and indigenous knowledge. • A key success factor of this initiative is the involvement of local people on the basis of their local agricultural conditions.
CASE 37 An integrated Flood Early Warning System (FEWS) for Jakarta **Hazard(s):** Flood **Source(s):** UNDP. (2010). **Local Governments and Disaster Risk Reduction**. Retrieved at http://www.memorisks.org/docs/ISDR_2010_LocalGovernmentsandDisasterRiskReduction.pdf	•	Project Details: Integrating improvements into the Flood Early Warning System for Jakarta has been a true multi-stakeholder process, involving a huge range of local authorities and partners. Through managing everyone's interests and roles, and improving coordination, the Early Warning System was upgraded from top to bottom. Technical improvements mean that earlier flood warnings are now possible. But more importantly, preparedness capacity has been built and streamlined. Key coordination hubs and standard operating procedures have been established and tested with comprehensive drills, so that institutions and communities are now more ready to act on warnings.	• This was a successful example of a multi-level multi-stakeholder collaboration between the national, provincial and city governments, working with local NGOs and communities, for a fully integrated early warning system. Each stakeholder actively fulfilled their roles and responsibilities, and there was a common vision and shared perspective on improving the Integrated FEWS. • Stakeholders at all levels were involved in a mix of multi-level capacity building activities, such as training of trainers and simulation exercises, from government institutions to very local communities. This raised the level of readiness of the government officials in charge of disseminating warnings and hazard information, as well as preparing communities better for response, evacuation, and coping strategies. • Participatory consultation was built in through creating a feedback process. The Participatory Feedback Groups attended by all stakeholders bridged the gap between government and community perceptions of flood risk

Case Details	Resilience Identified/implied	Problems/Vulnerabilities	Lessons Learnt & Good Practices
			reduction initiatives. • The existence of a Technical Working Group consisting of experts from prominent institutions was a key factor for success
CASE 38 Tsunami Ready Toolkit **Hazard(s):** Tsunami **Source(s):** UNISDR. (2008). **Private Sector Activities in Disaster Risk Reduction: Good Practices and Lessons Learned**. Retrieved at http://www.unisdr.org/2006/ppew/PPP-bestpractices.pdf	•	• In order to improve the tsunami preparedness of the country's hotel industry the Indonesian Ministry of Culture and Tourism (BUDPAR) cooperates closely with the Bali Hotels Association (BHA). • Together they have developed the 'Tsunami Ready Toolkit' which is geared to assist hotels to prepare for tsunamis. • The toolkit consists of a collection of fact sheets and background information papers, SOP's and best practice examples. BHA strives to prepare its member hotels for tsunami on the base of the toolkit, BUDPAR is familiarizing the hotel industry with its contents Indonesia wide.	• As with security related issues sustainability is a problem. The challenge is to keep people's attention and commitment even though nothing happens for an extended period of time. It is innate to human nature to forget about threats and dangers if they are not obviously recognizable and felt regularly. Another challenge lays in the timely marking of evacuation routes in public spaces since many local administrations still require official clarification and input on the issue. It is always a challenge to transform awareness into sustainable action. • Hotels have started realizing that they should not 'go it alone' and in some cases like in Tanjung Benoa, open their grounds to the public as safe heavens while at the same time providing resources for the education of the local population on tsunami relevant subjects as well as on evacuation procedures.
CASE 39 Nias Island, Sumatra **Hazard(s):** Torrential Rain →Flood →Landslide **Year(s) of event:** August 2001 **Source(s):** http://reliefweb.int/report/indonesia/indonesian-vp-visits-flood-hit-nias-death-toll-hits-95 http://www.nytimes.com/2001/08/02/international/02INDO.html	• Lifeline facilities • Uncontrolled logging/ deforestation • Environmental preservation	• Hundreds more people were reported missing in the deluge that engulfed the tiny island. • Mountain settlements are cut off from the outside. • The disaster was the latest in a rising number of flash floods around Indonesia and elsewhere, where uncontrolled logging has stripped mountainsides of the vegetation that holds rainfall and the earth itself. • It was not immediately clear whether deforestation was the cause of the Nias floods as it has been for others where a rise in deaths has been recorded in recent years. But in a study this year, Indonesia's largest environmental group, Walhi, found that a surge of flash floods early in the year coincided exactly with areas that have suffered the highest levels of deforestation. • Much of the problem is caused by illegal logging, one symptom of economic hardship, Mr. Ginting said.	

Case Details	Resilience Identified/implied	Problems/Vulnerabilities	Lessons Learnt & Good Practices
CASE 40 Sumatra Flash flood **Hazard(s):** Flash flood **Year(s) of event:** December 2006 **Source(s):** http://www.nytimes.com/2006/12/27/world/asia/27iht-flood.4027106.html?_r=0	• Linkage to the affected areas • Lifeline facilities during crisis • Food, sanitation, and medicine provision • Evacuation site provision • Epidemic after crisis • Environmental preservation • Controlled logging	• Emergency workers struggled Wednesday (December 2006) to feed and shelter more than 400,000 people displaced by flash floods and a landslide on the northwestern Indonesian island of Sumatra that killed at least 109. • Survivors waded through shoulder-high water, stood on rooftops or paddled boats to dry land. • Food and medicine was being airlifted by helicopter to six northern and eastern districts of Sumatra, where an estimated 1,400 homes were submerged over the weekend. • Aid is being distributed but there are some areas that are still isolated, so the aid has to be airdropped to those areas. • Thousands of victims headed for shelters on the road to the regional capital, Medan, many of them suffering from skin problems and fever caused by poor hygiene and dirty water. • At least 70 people were killed in flooding and twice as many were missing in Aceh, while 39 drowned in storm waters or were buried in a landslide in North Sumatra Province. • The authorities say that deforestation exacerbated the latest destruction.	
IRAN			
CASE 41 Bam, Kerman Province **Hazard(s):** Earthquake **Year(s) of event:** December 2003 **Source(s):** https://en.wikipedia.org/wiki/2003_Bam_earthquake http://www.wsws.org/en/articles/2004/01/iran-j06.html	• Seismic design code • Effective urban planning • International aids	• The earthquake was particularly destructive in Bam, with the death toll amounting to 26,271 people and injuring an additional 30,000 • The effects of the earthquake were exacerbated by the use of mud brick as the standard construction medium; many of the area's structures did not comply with earthquake regulations set in 1989. • Bam contained many buildings that were not constructed to survive such ruptures. Many houses in Bam were homemade, and its owners did not use skilled labor or proper building materials to resist earthquakes in the construction. These were often built in the traditional mud-brick style.	• Following the earthquake, the Iranian government seriously considered moving the capital of Tehran in fear of an earthquake occurring there. The earthquake had a psychological impact on many of the victims for years afterwards. A new institutional framework in Iran was established to address problems of urban planning and to reconstruct the city of Bam in compliance with strict seismic regulations. This process marked a turning point, as government ministers and international organizations collaborated under this framework with local engineers and local people to organize the systematic rebuilding of the city.

Case Details	Resilience Identified/implied	Problems/Vulnerabilities	Lessons Learnt & Good Practices
		• One reason for the large amount of casualties was that when the walls began to fall down, the heavy roofs would collapse, leaving few air pockets in them. The dust and lack of oxygen contributed to the suffocation of survivors. • No section of the city was spared, with upscale housing collapsing along with the more modest homes. Two hospitals were destroyed and a prison on the edge of town was demolished, setting inmates free. Bam's most well-known tourist attraction, a seventeenth century, 38-tower mud-brick citadel, was destroyed. • Although the government has accepted aid in the latest catastrophe, there are many indications that the human tragedy in Bam—while the result of a natural phenomenon—has been exacerbated by slow response, poor planning and a lack of regard for safety standards on the part of local and national authorities.	
CASE 42 Northern Iran **Hazard(s):** Earthquake → landslides **Year(s) of event:** May 2004 **Source(s):** http://edition.cnn.com/2004/WORLD/meast/05/28/iran.quake/index.html http://www.freerepublic.com/focus/f-news/1144155/posts		• A strong earthquake shook central and northern Iran on Friday, killing at least 23 people - some buried by landslides on a mountain road - and seriously damaging more than 80 villages, the Interior Ministry and state-run media said. • The quake unleashed landslides and falling boulders that killed 16 people and injured 70 others by burying them in their cars along the mountainous Tehran-Chalous road.	
ITALY			
CASE 43 Aeolian islands, Italy **Hazard(s):** Stromboli Volcano Eruption **Year(s) of event:** Active Volcano until present **Source(s):** http://www.volcanolive.com/stromboli.html	• Hospital & medical assistance after disaster • Evacuation site provision	• A large explosion occurred on 23rd January 2002 at 2054 hr. • On 30th December 2002 two landslides occurred at 1315 and 1322 hr along the Sciara del Fuoco. The large volume of rock crashing into the sea created two tsunamis, with wave heights of several metres. The tsunamis hit the villages of Stromboli and Ginostra, damaging buildings and boats and	

Case Details	Resilience Identified/implied	Problems/Vulnerabilities	Lessons Learnt & Good Practices
https://en.wikipedia.org/wiki/Strombolian_eruption http://www.swisseduc.ch/stromboli/volcano/beso/bes03a-en.html		injuring several people. Six people were evacuated by helicopter to two hospitals on Sicily.	
JAPAN			
CASE 44 The Great Hanshin Earthquake (Kobe Earthquake) **Hazard(s):** Earthquake **Year(s) of event:** January, 1995 **Source(s):** https://en.wikipedia.org/wiki/Great_Hanshin_earthquake	• Volunteerism during crisis • Comprehensive disaster management • Built-in structural reinforcement • Private participation in recovery	• The Mj 7.3 earthquake struck at 05:46 JST on the morning of January 17, 1995. It lasted for 20 seconds. During this time the south side of the Nojima Fault moved 1.5m to the right and 1.2 meters downwards. There were four foreshocks, beginning with the largest (Mj 3.7) at 18:28 on the previous day. • Damage was extremely widespread and severe. Structures irreparably damaged by the quake included nearly 400,000 buildings, numerous elevated road and rail bridges, and 120 of the 150 quays in the port of Kobe. The quake triggered around 300 fires, which raged over large portions of the city. Disruptions of water, electricity and gas supplies were extremely common. In addition, residents were afraid to return home because of aftershocks that lasted several days (74 of which were strong enough to be felt) • The majority of deaths, over 4,000, occurred in cities and suburbs in Hyōgo Prefecture. A total of 68 children under the age of 18 were orphaned, while 332 additional children lost one parent	• The earthquake proved to be a major wake-up call for Japanese disaster prevention authorities. Japan installed rubber blocks under bridges to absorb the shock and rebuilt buildings further apart to prevent collateral damage. The national government changed its disaster response policies in the wake of the earthquake, and its response to the 2004 Chūetsu earthquake was significantly faster and more effective. The Ground Self-Defense Forces were given automatic authority to respond to earthquakes over a certain magnitude, which allowed them to deploy to the Niigata region within minutes. Control over fire response was likewise handed over from local fire departments to a central command base in Tokyo and Kyoto. • In response to the widespread damage to transportation infrastructure, and the resulting effect on emergency response times in the disaster area, the Ministry of Land, Infrastructure and Transport began designating special disaster prevention routes and reinforcing the roads and surrounding buildings so as to keep them as intact as possible in the event of another earthquake. • Hyōgo's prefectural government invested millions of yen in the following years to build earthquake-proof shelters and supplies in public parks. • The fact that volunteers from all over Japan converged on Kobe to help victims of the quake was an important event in the history of volunteerism in Japan. The year 1995 is often regarded as a turning point in the emergence of volunteerism as a major form of civic engagement. • Retailers such as Daiei and 7-Eleven used their existing supply networks to provide necessities in affected areas,

Case Details	Resilience Identified/implied	Problems/Vulnerabilities	Lessons Learnt & Good Practices
			while NTTand Motorola provided free telephone service for victims.
CASE 45 Typhoon Talas **Hazard(s)**: Typhoon →Flood →Landslide **Year(s) of event**: September 2011 **Source(s)**: http://redraiders.com/world/2011-09-05/typhoon-dumps-record-rain-japan-killing-20#.Vr00pVh97ct	• Effective early warning system • Emergency rescue of the vulnerable people (this case, the elderly)	• Typhoon Talas dumped record amounts of rain Sunday in western and central Japan, killing at least 20 people and stranding thousands more as it turned towns into lakes, washed away cars and triggered mudslides that obliterated houses. • At least 50 people were missing, local media reported. Evacuation orders and advisories were issued to 460,000 people in the region, which is hundreds of miles (kilometers) from the country's tsunami-ravaged northeastern coast. • At least 3,600 people were stranded by flooded rivers, landslides and collapsed bridges that were hampering rescue efforts, Kyodo News agency reported • With the ground already soaked, fears of additional mudslides were growing, and the agency issued landslide warnings in nearly all of the country's prefectures. • A 73-year-old man died in Nara when his house collapsed in a landslide, police said.	
CASE 46 Tohoku Earthquake and Tsunami **Hazard(s)**: Earthquake→Tsunami **Year(s) of event**: March 2011 **Source(s)**: https://en.wikipedia.org/wiki/2011_T%C5%8Dhoku_earthquake_and_tsunami	• Early warning system • Disaster awareness raising	• The 2011 earthquake off the Pacific coast of Tōhoku was a magnitude 9.0 (Mw) undersea megathrust earthquake off the coast of Japan. • The earthquake triggered powerful tsunami waves that reached heights of up to 40.5 metres (133 ft) in Miyako in Tōhoku's Iwate Prefecture, and which, in the Sendai area, travelled up to 10 km (6 mi) inland. • The earthquake moved Honshu (the main island of Japan) 2.4 m (8 ft) east. • a Japanese National Police Agency report confirmed 15,885 deaths, 6,148 injured, and 2,623 people missing across twenty prefectures, as well as 127,290 buildings totally collapsed, with a further 272,788 buildings 'half collapsed', and another 747,989 buildings partially damaged. • The earthquake and tsunami also caused extensive and severe structural damage in north-eastern Japan,	

Case Details	Resilience Identified/implied	Problems/Vulnerabilities	Lessons Learnt & Good Practices
		including heavy damage to roads and railways as well as fires in many areas, and a dam collapse. • Around 4.4 million households in northeastern Japan were left without electricity and 1.5 million without water. The tsunami caused nuclear accidents, primarily the level 7meltdowns at three reactors in the Fukushima Daiichi Nuclear Power Plant complex. • The warning for the general public was delivered about 8 seconds after the first P wave was detected, or about 31 seconds after the earthquake occurred.	
CASE 47 Building Public-Private Partnership to ensure safe gas use: Tokyo Gas **Hazard(s):** Fire, Gas Leakage & Explosion (secondary disaster) **Source(s):** UNISDR. (2008). **Private Sector Activities in Disaster Risk Reduction: Good Practices and Lessons Learned**. Retrieved at http://www.unisdr.org/2006/ppew/PPP-bestpractices.pdf	• Public private partnership in disaster management	• Tokyo Gas (TG) has been aware of the possibility of a major earthquake, and adopted various measures to protect the safety of communities. • Secondary disasters can be prevented through the activation of pre-installed safety devices (Gas Meters Using Automatic Earthquake Shut-Off Devices), and the activation of disaster management systems that can remotely control the gas supply to an entire area.	• **Gas Meters Using Automatic Earthquake Shut-Off Devices** • **Building Ties With Local Governments and Communities to Ensure Safe Gas Use** • Tokyo Gas works with relevant institutions, including local government agencies to conduct public relations campaigns targeting the general public. • It is extremely important that, when emergencies strike, the company has ties to local government disaster management officials, who serve as the core promoters of local disaster management efforts, local government community relations officials, who serve as the gateway to community associations, citizens with a special interest in disaster management (disaster management volunteers), citizens with strong community networks (disaster management volunteers), and NPOs. • It is important to develop relationships with these parties to get to know one another and can share opinions effectively
CASE 48 Private-led Initiatives and Public Support in Activities for Widespread Use of Disaster-resistant Glass: Asahi Glass Co., Ltd. **Hazard(s):** Various Types **Source(s):** UNISDR. (2008). **Private Sector Activities in Disaster Risk Reduction: Good Practices and Lessons Learned**. Retrieved at	• Public private partnership in disaster management	• The Glass Power Campaign being carried out by Asahi Glass Co., Ltd. (AGC) came up with a means of addressing global environmental problems, including natural disasters, and of raising public awareness of the disaster resistance properties of laminated glass. Laminated glass does not shatter into small pieces, but instead stays in place in the windowpanes even if it breaks or cracks. Its use could thus be used to help make evacuees more safe and comfortable.	• **Private-led Initiatives and Public Support in activities for widespread use of disaster resistant glass** • AGC donated laminated glass (glass + installation) to 15 shelters in the first two years and plans to make・ donations to five more shelters in 2008. • Public supporters include the Cabinet Office, MEXT, and local governments. The project is promoted on・the official websites of seven cities

Case Details	Resilience Identified/implied	Problems/Vulnerabilities	Lessons Learnt & Good Practices
http://www.unisdr.org/2006/ppew/PPP-bestpractices.pdf			
CASE 49 Women's Net Kobe **Hazard(s):** Various Types **Year(s) of event:** **Source(s):** http://www.nwec.jp/en/data/newsletter43.pdf	• Participatory recovery & rehabilitation	• The 'Women's Net Kobe' is a voluntary group under NPO's center of women and children to ensure their rights and provide a forum for learning and networking.	• **Voluntary Activity in Post-disaster Recovery & Rehabilitation** • The actions taken after the Great Hanshin Awaji Earthquake in 1995 included distribution of relief supplies, phone counselling, and organizing public seminars for women in the stricken areas. The activities brought out the difficult situations that many women were exposed to after the devastating earthquake.
CASE 50 Children and communities study mountain and urban risks **Hazard(s):** Typhoon →Flood →Landslide **Source(s):** UNDP. (2010). **Local Governments and Disaster Risk Reduction**. Retrieved at http://www.memorisks.org/docs/ISDR_2010_LocalGovernmentsandDisasterRiskReduction.pdf	•	Project Details: In 2004, Saijo City was hit by record typhoons that led to flooding in its urban areas and landslides in the mountains. As a small city with semi-rural mountainous areas, it faces unique challenges in disaster risk reduction. First, Japan's aging population represents a particular problem. Young able-bodied people are very important to community systems of mutual aid and emergency preparedness, and as young people tend to move away to bigger cities, smaller cities and towns in Japan have an even older population than the already imbalanced national average. Secondly, people within a small city with semi-rural areas may not often be familiar with how to help people in a different physical environment just on the other side of town. To meet both of these challenges, the Saijo City Government has instigated a risk awareness programme targeting schoolchildren, and focusing on different physical environments of the city, from the mountainside to the town.	• The initial activity has been institutionalized through participant teachers developing a mountain and town watching handbook. This means teachers anywhere in Japan will be able to carry out the same initiative as a part of the school curriculum. • It is a successful tool for community participatory risk education in smaller cities and towns. Coordinated by the local government to start with, it has involved many stakeholders, such as pupils in elementary schools and junior high schools, teachers, parents, urban residents' associations, residents in mountains, forest workers, the Citizens' Safety Department and the Education Board. This provides an excellent way for different sectors of the community to build relationships that are vital for community disaster preparedness and response. • The approach turns disaster recovery into an opportunity for increasing risk awareness and disaster preparedness. • Sustainable disaster prevention that starts at school can come to involve the entire city. The involvement of schoolchildren can attract different elements of the community to work together and build valuable relationships. • The very direct and participatory methods of mountain and town watching are good for inspiring participant interest in their local area, and motivating learning about disaster prevention. • Mountain and town watching should not just happen once. It is enriched through repetition.

Case Details	Resilience Identified/implied	Problems/Vulnerabilities	Lessons Learnt & Good Practices
			• A clear implementing body and a guideline are necessary for successful and continuous implementation.
CASE 51 Puppet Show Project 'Inamura no Hi' Sompo Japan's efforts to raise disaster awareness through puppet shows **Hazard(s):** Earthquake, Tsunami **Source(s):** ADRC. (2009) **Total Disaster Risk Management: Good Practices 2009**. Retrieved at http://www.adrc.asia/publications/TDRM2005/TDRM_Good_Practices/PDF/PDF-2009e/4.Japan-5.pdf UNISDR. (2008). **Private Sector Activities in Disaster Risk Reduction: Good Practices and Lessons Learned**. Retrieved at http://www.unisdr.org/2006/ppew/PPP-bestpractices.pdf		Project Details: The "Inamura no Hi" (the Fire of Rice Sheaves) is a Japanese folktale based on the true story of a squire who noticed the very early signs of a tsunami triggered by a large-scale earthquake in 1854. As the story goes, the squire led his fellow villagers to high ground by burning his valuable harvested rice sheaves. Inspired by the story, a SOMPO Japan employee who experienced the Great Hanshin-Awaji Earthquake in January 1995 appealed to puppet theater groups in Shizuoka Prefecture to develop a puppet show based on this tale, and the Inamura no Hi puppet show project was inaugurated in June 2003. By fiscal 2008, the puppet show has been performed a total of 38 times across the nation, conveying to about 9,500 children and adults what to do when an earthquake or a tsunami hits and the importance of mutual assistance. This group also participated in "the YOKOHAMA Bosai (disaster reduction) Fair 2007" held in December 2007 in Yokohama and which communicated the importance of enhancing the ability of local communities to cope with disasters.	• On June 2007, we held a class for parents and children titled "The Fire of Inamura and the Paradise for Catfishes" to learn how to prevent disasters through the puppet show at the Yokohama Doll Museum. The Inamura no Hi is now gaining international recognition as an effective tool for disaster education, with the power to deeply impress children. • Even after the Inamura no Hi NPO puppet show project was incorporated, its operation was weakly financed and lacked adequate administrative capacity. Therefore, its activities are exposed to a considerably difficult situation, to the same extent as they were at the beginning. However, the NPO avoided dissolution several times, and everyone involved is working to ensure the continuation of its activities. We take great pleasure in teaching children in the audience about respect for human life and the dangers related to earthquakes and tsunamis. We are also thankful that our efforts have been supported by many people in various sectors, including the government, universities, the mass media, and disaster reduction volunteer organizations. • All disaster reduction activities, including disaster research, local disaster management plans, and corporate business continuity management (BCM) strategies, are important. However, it is of the utmost importance to teach as many people as possible about the significance of disaster preparedness, in order to protect lives. • It is impossible to capture the attention of citizens with complicated theories. The method of teaching the essence of disaster reduction through puppet shows that impress children and their parents has been proven effective in Shizuoka, a prefecture with advanced disaster reduction strategies. Today, disaster reduction education is taught not only through puppet shows, but also through a variety of media that interests children, including "shadow plays", picture-story shows, and songs.

Case Details	Resilience Identified/implied	Problems/Vulnerabilities	Lessons Learnt & Good Practices
KAZAKHSTAN			
CASE 52 Local Risk Management in Earthquake Zones: Strengthening the capacity of local communities in disaster preparedness and early warning through the development of knowledge and skills required for effective disaster mitigation **Hazard(s):** Earthquake **Source(s):** UNISDR. Disaster Risk Reduction 20 Examples of Good Practice from Central Asia. Retrieved at http://www.unisdr.org/files/2300_20GoodExamplesofGoodPractice.pdf		• In Almaty, 200,000 residents, at least, live in buildings that are recognized as vulnerable to seismic hazards, which most probably would be destroyed in an earthquake over 9 in magnitude. • Social infrastructure, including schools, hospitals, and other facilities are similarly vulnerable. Considering the scale of the expected seismic danger and the unknown timing, it was logical to focus on building the capacity of local organizations. Schools came first.	**Strengthening the capacity of local communities in disaster preparedness and early warning through the development of knowledge and skills required for effective disaster mitigation** ● Besides the increased awareness of the decision-makers and the general public, the project paid utmost attention to schools and developed specific training materials for school children in several grades. Thus, special brochures were developed for primary, secondary and high school students. These were supplemented by four documentaries in Russian, Kazakh, and English languages devoted to earthquakes, mudflows, and floods. ● Physical training took place in summer camps, orphanages, and other institutions. Small children could both enjoy and learn from specially developed cartoons based on computer animation, and from posters and coloring books.
KOREA			
CASE 53 One-Stop Service for Rapid and Easy Recovery Support **Hazard(s):** Various types **Source(s):** ADRC. (2007) **Total Disaster Risk Management: Good Practices 2007**. Retrieved at http://www.adrc.asia/publications/TDRM2005/TDRM_Good_Practices/PDF/PDF-sup2007e/Korea.pdf		• The Korean government is supporting 10 to 50 thousand sufferers from various disasters. The effectiveness of the recovery support system was questioned. • Delayed payments due to the itemized support system composed of 283 categorized items such as relief fund and living expenses. • Delayed budget dissemination due to a decentralized support system by 12 divisions in 7 central agencies. • Delayed damage estimation due to hand calculation, and finally possible duplicated support problems due to a lack of by the coordinating agency.	● **One-Stop Service for Rapid and Easy Recovery Support** integrated the supporting processes scattered in throughout the various agencies, based on the classified support scheme using comprehensive disaster indices. ● One coordinating agency is designated with utilizing a computer database system to accomplish the "disaster fund One-Stop support service." ● Korea developed a comprehensive disaster database system connecting local governments and the central government called as the National Disaster Management System.
KYRGYZSTAN			
CASE 54 UNDP's projects since 2015, disaster risk mitigation Capacity Building by Local Community Participation & Establishment of		**KYRGYZSTAN:** UNDP projects since 2005 - The Kyrgyz Republic is extremely vulnerable to natural disasters, predicated on the development of various types	● **Capacity Building by local community** in disaster risk management, including the realization of mitigation projects aimed at protecting the population from hazards and sharing with local communities, and other

Case Details	Resilience Identified/implied	Problems/Vulnerabilities	Lessons Learnt & Good Practices
Volunteer 'Rural Rescue Teams' in Vulnerable Communities **Hazard(s):** Various types (Earthquake, Mudflows, Floods, Landslide, Avalanches) **Source(s):** ADRC. (2009) **Total Disaster Risk Management: Good Practices 2009**. Retrieved at http://www.adrc.asia/publications/TDRM2005/TDRM_Good_Practices/PDF/PDF-2009e/5.Kyrgyz-1.pdf		of potential natural disasters country-wide and on the poverty of the rural population. - Approximately 200 emergency situations occur annually. The annual damage costs from emergency situations is approximately US$35 million and the number of casualties approximately attains 2000 families.	stakeholders. For example, training for the development and implementation of mitigation projects; mobilizing community members for disaster activities; training communities to obtain fundraising skills for disaster prevention activities; operating and repairing the mitigation facilities. ● **Establishment of Volunteer 'Rural Rescue Teams' in Vulnerable Communities.** About 45 rural rescue teams have been established so far. Activities include implementing hazard assessment and disaster risk mapping, developing disaster preparedness and response plans, installing simple alarm systems and carrying out mitigation projects.
CASE 55 Utilization of Satellite Surveillance System **Hazard(s):** Wildfire **Source(s):** ADRC. (2007) **Total Disaster Risk Management: Good Practices 2007**. Retrieved at http://www.adrc.asia/publications/TDRM2005/TDRM_Good_Practices/PDF/PDF-sup2007e/Kazakhstan3.pdf		• The features of the province of Qaraghandy are not only its large size (428,000 square kilometers) and large rice cultivation area, but also its numerous coniferous forest zones, which are unique, environmentally protected areas. • Summer temperatures that climb to 40 - 45°C and low rainfall make July and August prone to wildfires. • Also, it is especially difficult to fight fires in this area because of the oil and gas pipelines that pass through Zelenov, Taskala, Dzhangala, and Akzhaik.	**Utilization of Satellite Surveillance System**, where the wildfires satellite surveillance system was designed to discover fires and pinpoint their source at an early stage, predict the fire development route, evaluate the latent dangers of fire, specify the area affected by fire, and evaluate the extent of injury and damage
MALAWI			
CASE 56 Multi-stakeholder flood management: Small, Medium-scale Initiatives to Control River Flow **Hazard(s):** River Flood **Source(s):** UNDP. (2007). **Building Disaster Resilience Communities**. Retrieved at http://www.unisdr.org/files/596_10307.pdf		Project Details: • Over 10 to 15 years, the district of Chikwawa in southern Malawi suffered from the increased impact of flooding from Mthumba River, including disruption of agricultural production, loss of lives and destroyed buildings. This not only re-enforced the local cycle of poverty but also reduced the impact of development gains in the district. • In 2003, Tearfund's partner NGO "Eagles" undertook a "Participatory Assessment for Disaster Risk" with five villages. The villages' specific vulnerabilities to flooding were assessed, and their capacities to address the problem reviewed. Some of the root causes of their	• The overall impact for all the villages is significant. There has been a decreased incidence in water-borne diseases during the rainy season and also increased school attendance. Indeed, schools and clinics in the past had been disrupted either from the temporary closure of public buildings or through lack of access. Agricultural lands have also increased their yield and production, and there is increased food security. All parties agree that with collective discussion, agreement and action, they managed to address a problem that was previously deemed impossible to manage. • In particular, the following specific impacts have been observed from 2005-2006 onwards: • Significant

Case Details	Resilience Identified/implied	Problems/Vulnerabilities	Lessons Learnt & Good Practices
		vulnerability were identified, as well as the reasons for a more frequent occurrence of the hazard. In conjunction with the villages, Eagles initiated small-scale mitigation initiatives, including the creation of a wood lot and a storm drain. • In 2005-2006, Eagles consulted with another 11 villages and the local government authorities, as it became clear that a multi-stakeholder approach was needed. Sufficiently motivated after two years of awareness raising efforts by Eagles, the villagers established a community-based task force. Once created, the task force along with government authorities and experts widely consulted with all communities and designed an earthen dike that would re-instate the previous river course of Mthumba River and reduce the impact of flooding on a wide area. The impact of the project was felt virtually immediately. During the 2005-2006 rainy season, excess run-off was diverted by the storm drain, rainfall run-off was reduced by the wood lot, and the original river course of Mthumba River was restored through the earthen dike.	reduction of flooding in prime agricultural lands, including the re-enforcement of a river bank with a 400-metre section; • Reduced water-borne diseases in flood-affected villages; • Increased school attendance (flooding stopped schools from operating or prevented children from attending class during rainy season); • Provision of food through food-for-work programmes; Communities' better understanding of causes of flooding; • Communities' increased skills in planting and raising tree saplings; and • Communities' increased confidence through all the above to solve their flood-related problems. • Furthermore, this project can be regarded as a good practice because: • All stakeholders were consulted during the project • Disaster risks leading to effective initiatives were analyzed in a participatory manner • Learning was also explored from historical and indigenous knowledge • Use of intermediate technology enabled local community involvement • Communities were sensitized on the underlying causes of flooding.
MONGOLIA			
CASE 56 Establishment of the National Emergency Management Agency of Mongolia (NEMA) **Hazard(s):** Various Types **Source(s):** ADRC. (2009) **Total Disaster Risk Management: Good Practices 2009**. Retrieved at http://www.adrc.asia/publications/TDRM2005/TDRM_Good_Practices/PDF/PDF-2009e/6.Mongolia.pdf		• Mongolia has experienced huge economic losses caused by hazardous incidents and by technical accidents due to the continental climate, environmental degradation, ecological unbalance and man-made activity. • For the last 10 years, the number of hazardous incidents has reached 2200. A survey has shown that the frequency of such incidents is increasing by 150 cases every year.	• **Establishment of the National Emergency Management Agency of Mongolia (NEMA)** to implement the Disaster Protection Objectives. • The Government of Mongolia has strengthened NEMA through regularly increasing the budget, creating a suitable legal environment, improving the knowledge and professional skills of personnel, and by providing technical training. • NEMA cooperates with the USA, the Russian Federation, the People's Republic of China, Japan, the Republic of Korea, the Republic of Hungary, the Republic of Kazakhstan, the Federal Republic of Germany, the United Kingdom, the United Nations and other international and regional organizations in the field of emergency management
MOROCCO			

Case Details	Resilience Identified/implied	Problems/Vulnerabilities	Lessons Learnt & Good Practices
CASE 58 Western and Central Morocco **Hazard(s):** Heavy rainfall → Flood **Year(s) of event:** November 2002 **Source(s):** http://reliefweb.int/report/morocco/morocco-floods-ocha-situation-report-no-1	• Disaster financial reserves and contingency mechanisms • Comprehensive hazard management: flood, embankment • Effective emergency response	• Heaviest casualties are reported in the Settat region when the river Bengueribi burst out of its banks flooding cities of Bengueribi and El-Ghara near Settat and sweeping away at least 37 people. • The industrial zone of Berrechid and the university campus of Settat have been affected. The road between Berrechid and Settat as well as the railway link between Mohammedia and Marrakech are closed. Many landing strips of the international Airport Mohammed V in Casablanca are flooded.	• The Government has set up a crisis management cell to coordinate relief efforts under the Interior Minister, Mr. Mostafa Sahel. • The Mohammed V Solidarity Fund has made available 2 million dirhams (approx. USD 187,265) upon request of King Mohammed VI' for homeless families. A further 500,000 dirhams (USD 46,816) will be disbursed to families who suffered human (relatives) and material losses in the disaster. Food and clothing distribution has already started. • An advanced surgical unit of the Army has been established in the city of Mohammedia to assist victims of the refinery's fire and current floods.
CASE 59 Northern coast of Morocco **Hazard(s):** Earthquake **Year(s) of event:** February 2004 **Source(s):** http://edition.cnn.com/2004/WORLD/africa/02/24/morocco.quake/ http://www.geotimes.org/feb04/WebExtra022404.html	• Seismic design code	• The shattering earthquake that struck northern Morocco claimed 564 lives, the country's Interior Ministry said as hundreds of people prepared to spend the night outside for fear of aftershocks. Another 300 people were reported injured, 80 of them seriously. Most of the dead were women and children, as most of the men of the area mainly work overseas. • Other deaths were reported in nearby, remote inland villages in Rif Mountains. Residents in rural areas such as Tazaghin, Tizi Ayash and Imzourn live mainly in mud huts that cannot withstand such a powerful earthquake. • "Everyone knows that downtown Al Hoceima is a seismic area so buildings there were built to withstand earthquakes, which is why there was not so much damage in Al Hoceima," a Moroccan official said. "The casualties are mainly in the rural areas."	
MYANMAR			
CASE 60 Nargis Cyclone **Hazard(s):** Cyclone & Flood **Year(s) of event:** May 2008 **Source(s):**	• International aids acceptance • International relations • Stable and democratic state	• Tropical cyclone Nargis made landfall in the Asian nation of Myanmar on May 2, 2008, causing the worst natural disaster in the country's recorded history, with a death toll that may have exceeded 138,000. • The cyclone created a storm surge as much as five meters high – topped by two-meter storm waves – that	

Case Details	Resilience Identified/implied	Problems/Vulnerabilities	Lessons Learnt & Good Practices
https://en.wikipedia.org/wiki/Cyclone_Nargis http://www.sciencedaily.com/releases/2009/07/090717104618.htm		together inundated areas as much as 50 kilometers inland. ● Fatality rates reached 80 percent in the hardest-hit villages, and an estimated 2.5 million people in the area lived in flood-prone homes less than 10 feet above sea level. ● On 6 May 2008, the Burmese government representation in New York formally asked the United Nations for help, but in other ways it remained resistant to the most basic assistance. ● As of 7 May 2008, the government of Myanmar had not officially endorsed international assistance, but stated that they were, "willing to accept international assistance, preferably bilateral, government to government." The biggest challenge was obtaining visas for entry into the country. ● The Burmese junta permitted Italian flights containing relief supplies from the United Nations, and twenty-five tonnes of consumable goods, to land in Myanmar. However, many nations and organisations hoped to deliver assistance and relief to Myanmar without delay; most of their officials, supplies and stores were waiting in Thailand and at the Yangon airport, as the Burmese junta declined to issue visas for many of those individuals. These political tensions raised the concern that some food and medical supplies might become unusable, even before the Burmese junta officially accepted the international relief effort.	
CASE 61 Using local wisdom as prevention measures. **Hazard(s):** Flood (Dyke Failure Prevention) **Source(s):** ADRC. (2008) **Total Disaster Risk Management: Good Practices 2008**. Retrieved at http://www.adrc.asia/publications/TDRM2005/TDRM_Good_Practices/PDF/PDF-2008e/5.Myanmar.pdf		**MYANMAR, Hinthada's Successful Flood Prevention, 2004**, the Hinthada District of Ayeyawady Division • Flood prevention measures by using Myanmar traditional technique of protecting dykes called 'Yaing Khway'. • The technique prevented flood during monsoon season of 2004 in the Hinthada district, saving 5 million people and 500,000 acres of farmland	**Multilevel participation of state and local authorities in using local wisdom as prevention measures.** ● Under the guidance of the Ayeyawady Division Peace and Development Council, a total of 35,000 volunteers from local authorities, concerned departments, armed forces personnel, police departments, NGOs, students and members of local communities were mobilized in flood prevention activities. ● They checked for weakness in the dyke and for the information of holes. Once these were found, they were immediately reported to the responsible people or

Case Details	Resilience Identified/implied	Problems/Vulnerabilities	Lessons Learnt & Good Practices
			experts. ● They used Yaing Khway to protect the dykes and prevent the soil from eroding.
NAMIBIA			
CASE 62 **Supporting Local Decision Making with Inter-Community Platform and Local-Level Monitoring** **Hazard(s):** Various Types **Source(s):** UNDP. (2007). **Building Disaster Resilience Communities**. Retrieved at http://www.unisdr.org/files/596_10307.pdf		Project Details: • Drought and desertification are slow-onset disasters that impact on livelihoods of people living in drylands. They are often exacerbated by poverty and a naturally variable climate and compounded by lack of organization in communities affected. With increasing population, urbanization, climate change, evolving policy and political frameworks and other pressures, capacity of drylands residents to cope with and adapt to natural climate variability and intervening extreme events is diminished. Increased understanding of variable natural environmental conditions and potential effects of climate change, enhanced cooperation amongst the growing population, appropriate organizational and communication structures and community-based monitoring to support local decision making are all essential components of community-based disaster management and risk reduction. • In Namibia, in Southwestern Africa, an approach known as "Forums for Integrated Resource Management" has provided the platform for organization and communication within and amongst communities. This approach has contributed to placing communities at the centre of their own development. Whether based, inter alia, on a water point committee or a farmers' association, the approach strengthens capacity amongst the community to coordinate their own activities in conjunction with service providers through planning, monitoring and adjustment of mutually agreed upon development plans. • To support information exchange and decision making, an approach known as "Local Level Monitoring" is designed by communities with support from service	• This can be considered good practice because it contributes to capacity building and institutional development amongst rural farming communities so they can enhance their own resource management and livelihoods and thereby enhance their capacity to manage and reduce risks related to drought and desertification and other potential disasters. • The FIRM approach is an innovative, flexible approach to enhancing individual and institutional capacity of rural communities; the LLM is an innovative way to monitor livelihood and environmental changes based on the communities' own interests and used by the communities for their own decision making. The LLM approach is being expanded to provide community-derived information to national level with the aim of national coverage in support of risk reduction and management. • The programme was implemented through a joint venture between NGOs and government departments working with farming communities. While NGO staff and resources undertook the community-level facilitation, the programme was guided by a national Steering Committee. • The key lesson learned from this initiative is that community capacity building requires time from the community and the service providers involved with the community. There must be obvious benefits for the community, and facilitators must be able to elaborate on these benefits from the first engagement. Since time is a key factor, funding to support the ongoing facilitation is also essential, something which is rarely available from donor programmes. Consequently, involvement of the relevant government departments is

Case Details	Resilience Identified/implied	Problems/Vulnerabilities	Lessons Learnt & Good Practices
		providers. Communities identify relevant indicators to monitor their livelihoods including key environmental elements. Service providers contribute to design of a monitoring and information capturing system. The communities discuss the results, analyze them and use them where appropriate for decision making. This provides a tool for identification of environmental changes affecting livelihoods that may be based on management actions, climate variability, policy changes or other factors. At the same time, this information can be used to identify and track evolving drought and decreasing productivity and apply the results to decision making related to coping with the identified risks.	also essential - from the head office to the extension level on the ground. • Major challenges to be overcome during the project involved changing personnel in government who often were not aware of or convinced of the benefits to be derived from community capacity development. Limited capacity amongst newly appointed extension personnel was part of the ongoing capacity strengthening associated with the project.
NEPAL			
CASE 63 Gorkha **Hazard(s):** Flood & Landslide **Year(s) of event:** August 2003 **Source(s):** http://www.terradaily.com/2003/030801043306.6phqw5kk.html	• Learning from past experience • Effective mitigation construction • Lifeline facilities protection (power plant) • Early warning system	• At least 58 people have been killed in Nepal and over 30 were missing after massive landslides engulfed homes following heavy rains. • A total of 22 people were killed in Manakamana village in the Gorkha district, 85 kilometres (53 miles) west of Kathmandu, when seven houses were buried in a landslide. Since the beginning of the monsoon season in June, 120 people had been killed in landslides and floods, 27 were missing and 57 injured, the Annapurna Post newspaper said. • A total of 1,443 houses had been completely destroyed and 3,199 families affected. Almost all the highways that link the Nepalese capital with the rest of the country have been closed by the landslides, which are common in Nepal's summer, as snow melts in the Himalayas and lowland areas are hit by monsoon rains. • Home ministry spokesman Gopendra Bahadur Pandey told AFP that the incessant rains have caused a widespread damage in two-thirds of the country. The floods have extensively damaged Marsyangdi hydro-electric power station. The power plant has been completely flooded, affecting power generation.	

Case Details	Resilience Identified/implied	Problems/Vulnerabilities	Lessons Learnt & Good Practices
NEW ZEALAND			
CASE 64 Christchurch **Hazard(s):** Earthquake **Year(s) of event:** February 2011 **Source(s):** https://en.wikipedia.org/wiki/2011_Christchurch_earthquake	• Effective emergency response • Centralized single command	• Christchurch earthquake was a powerful natural event that severely damaged New Zealand's second-largest city, killing 185 people in one of the nation's deadliest peacetime disasters. • The earthquake caused significant damage to Christchurch and the central Canterbury region, with damage exacerbated by buildings and infrastructure already being weakened by 4 September 2010 earthquake and its aftershocks. • Immediately following the earthquake, 80% of Christchurch was without power. Water and wastewater services were disrupted throughout the city, with authorities urging residents to conserve water and collect rainwater.	• A full emergency management structure was put in place within two hours, with national co-ordination operating from the National Crisis Management Centre bunker in the Beehive in Wellington. • As per the protocols of New Zealand's Coordinated Incident Management System and the Civil Defence Emergency Management Act, the Civil Defence became lead agency—with Air Vice Marshal John Hamilton as National Controller. They were supported by New Zealand Police, Fire Service, Defence Force and many other agencies and organisations.
PAKISTAN			
CASE 65 Balochistan **Hazard(s):** Flood **Year(s) of event:** February 2005 **Source(s):** https://www.wsws.org/en/articles/2005/04/pakis-a14.html	• Infrastructure maintenance • Mitigation structure maintenance • Government Effectiveness • Lifeline facilities • Financial assistance to the affected • Post-disaster epidemic control	• At least two million people have been affected in Balochistan and the North West Frontier Province (NWFP) by the disaster, which left houses, roads, schools and hospitals severely damaged. • 561 people were killed in Balochistan province and 750,000 people were affected. The cost due to damaged or destroyed property and the loss of livelihoods was estimated at 670 million Pakistani rupees or about $US11 million. • A major disaster occurred on February 11 when five dams, including the large Shadikor Dam, burst. Raging floodwaters swept away five villages and killed 250 people. • Victims have blamed faulty construction and the failure of the national and provincial administrations to come to their aid. • Throughout the province, there is extensive damage to water supply and sanitation systems, electricity supplies, roads, bridges and communication networks. • North West Frontier Province NWFP relief coordinator for UN agencies Dr Quaid Saeed recently told the IRIN website that despite official announcements, no steps	

Case Details	Resilience Identified/implied	Problems/Vulnerabilities	Lessons Learnt & Good Practices
		have been taken so far to help the affected people and compensate for damage to houses, livestock and agriculture.	
PERU			
CASE 66 Disaster Prevention among Native and Mestizo Communities **Hazard(s):** Flood **Source(s):** UNDP. (2007). **Building Disaster Resilience Communities**. Retrieved at http://www.unisdr.org/files/596_10307.pdf		Project Details: • Some native and mestizo communities in Peru are extremely vulnerable to natural hazards such as floods, landslides and sludge avalanches. As their vulnerability is mainly due to poor economic conditions and lack of disaster prevention and response mechanisms and services, German Agro Action and ITDG - Soluciones Practicas11 embarked on an innovative disaster prevention and response capacity building project involving the communities. The project aims to enhance their capacity to respond to disasters and reduce their vulnerability through a participatory process. • Even though winning the support and participation of the communities was a major challenge, the project finally took off with the help of local Civil Defence Committees formed by community members themselves. The establishment of the local Civil Defence Committees had a positive catalytic effect on general participation. Native elders and leaders, women's and men's representatives, teachers and students, as well as local government officials joined the project, discussing disaster issues, devising risk reduction plans, assessing flood damage, promoting disaster prevention on local radio stations, integrating the topic into schools, establishing an educational network, identifying pilot projects, and so forth. The project, launched in March 2006, will be completed in June 2007. • Even though this is a first disaster prevention initiative with native and mestizo communities in Peru, it has achieved impressive results over its first 12 months of implementation. Better still, it can easily be replicated in communities with participatory decision making	• The project is a good practice because: • It has achieved activity coordination between schools and communities. • The civil defence committees have been created and trained and are able to provide technical assistance to civil defence groups in schools. • Students have formed learning circles for risk management which are part of the project's group of communicators. • The above-mentioned civil defence groups are operational and provide assistance to community based mitigation work. • The project also includes innovative elements such as: • Working with native communities and forming native promoters of disaster prevention. • Producing educational material in the native Awajun and Kechua languages. • Forming students' working groups which facilitate the learning process and help promote DRR activities in the communities. • The project activities are being implemented through a participatory process supported by local elders and leaders. Beneficiaries are integrated into the learning process, the development of risk reduction plans and the prioritization of activities to reduce vulnerability to natural hazards. A key success factor is people's awareness of the disaster risks and their awareness of the fact that they need to reduce their vulnerabilities. • Key lessons learned from this practice are: • Work coordination and activity identification among schools and communities have enhanced people's participation. • Local involvement and local "political" commitment are fundamental to the success of risk management processes. From the outset, local decision makers, elders, leaders and officials were integrated into the process and into the development of risk reduction plans.

Case Details	Resilience Identified/implied	Problems/Vulnerabilities	Lessons Learnt & Good Practices
		processes - provided that their "political" commitment is secured.	
CASE 67 Empowering local government as leaders in disaster reduction and recovery **Hazard(s):** Various Types **Source(s):** UNDP. (2007). **Building Disaster Resilience Communities**. Retrieved at http://www.unisdr.org/files/596_10307.pdf		Project Details: After the 2007 earthquake in Peru, reconstruction and recovery in the affected regions was typically fragmented and not well integrated into overall development and risk reduction work. Affected themselves by the quake, local government institutions were cast into a passive role. This UNDP project partnered with municipal governments to help them enhance their roles as leaders and coordinators of local development and recovery.	• Local governments are being supported to implement disaster risk reduction through helping them assume responsibility for coordinating and leading development-focused recovery, alongside central government and civil society organizations. • Development plans are including disaster risk reduction. • The whole project adopts a gender approach across the board, supporting the initiatives of 20 women's organizations. • In reconstruction and recovery, short-term, immediate and visible results are prioritized by national and local political interests. The challenge is to combine short-term activities with strategic longer-term initiatives to reduce risk, using political interests as an opportunity for gaining real commitments to risk-sensitive development. • Recovery stakeholders often intervene in an isolated manner, disconnected from development initiatives and with no inter-institutional coordination. It is important to coordinate different actors for joint interventions in ways that integrate with development work. • It is crucial to reinforce local capacities as a main goal of recovery, because local governments are the institutions that will sustain development once external supporters leave. For example, the effect of a disaster on the local authorities and staff themselves, combined with a top-down style of external aid, can lead to passivity in local government. Not only is technical advice needed, but support to restore local authorities' confidence and abilities to lead both recovery and development. • Recovery planning and implementation should be a part of the development planning and implementation. This is needed to make disaster risk reduction sustainable far beyond the reconstruction stage.
PHILIPPINES			
CASE 68 Mainstreaming Community-Based Mitigation in City Governance		Project Details:	• Mainstreaming CBDRM in good governance is a good practice. Indeed, when the NGO and other partner

Case Details	Resilience Identified/implied	Problems/Vulnerabilities	Lessons Learnt & Good Practices
Hazard(s): Various Types **Source(s):** UNDP. (2007). **Building Disaster Resilience Communities**. Retrieved at http://www.unisdr.org/files/596_10307.pdf		• The present project is part of a larger initiative called "Program for Hydro-Meteorological Mitigation for Secondary Cities in Asia" (PROMISE), a programme that covers several countries in Asia. • It is considered to be innovative because it seeks to mainstream community-based disaster risk management project (CBDRM) into city good governance. Implemented in the City of Dagupan, north of Manila on Luzon Island in northern Philippines, by the "Center for Disaster Preparedness" (CDP), the project has provided an opportunity for city officials to go back to the city's (urban) village communities and train them on CBDRM. Barangay12 Disaster Coordinating Councils were revitalized, which helped develop village disaster risk reduction plans that have benefited the city. • The project has been instrumental in bridging the gap between high-level officials and the community through disaster risk communication and understanding of development projects. The project experience is being shared with regional partners and donors.	agencies leave the city, residents are already equipped with tools to advance disaster risk reduction. The convergence of a community-level approach and City government's participation also helps enduring sustainability and ownership. The regional network facilitated by the Asian Disaster Preparedness Center (ADPC) ensures replication and wider practice. And the active involvement of City Government and village officials ensures the overall success of the project. • This project is innovative because, unlike other CBDRM projects that are usually implemented by NGOs with communities, it is implemented in partnership with a City government. • A key success factor of this project was the City mayor's continuous support to the larger programme. The mayor's support has significantly contributed to the smooth implementation of the project. • Key lessons learned from the project are: • Consultation with the Asian Disaster Preparedness Centre (ADPC) is essential for effective reporting of updates, logistical requirements and the overall flow of the project. • Flexibility towards community and city schedules ensures acceptance and participation from community members. • Children's participation ensures that their needs are considered and included. • Networking is deemed essential in early warning system. • Building linkages with both local and international NGOs helps in resource mobilization and in enhancing partnerships. • Barangay residents are very supportive of the programme on disaster preparedness, especially if they are involved in events that showcase their experience to other agencies, partners and organizations.
CASE 69 Mainstreaming Community-Based Mitigation in City Governance **Hazard(s):** Various Types **Source(s):**		Project Details: • The Albay Provincial Government in the Philippines established a permanent disaster risk management office in 1995 to deal with the area's high risk of typhoons, floods, landslide and earthquakes. This meant that disaster risk reduction was institutionalized, funded properly, and genuinely	• APSEMO has shown that having a permanent and institutionalized disaster management offices at a local or provincial level is a good practice. Having a permanent body that is the overall coordinator in times of emergency is particularly important for saving lives and implementing effective and sustainable disaster risk reduction and response.

Case Details	Resilience Identified/implied	Problems/Vulnerabilities	Lessons Learnt & Good Practices
UNDP. (2010). **Local Governments and Disaster Risk Reduction**. Retrieved at http://www.memorisks.org/docs/ISDR_2010_LocalGovernmentsandDisasterRiskReduction.pdf		mainstreamed within local government planning and programmes. As a result, disaster prevention, preparedness and response have been well coordinated, and numerous major natural hazards have resulted in no casualties for the province.	• Specifically, the project was the first in the country to make disaster risk reduction staff in Local Government Units permanent – rather than allowing them to be replaced after each election. Notably, the project gained consistent support for its policies and funding from six Provincial Governors since its inception, showing that political decision-makers have been able to see the benefits of stability and non-partisanship in disaster risk reduction work. This stability of staffing contributed to more effective teamwork, coordination and relationship building throughout the 14 years of APSEMO.
CASE 70 Guinsaugon in Southern Leyte **Hazard(s)**: Landslide **Year(s) of event**: February 2006 **Source(s)**: http://www.nat-hazards-earth-syst-sci.net/7/89/2007/nhess-7-89-2007.pdf http://landslides.usgs.gov/learn/photos/international/2006_guinsaugon_village__leyte_island_philippines_landslide http://adsabs.harvard.edu/abs/2006AGUFM.T13D0539S http://www.nytimes.com/2006/02/21/international/asia/21filip.html?_r=2&	• Lifeline facilities • Preparedness: early warning • Evacuation site • Effective emergency response • Government effectiveness: corruption level • Effective law enforcement • Effective land use planning • National environment preservation • Forest preservation • Mitigation: Hazard map	• Policies were even in place to avert a pending disaster: area villages were evacuated late last year and a logging ban, to address the deforestation that helped cause the problem, had been adopted more than a decade ago. • But reality was another matter. Many residents soon returned to their homes. According to government officials and environmental groups, problems ranging from government corruption and ineffective laws to a lack of money and the political will to enforce the laws contributed to the collapse of the mountainside here in the first place, and allowed it to become a large-scale human tragedy. • "The real reason for this terrible tragedy is that forests have been badly denuded and no serious replanting has been done," Archbishop Gaudencio Rosales of Manila said in a statement on Sunday. "It is time for the powers that be to address strongly these issues." • But the logging ban already in place is widely seen as ineffective. Endemic corruption, lack of resources and weak law enforcement have allowed illegal logging to flourish and environmental predators to go unpunished, critics said.	
CASE 71 Typhoon Haiyan (Typhoon Yolanda) **Hazard(s)**: Typhoon **Year(s) of event**: November 2013	• Disaster financial reserves and contingency mechanisms • Lifeline facilities: hospitals, roads, water, sanitation	• Typhoon Haiyan, called typhoon "Yolanda" in the Philippines, caused catastrophic damage throughout much of the islands of Leyte, where cities and towns were largely destroyed.	• As a result of the typhoon, the government is planning to replant mangroves in coastal areas while preserving the remaining ones.

Case Details	Resilience Identified/implied	Problems/Vulnerabilities	Lessons Learnt & Good Practices
Source(s): https://en.wikipedia.org/wiki/Typhoon_Haiyan http://earthquake-report.com/2013/10/15/very-strong-earthquake-mindanao-philippines-on-october-15-2013/	• Preparedness: early warning • Timely evacuation • Evacuation site • Effective emergency response • Law and order during emergency • Government effectiveness: corruption level	• There was widespread devastation from the storm surge in Tacloban City especially in San Jose, with many buildings being destroyed, trees knocked over or broken, and cars piled up, the terminal building of Tacloban Airport destroyed. • By November 11, the provinces of Aklan, Capiz, Cebu, Iloilo, Leyte, Palawan, and Samar, were placed under a state of national calamity, allowing the government to use state funds for relief and rehabilitation and to control prices of basic goods. • Extreme damage to infrastructure throughout the region posed logistical problems that greatly slowed relief efforts. Though aid was flown into local airports, most of it remained there as roads remained closed. • With lack of access to clean water, some residents dug up water pipes and boiled water from there in order to survive. • Thousands of people sought to evacuate the city via C-130 cargo planes, however, the slow process fueled further aggravation. • Hospitals in the city were either shut down or working at partial capacity, leaving many of the nearly 2,000 injured in the city without medical assistance. In nearby Baybay, lack of assistance fueled anger and incited looting for survival. • Throughout Tacloban City, widespread looting took place in the days following Haiyan's passage. In some instances, relief trucks were attacked and had food stolen in the city. Two of the city's malls and numerous grocery stores were subjected to looting. • Condemnations of slow government action in the relief effort in response to the typhoon mounted days after the storm had passed due to the breakdown of the local governance in affected areas.	• Typhoon Haiyan knocked over Power Barge 103 of Napocor in Estancia, Iloilo, causing an oil spill. Affected residents were allowed to return to their homes by the Department of Health on December 7, 2013 after an air quality test found out that benzene level in affected areas reached near-zero parts per million.
RUSSIA			
CASE 72 North Ossetia **Hazard(s):** Landslide (Glacier slide)	• Frequent monitoring of hazards (glacier) • Early warning system	• Hundreds of lives may have been saved if the Kalka glacier had been monitored.	

Case Details	Resilience Identified/implied	Problems/Vulnerabilities	Lessons Learnt & Good Practices
Year(s) of event: September 2002 **Source(s):** http://reliefweb.int/report/russian-federation/russia-north-ossetia-disaster-was-avoidable	• Hazard mapping	• Locals believe as many as 300 people may have been killed - far higher than official estimates - when the Kalka glacier plunged 24 km down into the Genaldon Gorge on September 20. • Some believe proper monitoring of the glacier could have given prior warning of the impending cataclysm. The area has not been studied for more than a decade, after a dedicated team of glaciologists ran out of funds following the collapse of the Soviet Union. • The glacier, which sped down the mountains at around 150 km an hour, buried the village of Karmadon and adjacent holidaying areas under a 50 m layer of stones and ice.	
CASE 73 Stavropol Flood **Hazard(s):** Flood **Year(s) of event:** June 2002 **Source(s):** http://www.heatisonline.org/contentserver/objecthandlers/index.cfm?id=3991&method=full	• Disaster management • Effective early warning • Infrastructure maintenance • Government effectiveness •	• The death toll from flooding in southern Russia climbed to 93. • Two local officials in the Stavropol region have already face criminal charges for failure to inform people of the impending flood. The floods caused more than $385 million damage. • Russian President Putin said that poor preparation by local authorities had significantly increased the region's misery and that the system of notification practically didn't exist. Officials said that least 86,000 people were left homeless by the rising waters, more than 3,000 homes have been completely destroyed, and around 45,000 others were flooded. • The region's infrastructure has suffered massive damage. More than 230 bridges have been destroyed, and nearly 1000 kilometres (75 miles) of roads damaged. Railway lines and gas pipelines have been severed, along with water and electricity distribution networks. • Some victims' relatives have accused the authorities of a slow and ineffective response. Officials blamed each other for a poorly co-ordinated response. "We could have prevented some of the casualties if the whole system had worked well together, starting with the weather forecasts."	

Case Details	Resilience Identified/implied	Problems/Vulnerabilities	Lessons Learnt & Good Practices
CASE 74 Southern Russia (Stavropol, Krasnodar, Karachayevo-Cherkessia, North Ossetia, and Kabardino-Balkeria regions) **Hazard(s)**: Heavy rainfall → Flood **Year(s) of event**: 2002 **Source(s)**: http://www.heatisonline.org/contentserver/objecthandlers/index.cfm?id=3991&method=full	• Government effectiveness • Timely evacuation • Preparedness: early warning • Evacuation site: shelters, foods, waters, sanitation • Effective emergency response	• The floods have forced thousands to flee their homes and caused more than $385 million in damage. (53 confirmed deaths, 75,000 people made homeless, 70 villages under water, 105,000 people without electricity, 14 bridges swept away in Stavropol alone, and oil slick in the Sunzha river from a flooded refinery) • Emergency officials said many of the deaths were caused by the collapse of structures weakened by the flooding, exposure to cold water and heart attacks. • Two local officials in the Stavropol region have already face criminal charges for failure to inform people of the impending flood, the newspaper Izvestia reported • Putin said he saw victims sitting in the camps naked and barefoot, sleeping in tents erected in mud. "We must do everything for them to have food and drinking water and a little money. • Russian emergency workers are distributing food and medicine by helicopter to areas where there is no road access, because bridges have been swept away. • Some victims' relatives have accused the authorities of a slow and ineffective response. Officials blamed each other for a poorly co-ordinated response. • "We could have prevented some of the casualties if the whole system had worked well together, starting with the weather forecasts," reported in BBC news.	•
CASE 75 The Amur River (Khabarovsk) **Hazard(s)**: Heavy rainfall → Flood **Year(s) of event**: August 2013 **Source(s)**: http://reliefweb.int/report/russian-federation/russia-evacuates-19000-flooded-far-east	• Government effectiveness • Timely evacuation • International disaster management • Post-disaster recovery plan	• Massive rains since the end of July caused both the Amur River and one of its tributaries to burst their banks. • Russian authorities have evacuated more than 19,000 people from unprecedented floods. • Five hundred kilometres of roads have been destroyed, bridges are destroyed, 38 villages have been cut off. • Several areas have been left without power and Kozhemyako said more than 43 percent of coal stockpiled for the winter had been lost in the flood.	• Deputy Prime Minister Dmitry Rogozin said he would hold talks with Chinese counterpart Wang Yang over a common approach to the rising Amur river, which serves as the border between the two countries. "We will discuss coordination of flood management," he wrote on Twitter.
CASE 76 Kalka glacier, North Ossetia	• Mitigation: hazard study and monitoring	• Hundreds of lives may have been saved if the Kalka glacier had been monitored. Some believe proper	• Beroyev said that the scientists of North Ossetia have frequently spoken of the need to set up a research

Case Details	Resilience Identified/implied	Problems/Vulnerabilities	Lessons Learnt & Good Practices
Hazard(s): Glacier slide **Year(s) of event:** September 2002 **Source(s):** http://reliefweb.int/report/russian-federation/russia-north-ossetia-disaster-was-avoidable	• Preparedness: early warning	monitoring of the glacier could have given prior warning of the impending cataclysm. The area has not been studied for more than a decade, after a dedicated team of glaciologists ran out of funds following the collapse of the Soviet Union. • The glacier, which sped down the mountains at around 150 km an hour, buried the village of Karmadon and adjacent holidaying areas under a 50 m layer of stones and ice. Local geologists estimate that the debris may comprise between 80 and 150 million tons of rock. • The material damage caused by the disaster runs to around 15-17 million US dollars. • Locals say the actual number of those missing is far greater than the official estimates, as the ice stream overwhelmed recreation areas filled with weekend visitors.	institute to study ice flow developments in mountainous areas. It is believed such a programme could have helped them forecast large-scale natural catastrophes such as the recent one, preventing loss of life. • The last time Kalka shifted was in 1969. While the glacier moved less than four km, residents of the adjacent village of Gizel were evacuated as a precaution.
CASE 77 Yukutsk, Siberia **Hazard(s):** Flood **Year(s) of event:** 2001 **Source(s):** http://articles.latimes.com/2001/may/22/news/mn-1012 http://eyakutia.com/2010/05/2010-spring-flood-the-lena-river-yakutsk-yakutiasiberia/ http://news.bbc.co.uk/2/hi/europe/1342310.stm http://news.bbc.co.uk/2/hi/europe/1346139.stm	• Preparedness: early warning system • Dikes reinforcement	• An exceptionally harsh winter caused a massive ice floe to form on the Lena about 50 miles east of Lensk, leading to a buildup of meltwater after the spring thaw that triggered the flooding, the worst eastern Siberia has seen in a century. • Jets had to drop bombs on an 18-mile ice jam clogging the Lena River to unblock the swollen waterway, sending a wave of water surging downstream toward Yakutsk. • Rescue workers were warning people in outlying districts to leave their homes before the water rose any further. • The town of Lensk, 525 miles upstream from Yakutsk, was wiped out by meltwater, and many of its 27,000 residents were rescued from their rooftops by helicopter.	
SLOVENIA			
CASE 78 Log pod Mangartom, Bovec **Hazard(s):** Heavy rainfall → Landslide **Year(s) of event:** November 2000	• Security of lifeline facilities: roads, bridges, electricity, water • Preparedness: evacuation sites	• Several residential (50 houses) and industrial buildings were also destroyed, and there was damage to the low- and high-voltage networks, power facilities and water reservoirs.	

Case Details	Resilience Identified/implied	Problems/Vulnerabilities	Lessons Learnt & Good Practices
Source(s): https://www.novapublishers.com/catalog/product_info.php?products_id=13700 http://iaps.zrc-sazu.si/sites/default/files/Ostir_Landslide_Log_pod_Mangartom.pdf		• The operation to stabilise the situation at Log and provide overall sanitation is still underway and more than 100 locals evacuated from the affected area will not return before spring. • The villages in this area were reachable only by air for a few weeks, as the road and several houses were swept away by the landslide.	
SURINAME			
CASE 79 Paramaribo **Hazard(s):** Flood **Year(s) of event:** June 2013 **Source(s):** http://news.trust.org//item/20130613133739-o9heu	• Urban Planning • Waste management (Trash clog) • Evacuation site • Displaced people management	• Suriname was lashed by heavy rains – nearly double the usual rainfall for the period - that led to evacuations and crop and livestock losses as floodwater rapidly overflowed the country's waterways. • Officials blamed the crisis in part on failure to prepare for the growing risks. • Trash-clogged drainage canals, growing development in low-lying areas and increasingly extreme weather are adding up to worsening flooding in Suriname. • Some cassava farmers have lost their entire year's harvest. Cassava is widely considered a climate-resilient crop. • Some 300 people from five communities in Marowijne district, in the east of the country, were relocated when the Cottica River overflowed, reaching up to one metre in depth in their villages. • The problem is indeed that they get excessive rains, but the true culprit is the garbage that is dumped on the roadsides and in canals by those same environmental barbarians who dump the garbage and who complain later when they're flooded. Many important canals were clogged. • He noted that the traditional practice of building on higher ground and leaving lower-lying areas for agriculture has changed as the country's population has grown. Infrastructure and residential developments have moved to coastal areas, and newer canals have smaller gradients, slowing the flow of water.	

Case Details	Resilience Identified/implied	Problems/Vulnerabilities	Lessons Learnt & Good Practices
SWITZERLAND			
CASE 80 Rivers Kleine Emme, Reuss, Aare **Hazard(s):** Flood & Landslide **Year(s) of event:** August 2005 **Source(s):** http://swiss-news-media-press.all-about-switzerland.info/floodings-inundations-landslides-2005.html	• Lifeline facilities • Decentralization • Quick response • Local response team	• It is the heaviest rainfalls since more than 100 years. • Five people are reported to have been killed, two are still missing. Major roads and railroads crossing the alps (St. Gotthard, Lötschberg) have been cut for several days, but Southern Switzerland could always be reached over the San Bernardino route. • Though present in the media, could always easily be reached from outside, there was no shortage of supply, electricity was cut only for very limited number of households and almost everybody went to work within the city or commuted to other places almost as usual.	• Switzerland's political structures giving as much autonomy and responsibility to the cantons and communes proved to be very adequate to tackle the crisis: every family had food rations etc. to survive for one week, local rescue teams, though not professionals, but ordinary citizens professionally organized, equipped and trained on communal level did a fantastic job, cantonal task forces coordinated help from regions not hit by the catastrophe and of the Swiss Army in close cooperation with the communal authorities and these helpers, as far as needed, were right at the problem spots from the second day people who had to be evacuated found shelter within the region and took part in useful common actions everywhere private initiative and help among neighbours could be seen nobody was being treated as a refugee but rather as valuable members of the society. • Though nobody really waited for national politicians to act immediately, both Switzerland's president (and minister of defense), Samuel Schmid, and the minister of transportation and energy, Moritz Leuenberger, were soon present right at the problem spots, talked with local experts as well as with ordinary people and found words that both encouraged the population and showed respect for their local actions.
TAIWAN			
CASE 81 Earthquakes **Hazard(s):** Earthquake **Year(s) of event:** 2010, 2016 **Source(s):** https://en.wikipedia.org/wiki/List_of_earthquakes_in_Taiwan https://en.wikipedia.org/wiki/2010_Kaohsiung_earthquakes	• Lifeline facilities • Main transportation after disaster • Fire after disaster	• In 2010, the 2010 Kaohsiung earthquakes measuring 6.4, and 6.7 M, occurred on Thursday, March 4 at 8:20 a.m. local time. The epicenter was located in the mountainous area of Kaohsiung County (now part of Kaohsiung City) of the southwestern Taiwan. A bridge which connects Kaohsiung and Pingtung was blocked since it sunk after the quake. • In 2016, an earthquake with a moment magnitude of 6.4 struck 28 km (17 mi) northeast of Pingtung City in southern Taiwan. The worst affected city was Tainan, where numerous buildings reportedly	

Case Details	Resilience Identified/implied	Problems/Vulnerabilities	Lessons Learnt & Good Practices
https://en.wikipedia.org/wiki/2016_Taiwan_earthquake		collapsed, including at least one 17-story residential building in Yongkang District, with hundreds of people trapped in collapsed buildings. 80 people have died inside the Weiguan Jinlong building in Tainan City, including a six-month-old baby who died a few hours later in the hospital	
TAJIKISTAN			
CASE 82 REACT — Rapid Emergency Assessment and Coordination Team **Hazard(s):** Various Type **Source(s):** UNISDR. Disaster Risk Reduction 20 Examples of Good Practice from Central Asia. Retrieved at http://www.unisdr.org/files/2300_20GoodExamplesofGoodPractice.pdf		Since 2001, Tajikistan's Ministry of Emergency Situations (MoECD) has chaired the Rapid Emergency Assessment and Coordination Team (REACT), with support from the United Nations Disaster Risk Management Project (UNDRMP). REACT partners, including UN Agencies, donor organizations, and international and national NGOs operating in the area of disaster response, prevention, mitigation, and preparedness. REACT coordinates various organizations that support MoECD in assessing needs for disaster relief, and it facilitates timely and appropriate responses by the numerous assistance organizations	• REACT uses a cluster approach with 5 sector groups (food, shelter and non-food items, water and sanitation, education, health). It also has a network of regional teams. Coordination and information sharing is performed. • REACT has organized a series of training events in disaster management, and search and rescue methods for Government Officials. It has also successfully coordinated efforts in broader areas, including community-based mitigation and hazard mapping. • REACT is unique in the Central Asian Region in its ability to rapidly coordinate timely and equitable assistance to disaster-affected communities.
CASE 83 Disaster Preparedness Action Plan Tajikistan (DIPECHO) **Hazard(s):** Flash-flood & Mudslide **Source(s):** UNISDR. (2008). **Private Sector Activities in Disaster Risk Reduction: Good Practices and Lessons Learned**. Retrieved at http://www.unisdr.org/2006/ppew/PPP-bestpractices.pdf		(ECHO and CARE International project) • Floods and mudflows affect Tajikistan communities every year. • People of Tajikistan have long been using traditional ways to prevent and mitigate natural disasters. • However, Community Based Organization(s) (CBOs) can develop disaster response plans that lead to more systematic and effective responses to emergency situations.	• One of the sad lessons learned is that the poor not only suffer most from a disaster but will most probably suffer from the next disaster since they cannot afford reliable and costly mitigation measures. • No labor is to be looked upon as free. It is advisable to find ways to cover the cost of community labor with cash or food or other benefits. • Use of local knowledge and expertise was found to be a great asset. It has to do not only with the community's "institutional memory" of disasters but also with a high educational level of people in Central Asian countries. • No intervention, even when it brings a temporary relief, is a success if it inflicts damage to environment and biodiversity in the area. It is advisable to always address appropriate use of water, soil, and vegetation to prevent droughts and desertification. • All carefully conceived interventions have a capacity building component. In community training, use

Case Details	Resilience Identified/implied	Problems/Vulnerabilities	Lessons Learnt & Good Practices
			scenarios of alternative development and discuss means to achieve the alternative goals. • Think of the ways to exchange successful community experiences of sustainable development/poverty reduction in disaster-prone areas through joint sessions/workshops or in-country study tours.
CASE 84 International Involvement in rehabilitating the seismic monitoring network **Hazard(s):** Earthquake **Source(s):** UNISDR. Disaster Risk Reduction 20 Examples of Good Practice from Central Asia. Retrieved at http://www.unisdr.org/files/2300_20GoodExamplesofGoodPractice.pdf		• Tajikistan had a seismic network of 49 analogue seismic stations. The civil war of 1992 caused a lot of damage to the seismic network. By the year 2000, the network practically did not function. • The overall goal of the project is to strengthen the capacity of the Seismologic Service of the Republic of Tajikistan to carry out its role in disaster risk management, which is to closely monitor seismic events and to provide disaster related information to national and international stakeholders. • The project is implemented by the National NGO Prevention, Mitigation, and Preparedness International (PMP Int.) in close cooperation with the Institute of Earthquake Engineering and Seismology of the Academy of Sciences of the Republic of Tajikistan, and the Ministry of Energy ("Barki Tojik"). Financial and technical support are provided by the Swiss Agency for Development and Cooperation and the Swiss Seismological Survey.	• Risk assessment brings best results when it combines local knowledge with existing data and higher technology information, such as satellite imagery. • Risk assessment is not an ultimate objective in itself. Its outcomes should be well communicated and widely shared with all stakeholders through training in disaster risk reduction. • Effective monitoring and warning systems can be established to save lives and prevent damage to infrastructure, as proved by the unique in Central Asia system now installed and sustained at Lake Sarez in Tajikistan. • Poor communication in the field leads to unnecessary duplication of risk assessment. • Risk assessment, should ideally be carried out nationwide with the risk maps disseminated to all stakeholders, with a special attention to residential areas and social facilities. • Natural and artificial dams of 15 m and higher should be equipped with monitoring and warning systems. • Different hazards require different mapping techniques. Composite hazard maps are important tools for hazard assessments. It is very important to use simple classification based on the identification of both high-impact low frequency and low-impact high-frequency events, with clear indication of high, medium, low risk or no danger. • Promote cooperative assessments based on multi-sector/inter-agency activities to efficiently provide the baseline data needed by numerous agencies.
CASE 85 Children in Emergencies Training **Hazard(s):** Various Types		**Lake Sarez, Bartang Valley**	• The overall goal was to develop and demonstrate a method to raise primary and secondary school children's awareness of natural hazards.

Case Details	Resilience Identified/implied	Problems/Vulnerabilities	Lessons Learnt & Good Practices
Source(s): UNISDR. Disaster Risk Reduction 20 Examples of Good Practice from Central Asia. Retrieved at http://www.unisdr.org/files/2300_20GoodExamplesofGoodPractice.pdf		• School education curricula in Tajikistan do not yet include classes in disaster prevention, mitigation, and preparedness. • The Bartang Valley in mountainous Badakhshan is exposed to regular natural hazards like earthquakes, avalanches and landslides but also because of its vulnerability to the potential outburst of Lake Sarez. • Ten thousand residents had no opportunities to receive even basic information on disaster preparedness and mitigation.	• Some 120 children and 12 teachers were selected as direct project beneficiaries of disaster preparedness training. • The main idea of the project was to help children and their parents understand causes, conditions and consequences of natural disasters and help prepare for and overcome them, and to train teachers in the innovative methods. • The use of interactive techniques and audio-visual aids made training interesting and achieved excellent results. • Special attention was paid to practical measures, such as the development of household evacuation plans and emergency kits. • The project not only trained teachers, children, and their parents, but also promoted the integration of this most important subject in the school curriculum.
THAILAND			
CASE 86 'Mister Warning', a Village-based disaster warning volunteer **Hazard(s):** Flash flood & mudslide **Source(s):** ADRC. (2007) **Total Disaster Risk Management: Good Practices 2007 Supplement**. Retrieved at http://www.adrc.asia/publications/TDRM2005/TDRM_Good_Practices/PDF/PDF-sup2007e/Thailand.pdf		Thailand has shifted its traditional "response approach" to "total disaster risk management approach" which encompasses holistic disaster management activities including risk reduction, creation of the awareness and preparedness among all stakeholders, and encouraging the involvement of the community at risk.	**"Community-Based Disaster Volunteer Training Course, "Mr. Warning"** ● This training course aims at creating a disaster warning network for villages in flashfloods and mudslides by designating the trained villages as "Mr. Warning" who was selected by villagers to attend the training courses. ● Upon the completion of the training course and being designated, "Mr. Warning" will be assigned tasks to shoulder the responsibility as "vigilant", "forewarner", and "coordinator" in non-emergency, pre-disaster, during, and in post-disaster phases.
CASE 87 Central Thailand Flood **Hazard(s):** Flood **Year(s) of event:** March-April 2011 **Source(s):** https://en.wikipedia.org/wiki/2011_Thailand_floods	• Comprehensive disaster management • Government effectiveness • Timely and effective response • Evacuation site provision • Sanitation provision • Crime control in affected and evacuated areas	• Severe flooding occurred during the 2011 monsoon season in Thailand. The flooding began at the end of July triggered by the landfall of Tropical Storm Nock-ten. These floods soon spread through the provinces of northern, north-eastern, and central Thailand along the Mekong and Chao Phraya river basins. In October floodwaters reached the mouth of the Chao Phraya and inundated parts of the capital city of Bangkok. Flooding persisted in some areas until mid-January 2012, and resulted in a total of 815 deaths	• Bangkok is a member of the United Nations International Strategy for Disaster Reduction "Making Cities Resilient" campaign. Among the ten essential actions promoted by the campaign is the maintenance of critical infrastructure to reduce the risk of disaster. • In order to reduce the risk of future flooding, the Thai government has created a water management program, but the plan will take time to implement. The master plan includes an allocation of 50 billion Baht ($1.6 billion) to build dams in four basins in the northern region of the

Case Details	Resilience Identified/implied	Problems/Vulnerabilities	Lessons Learnt & Good Practices
http://www.thaiwater.net/web/index.php/ourworks2554/379-2011flood-summary.html http://patimes.org/lessons-learned-2011-flooding-thailand/		(with 3 missing) and 13.6 million people affected. Sixty-five of Thailand's 77 provinces were declared flood disaster zones, and over 20,000 square kilometres (7,700 sq mi) of farmland was damaged. The disaster has been described as "the worst flooding yet in terms of the amount of water and people affected. • The World Bank has estimated 1,425 billion baht (US$45.7 billion) in economic damages and losses due to flooding, as of 1 December 2011. Most of this was due to the manufacturing industry, as seven major industrial estates were inundated in water as much 3 meters (10 feet) deep during the floods. Disruptions to manufacturing supply chains affected regional automobile production and caused a global shortage of hard disk drives which lasted throughout 2012. • While there is often some flooding during the rainy season, there were several factors contributing to the severity of the 2011 floods. The three large dams that help regulate water flow in the central plains were unable to cope with the large amount of rainfall. Authorities had to release water into already very full rivers. In addition, the high tides in October and November meant the water level of the Chao Phraya was already high, making it more difficult to accommodate the runoff of floodwaters from the north. • The situation was further complicated by the government's decision to keep the center of Bangkok dry by shoring up floodwalls. The rationale was to try to save the economic engine of the country, and flooding the inner parts of the city arguably would not have a great enough impact on draining surrounding suburbs to justify the cost. However, this resulted in some communities being flooded in order to spare the capital, leading to resentment among those who ended up on the wrong side of the sandbags. There were protests in some affected communities and reports of residents intentionally breaching the floodwalls. In some cases, this happened while the authorities and police looked	country. Another 120 billion Baht ($3.9 billion) have been designated for the construction of floodways and flood diversion channels, with work scheduled to begin this year to enhance canals. • Sixty billion Baht ($1.9 billion) have been allocated to convert two million rai (800,000 acres) of farmland along the Chao Phraya into water retention areas. This would require moving current residents elsewhere. • A World Bank publication, "Cities and Flooding: A Guide to Integrated Urban Flood Risk Management for the 21st Century," is available free of charge and provides guidance on how to manage the risk of floods in the urban environment. Among the cautions in the document is the reminder that heavily engineered structural measures (such as the construction of dams) can be effective when used properly, but they reduce flood risk in one location and transfer risk to other areas upstream and downstream. Non-structural measures are usually designed to minimize rather than prevent risk. • Effective flood risk management requires the cooperation of multiple stakeholders. Effective engagement with those at risk is key to successful implementation. Engagement increases a sense of involvement, increases compliance, and reduces conflict. • The public should keep in mind that any measures, when complete, are designed to mitigate the impact of floods, but cannot prevent flooding from occurring.

Case Details	Resilience Identified/implied	Problems/Vulnerabilities	Lessons Learnt & Good Practices
		on, not wanting to intervene in an explosive political and public safety situation.	
TURKEY			
CASE 88 Bingöl **Hazard(s):** Earthquake **Year(s) of event:** May 2003 **Source(s):** http://www.koeri.boun.edu.tr/depremmuh/eski/eqspecials/bingol/bingol_eq.htm	• Seismic design code • Retrofitting of the traditional houses 'Himis' • Concrete Quality	• 308 housing units were collapsed, 2566 housing units were heavily damaged and 2546 housing units were lightly damaged. • Death of 168, and injuries of 520 people have been reported by the Government sources. • The structural type of the city is generally composed of reinforced concrete buildings up to five or six stories, himis (buildings composed of timber frames and braces with adobe infills), and un-reinforced masonry structures. • As a result of the site investigations in the earthquake region, it has been indicated that significant portion of the government buildings (schools, dormitories, state buildings) have the highest level of damage in reinforced concrete structures. Also it has been seen that recently built (within 5 years) do not have significant damage. • A typical himis building is composed of the thick perimeter walls and heavy roofs to provide heat isolation of the structure. The observed performances of the himis buildings are not so good. Most of them had heavy damage and a few of them have totally collapsed. • Another type of failure was the poor quality of concrete. It has been learned that there was only one ready-mixed concrete plant in the vicinity. And the people do not prefer to use the ready-mixed concrete just because it is too expensive. Instead they produce their own concrete by using the material they get from Murat River as aggregate. A few number of buildings had shear walls but in some cases due to insufficient transverse reinforcement and poor concrete quality wide shear cracks occurred in the shear walls.	
USA			

Case Details	Resilience Identified/implied	Problems/Vulnerabilities	Lessons Learnt & Good Practices
CASE 89 Hurricane Katrina, New Orleans **Hazard(s):** Hurricane **Year(s) of event:** August 2005 **Source(s):** https://en.wikipedia.org/wiki/Hurricane_Katrina	• (New Orleans Levee Failure) • Effective response and relief • Control of chaos after disaster • Government Effectiveness	• It was the costliest natural disaster, as well as one of the five deadliest hurricanes, in the history of the United States. • Katrina caused severe destruction along the Gulf coast from central Florida to Texas, much of it due to the storm surge and levee failure. Severe property damage occurred in coastal areas, such as Mississippi beachfront towns; over 90 percent of these were flooded. Boats and casino barges rammed buildings, pushing cars and houses inland; water reached 6–12 miles (10–19 km) from the beach. • The economic effects of the storm were far-reaching. • Katrina also had a profound impact on the environment. The storm surge caused substantial beach erosion, in some cases completely devastating coastal areas. • Shortly after the hurricane moved away on August 30, 2005, some residents of New Orleans who remained in the city began looting stores. Many were in search of food and water that were not available to them through any other means, as well as non-essential items. • Within the United States and as delineated in the National Response Plan, disaster response and planning is first and foremost a local government responsibility. When local government exhausts its resources, it then requests specific additional resources from the county level. • The criticisms of the government's response to Hurricane Katrina primarily consisted of criticism of mismanagement and lack of leadership in the relief efforts in response to the storm and its aftermath.	
CASE 90 Hurricane Gustav, New Orleans **Hazard(s):** Hurricane **Year(s) of event:** August, 2008 **Source(s):** https://en.wikipedia.org/wiki/Hurricane_Gustav		• Gustav was the second most destructive hurricane of the 2008 Atlantic hurricane season. The storm was the seventh tropical cyclone, third hurricane, and second major hurricane of the season. • In total, an estimated 153 deaths had been attributed to Gustav in the U.S. and Caribbean. Damage in the U.S. totaled to $4.3 billion (2008 USD) with additional	

Case Details	Resilience Identified/implied	Problems/Vulnerabilities	Lessons Learnt & Good Practices
		damage of $2.1 billion in Cuba and $210 million in damage in Jamaica. • 48 deaths in the state of Louisiana were blamed on Hurricane Gustav. Five were due to falling trees, two due to a tornado and the rest were indirect deaths.	
CASE 91 Hurricane Sandy **Hazard(s):** Hurricane **Year(s) of event:** October 2012 **Source(s):** https://en.wikipedia.org/wiki/Hurricane_Sandy	• Effective response and relief • Political effectiveness in releasing financial aids	• Hurricane Sandy was the deadliest and most destructive hurricane of the 2012 Atlantic hurricane season, as well as the second-costliest hurricane in United States history. • At least 286 people were killed along the path of the storm in seven countries. • In the United States, Hurricane Sandy affected 24 states, including the entire eastern seaboard from Florida to Maine and west across the Appalachian Mountains to Michigan and Wisconsin, with particularly severe damage in New Jersey and New York. • Its storm surge hit New York City on October 29, flooding streets, tunnels and subway lines and cutting power in and around the city. • Damage in the United States amounted to $65 billion (2013 USD).	• Several organizations have contributed to the hurricane relief effort. • On December 28, 2012, the Senate approved an emergency relief bill to provide $60 billion for states affected by Sandy, but the House (in effect) postponed action until the next session (which began January 3) by adjourning without voting on the bill. House leaders pledged to vote on a flood insurance bill on January 4, 2013 and to vote on an aid package by January 15. On January 28, the Senate passed the $50.5 billion Sandy aid bill by a count of 62–36. President Obama signed the bill into law January 29.
VIETNAM			
CASE 92 Planting Mangroves to Mitigate Sea Dyke Erosion **Hazard(s):** Sea dykes & Typhoon waves **Source(s):** ADRC. (2005) **Total Disaster Risk Management: Good Practices 2005**. Retrieved at http://www.adrc.asia/publications/TDRM2005/TDRM_Good_Practices/PDF/PDF-2005e/Chapter3_3.1.1-1.pdf		**Thai Binh & Nam Dinh** • The Vietnam Red Cross has planted mangroves along the coastal lines of Thai Binh and Nam Dinh provinces. • In 2003, two typhoons struck Northern Vietnam in July and August but only four people died, no rice fields were flooded and the impact of the typhoon rapidly weakened. The number of deaths fell.	**Mangroves Planting to mitigate sea dyke erosion:** The Red Cross has used a community-based disaster management approach. The community played an important role and was actively involved in the implementation. Many training courses and public awareness exercises have been carried out to assist the local community in fulfilling its role, such as planting training courses and DP training courses for teachers, children and local staff.
CASE 93 Flood and Typhoon-Resilient Homes through Cost-Effective Retrofitting **Hazard(s):** Various Types		Project Details: • Vietnam's disaster risk reduction strategy pays insufficient attention to the capacity of families and local communities to play a key role. Top-down	• The DWF programme is a good practice because it is both practical and efficient. This is evidenced by the fact that families and communities immediately put their money

Case Details	Resilience Identified/implied	Problems/Vulnerabilities	Lessons Learnt & Good Practices
Source(s): UNDP. (2007). **Building Disaster Resilience Communities**. Retrieved at http://www.unisdr.org/files/596_10307.pdf		approaches need to mesh with community-based disaster risk reduction potential. • A Development Workshop France (DWF) programme efficiently demonstrates that communities can be a dynamic force in reducing risks directly related to local contexts, and that their potential can be mobilized through participatory commune-level disaster risk reduction planning, training and outreach, and preventive strengthening of housing and public buildings. • The DWF Programme seeks to help reduce the impact of typhoons and floods on housing and public buildings; loss of housing being specifically a major family setback with repercussions on all other aspects of family life and development. • The Programme is practical, efficient and cost effective. Even though financial institutions have not taken up yet the idea of granting credit to people concerned, many families and communities immediately put their money into it after seeing its concrete and tangible results.	into the DWF approach after seeing its concrete and tangible results. • One innovative aspect of the Programme is the key role of participatory communication actions that involve people from all levels in getting the prevention message across. Another innovation is the demonstrative value of showing how housing and public buildings can be made to resist disasters. The third innovation consists in showing that the whole process is economically viable. • A long-term success/failure factor of this initiative may be the fact that financial institutions have not taken up the idea of granting credit for preventive strengthening of houses, yet the idea has been well received by beneficiary families. This issue still has to be addressed. A possible link with disaster insurance should be explored. • The key lessons learned from this initiative are: • Once convinced, people and families are well prepared to commit their own funds to take preventive action to reduce the risk of loss or damage to their own homes; • Community residents can give equal treatment to community facilities and public facilities as long as the "common good" dimension is perceived; and • Scepticism about the value of retrofitting houses has been replaced by confidence.
CASE 94 Building local capacity and creating a local government network for cyclone risk **Hazard(s):** Various Types **Source(s):** UNDP. (2010). **Local Governments and Disaster Risk Reduction**. Retrieved at http://www.memorisks.org/docs/ISDR_2010_LocalGovernmentsandDisasterRiskReduction.pdf		Project Details: Development Workshop France has been working with Viet Nam's Commune Local Governments since 2000 to make construction cyclone resistant. Training, education and public awareness has resulted in more resilient homes and communities, and genuine local leadership of disaster risk reduction. This has increased recognition of disaster risk reduction at local and provincial levels of government. Importantly, Commune Local Governments are now networking with each other to share experiences and expertise, spreading the benefits of the project to other Communes and even internationally.	• Already identified by as a good practice in other contexts, with regard to local government it is the role and development of the Commune Local Governments themselves as key players in community disaster risk reduction that stands out. Most specifically, the development of the Community Local Government network should be highlighted. The network provides a unique example of horizontal sharing in experience and decision-making about Commune disaster risk reduction. The networks draw on the skills and experience that have developed within the Communes in the past decade. • A key success has been the ability of Communes with several years of project experience to share their experience and guide other Communes in the process of

Case Details	Resilience Identified/implied	Problems/Vulnerabilities	Lessons Learnt & Good Practices
			developing and implementing their own disaster risk reduction action plans for their Commune. The network has been an efficient way to discuss, plan and implement risk reduction plans, warning systems (Radio FM, loudspeaker network), school programmes (lessons, plays), raising awareness through participatory events (like boat races with teams from different Communes), and practical evaluation of vulnerability of existing houses. • Already, alongside the DWF 'prevention' project, CLGs are strengthening their roles in disaster preparedness and response, in improving capacity for evacuation of vulnerable populations and the provision of food and other forms or relief managed by the Commune. CLGs have in the past decade been mandated by the central and provincial authorities with increasing responsibilities, and are developing capacity to act quickly and efficiently to save lives. Strengthening the CLG role in preventive action for disaster risk reduction has been a logical step.
MULTI-NATIONAL HAZARD EVENTS			
CASE 95 International Cooperation in Creating an Effective & Proper Emergency Supply Management System (SUMA), Latin America **Hazard(s)**: Various types **Source(s)**: ADRC. (2005) **Total Disaster Risk Management: Good Practices 2005**. Retrieved at http://www.adrc.asia/publications/TDRM2005/TDRM_Good_Practices/PDF/PDF-2005e/Chapter3_3.1.3.pdf		• Effective and Coordinated Emergency Supply not only reduces the impact of disasters in terms of human suffering but also contributes meaningfully to the Rehabilitation/Reconstruction phase of disaster response.	• **International Cooperation in Creating an Effective & Proper Emergency Supply Management System (SUMA)** • The Emergency Supply Management system known as SUMA began formal operations in 1992. It was developed in a cooperative fashion with the participation of experts from various Latin American countries, with the support of the Pan American Health Organization, the Regional Office for the Americas of the World Health Organization (PAHO/WHO), the Colombian Red Cross, and financial support from the Government of the Netherlands. • SUMA was modified to serve as a management tool for all types of supplies, not only those related to disasters. Over a period of several years, SUMA has demonstrated its value as a technical tool for the coordination and management of information following both large-scale and small-scale disasters in Latin America and the Caribbean.

Case Details	Resilience Identified/implied	Problems/Vulnerabilities	Lessons Learnt & Good Practices
CASE 96 Linking the private and public sectors on hazard mitigation projects that benefited communities by reducing disaster vulnerability to the community and to participating businesses **Hazard(s):** Various types, esp. Hurricane **Source(s):** UNISDR. (2008). **Private Sector Activities in Disaster Risk Reduction: Good Practices and Lessons Learned**. Retrieved at http://www.unisdr.org/2006/ppew/PPP-bestpractices.pdf	• Awareness raising • Public-private partnership	• **Central America and the Caribbean** (hurricanes Georges and Mitch, 1998, Haiti, Dominican Republic, Guatemala, El Salvador, Honduras, and Nicaragua) • The major goal of the project was to reduce future disaster damages in 25 communities in six Caribbean and Central American countries. • A major objective was to involve the private sector and encourage it to match the seed money provided (USD 250,000 per country). • Another objective was to promote awareness of hazards and actions that local government, citizens, and business could take to reduce the impact from future disaster losses.	• The private sector will get involved if it is clear that results will benefit them. • Local leaders, who are supportive, can motivate others to participate.
CASE 97 Knowledge Network in Central Asia **Hazard(s):** Various Types **Source(s):** UNISDR. Disaster Risk Reduction 20 Examples of Good Practice from Central Asia. Retrieved at http://www.unisdr.org/files/2300_20GoodExamplesofGoodPractice.pdf		**JOINT EFFORT: Tajikistan, Kazakhstan, Kyrgyzstan** (UN/ISDR & European Commission's Humanitarian Aid and Civil Protection Department's project) • During the Soviet times, experts from the different states used to meet on a regular basis. These meetings contributed substantially to the quality of research and development of knowledge. There still exists tremendous knowledge of disaster risk reduction in the region. However, due in part to a limited exchange during the past 15 years, this knowledge is not fully utilized.	**KNOWLEDGE NETWORK IN CENTRAL ASIA** • Disaster Risk Reduction should become part of all development strategies, including formal educational curricula, National Development Strategies (NDS) and Poverty Reduction Strategies (PRS). • Regarding investment projects, sustainability is evidenced by true government ownership and should not depend ultimately on external funding. • Every partner must have a voice at the negotiation table, especially in partnerships between the government, civil society, and private sector. • It is important to ensure stakeholders' early involvement in environmental and social assessment prior to launching projects. • Government and non-government organizations should cooperate to develop national disaster risk reduction strategies, since the perspectives of the various stakeholders will differ significantly, and those whose perspective is missing may not be able to cooperate in implementation of the strategy. • Disaster management agencies can enhance cooperation in risk reduction by disseminating basic information about the most likely hazards affecting a district or community.

Case Details	Resilience Identified/implied	Problems/Vulnerabilities	Lessons Learnt & Good Practices
			• Understanding of building standards and codes aimed at protecting important infrastructure and other private and public assets against seismic hazards.
CASE 98 Indian Ocean Earthquake and Tsunami **Hazard(s):** Tsunami **Year(s) of event:** 2004 **Source(s):** https://en.wikipedia.org/wiki/2004_Indian_Ocean_earthquake_and_tsunami https://www.dosomething.org/facts/11-facts-about-2004-indian-ocean-tsunami http://www.bbc.com/news/world-asia-30034501	• International cooperation for disaster management • International surveillance and early warning • Recovery process • Effective relief distribution	• According to the U.S. Geological Survey a total of 227,898 people died. Measured in lives lost, this is one of the ten worst earthquakes in recorded history, as well as the single worst tsunami in history. Indonesia was the worst affected area, with most death toll estimates at around 170,000. • The tsunami caused serious damage and deaths as far as the east coast of Africa. • Relief agencies reported that one-third of the dead appeared to be children. This was a result of the high proportion of children in the populations of many of the affected regions and because children were the least able to resist being overcome by the surging waters. • Oxfam went on to report that as many as four times more women than men were killed in some regions because they were waiting on the beach for the fishermen to return and looking after their children in the houses. • In addition to the large number of local residents, up to 9,000 foreign tourists (mostly Europeans) enjoying the peak holiday travel season were among the dead or missing, especially people from the Nordic countries. • Then-UN Secretary-General Kofi Annan stated that reconstruction would probably take between five and ten years. Governments and non-governmental organisations feared that the final death toll might double as a result of diseases, prompting a massive humanitarian response. In the end, this fear did not materialise. • Many health professionals and aid workers have reported widespread psychological trauma associated with the tsunami.	• Children, women, tourists were among the vulnerable.
CASE 99 Hurricane Jeanne (Puerto Rico, Haiti, Dominican Republic, and USA [Floria/ Bahamas])	• Preparedness: early warning • International disaster management • Lifeline facilities: water, shelters, electricity	• In Puerto Rico, the excessive rainfall resulted in damage to roads, landslides, and collapsed bridges. This resulted in one death and the evacuation of 400 people near the Río Grande de Añasco.	

Case Details	Resilience Identified/implied	Problems/Vulnerabilities	Lessons Learnt & Good Practices
Hazard(s): Hurricane → Flood, mudslide **Year(s) of event:** 2004 **Source(s):** https://en.wikipedia.org/wiki/Hurricane_Jeanne https://en.wikipedia.org/wiki/2004_Atlantic_hurricane_season#Hurricane_Jeanne http://www.history.com/this-day-in-history/hurricane-jeanne-crashes-into-haiti http://www.sun-sentinel.com/news/sfl-2004-jeanne-story.html		• In Haiti, heavy rains totaling about 13 inches (330 mm) in the northern mountains of Haiti caused severe flooding and mudslides in the Artibonite region of the country, causing particular damage in the coastal city of Gonaives, where it affected about 80,000 of the city's 100,000 residents. The storm's destruction echoed a tragedy in May 2003 in which hundreds were killed after a dam burst near Haiti's border with the Dominican Republic. • In Dominican Republic, major flooding was reported, with rivers overflowing, bridges collapsing, roads cut off, damage to agriculture, and mudslides. Strong winds disrupted telephone services and caused power outages. Overall, hundreds of people became homeless and there was 23 deaths and $270 million in damage. • Due to the destruction and deaths in Hispaniola, Puerto Rico, the Bahamas, and the southeastern US, the name "Jeanne" was retired from the list of hurricane names maintained by the National Hurricane Center. The name was replaced with "Julia". Jeanne has the fourth highest death toll on the list of retired names.	

ANNEX 4
Score comparison: Average Method VS Weight Method

1. PINE score 2014 : Top 25, a comparison between average and weight methods

Rank	PINE score (Average Method)		PINE score (Weight Method)	
1	Switzerland	1.61	Switzerland	1.26
2	Finland	1.51	Finland	1.18
3	Norway	1.41	Australia	1.10
4	Australia	1.39	Norway	1.10
5	Netherlands	1.33	Netherlands	1.05
6	Sweden	1.31	Sweden	1.03
7	Luxembourg	1.25	Luxembourg	1.02
8	New Zealand	1.25	New Zealand	1.02
9	Japan	1.24	Singapore	0.96
10	Austria	1.23	Japan	0.94
11	Singapore	1.18	Austria	0.94
12	Denmark	1.17	Denmark	0.90
13	United Kingdom	1.12	United Kingdom	0.88
14	Ireland	1.09	Ireland	0.84
15	Iceland	1.08	Iceland	0.84
16	Czech Republic	1.02	Estonia	0.74
17	Estonia	1.01	Canada	0.72
18	Slovenia	1.01	Portugal	0.71
19	Canada	0.98	Belgium	0.71
20	France	0.95	Korea (Republic)	0.71
21	Belgium	0.94	Czech Republic	0.68
22	Portugal	0.93	France	0.67
23	Korea (Republic)	0.92	Germany	0.67
24	Germany	0.90	Malta	0.64
25	United States of America	0.85	Slovenia	0.64

2. PINE score 2014 : Bottom 25, a comparison between average and weight methods

Rank	PINE score (Average Method)		PINE score (Weight Method)	
165	Côte d'Ivoire	-0.86	Syria	-0.64
166	Central African	-0.88	Iraq	-0.64
167	Nepal	-0.90	Tanzania	-0.66
168	Ethiopia	-0.92	Guinea	-0.66
169	Angola	-0.93	Togo	-0.66
170	Togo	-0.95	Madagascar	-0.68
171	Tanzania	-0.95	Sierra Leone	-0.68
172	Liberia	-0.96	Mauritania	-0.68
173	Libya	-0.97	Angola	-0.69
174	Madagascar	-0.99	Nigeria	-0.69
175	Nigeria	-1.01	Guinea-Bissau	-0.70
176	Myanmar	-1.03	Burundi	-0.71
177	Guinea	-1.05	Libya	-0.72
178	Sierra Leone	-1.07	Equatorial Guinea	-0.72
179	Djibouti	-1.13	Mali	-0.72
180	Eritrea	-1.16	Myanmar	-0.74
181	Sudan	-1.16	Djibouti	-0.80
182	Haiti	-1.18	Haiti	-0.80
183	Congo DR	-1.20	Yemen	-0.87
184	Burundi	-1.20	Central African	-0.88
185	Afghanistan	-1.22	Chad	-0.89
186	Mali	-1.25	Eritrea	-0.92
187	Mauritania	-1.28	Sudan	-0.93
188	Yemen	-1.37	Afghanistan	-0.93
189	Chad	-1.40	Congo DR	-0.95